Statistical Methods in Research

Dr. P.K. Gupta*

Abstract

Statistics is the science of collecting, analyzing and making inference from data. Statistics is a particularly useful branch of mathematics that is not only studied theoretically by advanced mathematicians but one that is used by researchers in many fields to organize, analyze, and summarize data. Statistical methods and analyses are often used to communicate research findings and to support hypotheses and give credibility to research methodology and conclusions. It is important for researchers and also consumers of research to understand statistics so that they can be informed, evaluate the credibility and usefulness of information, and make appropriate decisions. The present paper dealt with the use of Statistics in Research

Key Words : Statistical Methods, Research, Population, Sampling, Research Design.

Introduction:

Quality of a nation depends upon the quality of its citizen. That quality of citizens depends upon the quality of their education. The quality of their education depends than any other single factor upon the quality of their higher education. The quality of their higher education depends upon the quality of their research. The quality of their research depends upon the quality of a good statistical method.

Research commonly refers to a search for knowledge. It always begins with a question for a problem. Its main purpose is to find answer to question through the application of systematic & scientific methods. These scientific methods are the statistical methods. Thus research is a systematic approach towards purposeful investigation. These methods are widely used in all disciplines.

"Research is a systematized effort to gain new knowledge." **Redmon & Mary**

"Research is a careful inquiry or examination to discover new information or relationships and to expand and to verify existing knowledge" **Francis Rummel**

"Research is essentially an investigation a recording or analysis of evidence for the purpose of gaining knowledge" **Robert Ross**

Thus, research at every step involves the use of statistical methods.

Characteristics of Research:

1. Controlled: - The concept of control implies that, in exploring causality in relation to two variables, researcher set up his study in a way that minimizes the effects of other factors affecting the relationship. This can be achieved to a large extent in the physical sciences, as most of the research is done in a laboratory.

2. Careful:- The researcher must be scrupulous in ensuring that the procedures followed to find answers to questions are relevant, appropriate & justified.

3. Systematic: - This implies that the procedures adopted to undertake an investigation follow a certain logical sequence.

* Associate Professor, Department of Statistics, D.A.V. (P.G.) College, Muzaffarnagar (UP)

4. Valid & Verifiable: - This concept implies that whatever the researcher concludes on the basic of his findings is correct & can be verified by him & others.

5. Empirical: - This means that any conclusions drawn are based upon hard evidence gathered from information collected from real-life experiences.