DESIGNS OF STUDY IN EMPIRICAL RESEARCH

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Place of empirical research in scientific method

ELSEWHERE[1] IT has been pointed out with illustration that scientific knowledge represents knowledge about the true reality (reality as it exists) and empirical knowledge stands for the empirical reality (reality as we perceive it). True reality and empirical reality are not co-terminous. Therefore empirical knowledge by itself does not enable us to know the true reality. But the use of the scientific method provides with a bridge between the empirical knowledge and true knowledge.

Thus empirical research is an integral part of the scientific method which combines reasoning with observation, and discovery with justification, for the acquisition of scientific knowledge. The search for the scientific knowledge usually starts with a scientific problem and the knowledge is the product of the process of understanding and solution of that problem. The solution of a problem is arrived at in two stages: First, a tentative solution of the problem is obtained through reasoning from the available knowledge, which is what is meant by discovery; second, the tentative solution is verified through observation, which is referred to as justification. Empirical research stands for the various procedures of obtaining, analysing and presenting data in the context of justification. It is useful for acquiring scientific knowledge only if it is undertaken as a complement to the theoretical exercise in scientific method.

Broadly speaking research design refers to the visualisation of the entire process of conducting empirical research before its commencement. It is possible to design a research project beforehand if the investigator is aware of the major stages and techniques in conducting research and of the purpose of the investigation. Although in its complete formulation every research design is unique, it resembles all other designs in the broad outline of conducting research. On the other hand research designs aimed at fulfilling different research purposes differ from one another in some of their salient features. An attempt is made here to present a skeletal description of the major types of research designs in terms of their salient common features as well as distinguishing characteristics.

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1. Victor S.D'Souza, "Use of Induction and Deduction in Research in Social Sciences: An Illustration", *supra* at 675-81.

Main steps in research design

The broad outline of the design of a research study may be spelt out in the following main steps:

(1) Formulation of the research problem.

(2) Decision about a suitable population for the study and setting down the sampling procedures.

(3) Devising tools and techniques for gathering data.

(4) Determination of the mode of administering the study.

(5) Setting the arrangements for the editing, coding and processing of data.

(6) Indicating the procedures and the statistical indices for the analysis of data.

(7) Deciding about the mode of presentation of the research report.

Every one of these steps of conducting research is a complex one and merits a separate discussion which is not attempted here. It must however be emphasised that several alternatives are possible at every step. Therefore the efficiency of a research design consists in selecting from among the several alternatives at every step, those procedures for the collection and analysis of data which are most economical as well as most relevant for the purpose of research.

In the preparation of the research design, the first step, namely, the formulation of the problem of research, is a crucial one because it is at this stage that the purpose of the research is classified and specified, which then suggests the suitable alternatives at the subsequent steps. This step is also the most creative aspect of the research endeavour, when the discovery of the tentative solution of the problem is made and the hypotheses are deduced. In the formulation of the problem the investigator has to take advantage of the relevant theory and available literature.

Types of research purposes

Researches are undertaken for various purposes. Insofar as the purposes of research influence the design of study, they may be subsumed under the following four broad categories:

(1) To gain familiarity with a phenomenon with a view to formulate the problem precisely.

(2) To describe accurately a given phenomenon and to test hypotheses about relationships among its different dimensions.

(3) To test hypotheses about causal relationships between variables.

(4) To study changes along with their causes, taking place in a given population.

The research designs which are appropriate for the first, second, third and the fourth purposes set down above may be termed exploratory (or formulative), descriptive, experimental (or explanatory) and panel studies respectively. Some of the distinctive features of these research designs may now be considered.

Exploratory or formulative study

Every research study is built on the existing stock of our knowledge. The formulation of the problem, spelling out the objectives of the study and the derivation of hypotheses—all depend upon the existence of adequate knowledge. But occasionally one is confronted with a problem in a hitherto uncharted area without sufficient knowledge to begin with. In such a situation the investigator himself has to grope for new knowledge even to formulate his problem adequately.

It may be recalled that the proper designing of the various stages of conducting research is contingent upon a clearcut formulation of the problem. But in this case, for want of such an exercise, the other steps of conducting the study cannot be properly charted. Consequently the researcher is obliged to explore the different possibilities to the best of his ability, drawing liberally upon his own ingenuity. Hence the title—exploratory study—given to such a research design. It is also called formulative study because its main purpose itself is to formulate the problem more clearly.

Research procedures in general have to be reliable, accurate and systematic. But in the case of an exploratory study the investigator is not bound down by such conditions, his main purposes being to gain insight into the problem and to arrive at some hypotheses somehow.

Even though it is not possible to lay down clearcut procedures, the investigator may follow some general guidelines in carrying out his exploratory study, for instance, a review of the related social science and other pertinent literature might give some clues for guiding the direction of his inquiry. He can benefit from the discussion of his problem with some of the persons who have practical experience in the given area. Analysis of some of the cases from the relevant population, which are strikingly different from one another, is useful for stimulating his insights. The study has to be pursued until the investigator comes up with a reasonably satisfactory solution of the problem.

By the very nature of the study, the results of the exploratory study are not finished products. Further research based on more rigorously designed studies is needed to confirm them.

Descriptive studies

Much of the empirical research conducted follows the design of descriptive studies. The descriptive study is aimed at measuring the different aspects of a phenomenon or the characteristics of a population, accurately. The systematic collection of the existing information from a set of people is known as a survey. Therefore the survey or sociol survey is another name for the descriptive study. It is mainly a fact-finding study.

Since the information from a descriptive study is aimed at an accurate description of the various characteristics of a population or examining the relationships among the different characteristics or variables, every step in this research design has to be very carefully worked out. In the formulation

of the problem the objectives of the study and the different dimensions of the phenomenon to be described, should be clearly indicated and defined. The variables involved should be operationalised so that their measurement becomes practicable.

Utmost attention should be paid to the demarcation of the universe or the population and the procedures for the selection of the sample. Since it is possible to obtain the information about the characteristics of a population by studying a section of the population, in most studies it is only a section which is taken up for investigation and not the whole of the population. But there are important conditions to be satisfied. First of all the section must be representative of the total population. A representative section of the population is known as a sample. Second, the sample must be chosen randomly. It is only from the study of a random sample that it is possible to estimate the characteristics of a population from the measures of the characteristics of its sample. Since the descriptive studies are mostly based on samples they are also called sample surveys or cross-sectional surveys. When a descriptive study embraces the total population it is called a census.

The tools of data collection should be objective, precise and systematic so that different researchers collecting information from the same persons should arrive at the same results. As far as possible the information should be such that it is amenable to quantification. Preparation of scales and indices come in handy for this purpose.

In many descriptive studies involving large samples, teams of research workers need to be engaged. In such eventualities thought has to be given to the specification of the types and number of personnel, to their training and to matters pertaining to supervision and coordination. Unless the work is strictly supervised, the involvement of a large staff is likely to result in a proliferation of errors.

Accuracy and reliability are needed not only at the time of collection of data but more so at the stage of their processing. Conditions vary depending upon whether the processing is done manually or mechanically.

Statistical techniques and indices are often used for the analysis of data. In the case of sample surveys statistical inference is also necessary for estimating the characteristics of the population from those of the sample.

The mode of presentation of the results and writing of the report depends upon the audience in view. Among other matters attention has to be paid to the language, style and the length of the presentation.

In the descriptive study design every step can be visualised before launching the empirical investigation. Therefore it is possible to work out in advance the approximate outlay on the research project.

Experimental or explanatory studies

Scientific knowledge is aimed at answering three kinds of questions: What is it, how is it, and why is it? The answer to the question "why"

is actually the explanation of the phenomenon in question, and represents the most refined form of knowledge. The descriptive study design is aimed at answering the question, "what is it". It describes a given state of affairs. The explanatory knowledge, however, is usually formulated in a theoretical model in a set of deductively related propositions. But the validation of such a model depends upon testing hypotheses deduced from it. Hypotheses of this kind affirm cause and effect relationship between two variables, which represents the answer to the question, "how is it".

Therefore the testing of causal hypotheses is very important for the advancement of scientific knowledge. However the testing of causal hypotheses is a complex matter. At least three different kinds of evidence are needed to confirm that the given independent variable (the cause) produces the given dependent variable (the effect). First of all there are several independent variables which produce their effect on a given dependent variable. Therefore in order to test the effect of a given independent variable it is necessary to hold constant the effect of the other independent variable and to isolate the effect of the given variable. Second, it is necessary to show that the change in the given dependent variable did not take place before the change in the given independent variable, for, the cause ought to precede or be simultaneous with the effect but it should not succeed the effect. Third, of course, it is necessary to show that the change in the given independent variable has actually produced change in the given dependent variable; the greater the change in the independent variable the greater the change in the dependent variable.

The above three kinds of evidence may be summarised as follows:

(1) Ruling out the effect of other causal variables.

(2) Causal time sequence between the changes in the independent and the dependent variables.

(3) Concomitant variation between the independent and the dependent variables.

A descriptive study which is designed to make observation about the reality as it exists can at best provide evidence about concomitant variation. To procure the other two kinds of evidence, one has to make observation under controlled conditions. The procedures of making observation under controlled conditions constitute the experiment. The chief requirement of an experiment is to induce change in the given independent variable while holding constant the effect of the other independent variable.

There are different ways of conducting experiments. In the physical and natural sciences use of laboratories is made extensively for experimentation. But laboratory experiments for studying human behaviour are ruled out in most cases for obvious reasons. However the use of laboratories is not a necessary condition for experimentation. What is important is the logic of making observation under controlled conditions. Utilising this logic, the social scientists have devised, among other methods, an experimental

mechanism of using two groups of subjects, one termed the experimental group and the other, control group.

The subjects in the experimental and the control groups are so chosen that the two groups are similar, if not identical, with regard to the given independent and dependent variables as well as with regard to the various other variables which also exert their causal effect upon the given dependent variable. Observations and measurements are made at two points of time. First, before the change is induced in the independent variable, the given independent and dependent variables are measured in both the groups. Then change is induced in the given independent variable only in the experimental group. After allowing sufficient time for the impact of the change to be felt on the given dependent variable, the given independent and dependent variables are measured in both the groups for the second time.

According to the causal hypotheses it is expected that at the second point of time there would be greater change in both the given independent and the dependent variables in the experimental group as compared with their counterparts in the control group. Existence of such a difference would confirm the hypothesis.

It can be readily seen that the above experimental design is capable of generating simultaneously all the three kinds of evidence which are required for testing a causal hypothesis. The evidence ruling out the effect of other independent variables is secured by equating these variables in both the experimental and the control groups, so that whatever effect they produce on the given dependent variable would be of the same order in both the groups. The evidence that the change in the dependent variable did not take place before the change in the given independent variable is ensured by measuring the variables twice—once before inducing the change in the independent variable and a second time after the inducement. The evidence about concomitant variation is obtained by comparing the relationship between the two variables in the two different settings of the experimental and the control groups before and after the inducement of change in the given independent variable in the experimental group.

The experimental design of study poses special problems of equating the experimental and the control groups with regard to the variables to be controlled and of inducing change in the given independent variable, of which the investigator must be aware. As for securing control of the variables in the two groups there are different techniques such as randomisation, equated frequency distribution and precision control or control by identical individual pair matching. The investigator should be able to judge as to which one or more of these techniques are appropriate for his study.

Although to start with the units of study in the experimental study are drawn so as to be representative of their population, the process of equating the experimental and the control groups, invariably renders them non-

representative of the population. However the representative character of the units studied is not essential when the purpose is to test the causal relationship between variables. The success of the experimental design depends upon the similarity of the two groups before changing the experimental variable. But one should not commit the mistake of using the experimental and the control groups for estimating the characteristics of the population.

The experimental design differs from the descriptive study design, among other respects, in two important ways inasmuch as the groups studied need not be representative of their population and the variables under investigation are manipulated. Therefore the term sample survey is not applied to the experimental study.

It has been pointed out that there are different ways of designing an experimental study subject to the adherence of the same logic of experiment. Even as regards the particular experimental mechanism described above there are various adaptations and modifications possible. For instance, although ordinarily observations are made twice in an experimental study—once before the change is introduced in the experimental variable, and a second time after the inducement of change—sometimes the study is conduced after the change in the experimental variable has already taken place; but in the latter case the information about the earlier point of time is obtained from the existing records. The experimental study which is designed before the change in the experimental variable is termed the projected experimental design or "before and after" study, while the other type is named ex-post facto experimental design or "after only" study.

Panel study

Very often, especially in applied research, it becomes necessary to study changes in the characteristics of a population as a result of certain causes. Neither the descriptive nor the experimental design of study enables us to gauge such changes with their causal basis. It may be possible to study trends of aggregate change through sample surveys (descriptive studies) conducted at different points of time. But such studies hide the changes taking place in a characteristic in opposite directions and hence they do not reveal the real change. Moreover they cannot indicate the causes of change. On the other hand, whereas the experimental studies can indicate the causes of change they cannot give an estimate of the change in the characteristics of the population.

The requirements of studying changes in the characteristics of a population, with their causal basis, are met to some extent by the panel study. The panel method involves recruiting a sample of individuals representing the universe or population to be studied, and interviewing them at two or more different points of time, on the problems under consideration. The same group of individuals which is studied at different points of time is called the panel.

The panel study resembles the sample survey insofar as the panel is also a representative sample of the population, but it is different from sample surveys conducted at different points of time as in these studies, unlike the panel study, fresh samples are selected at every point of time. The panel study also resembles the experimental study insofar as the same group is studied more than once, but unlike the experimental study it does not resort to the controlling of the variables.

In the panel study the core questions of the inquiry are repeated at every interview, but at every time new questions are also added. Since it is the same group of individuals which is studied at two or more points of time, at any subsequent point of time it is possible to identify the individuals who have changed and also to find out the reasons for their change. Thus the panel study enables us to measure the real change as well as to assertain the causes. Since the panel is representative of the population, from the results of the panel study one can estimate the change in the characteristics of the population.

It may however be pointed out that the cause and effect relationship established in the case of the panel study is not a conclusive one as this design does not provide for the control of the variables. The panel study in this respect becomes particularly vulnerable to intervening events which may also affect the dependent variable. In such an eventuality it would be difficult to estimate the change due to the given independent variable and that due to the intervening event. Therefore the panel study becomes efficient if the subsequent waves of inquiry are conducted at short intervals so that the chances of some other independent variables intervening in the study are minimised.

Similarly though the panel is a representative group like the sample in a descriptive study, it may lose its representative character with the passage of time for various reasons such as the non-availability of some of the members of the panel at subsequent rounds of the study, the panel members becoming atypical of the population because of their having been exposed to some stimulus of the study and so on. There are however ways and means of overcoming such difficulties occasionally encountered in the panel studies.

Conclusion

It may thus be seen that whereas empirical research stands for observation, to be fruitful it should be made an integral part of the scientific method which combines reasoning with observation. The formulation of the research problem which belongs mainly to the realm of reasoning is the linchpin of the research design of the empirical study, for the various other aspects of the design revolve around it.

Research designs vary according to the purposes of the studies. Therefore it is not easy nor advisable to combine different research purposes

within the same research design. However every type of research design, while it serves a specific purpose, has its own limitations. Therefore the findings of any scientific study are never perfect and there is always room for improvement.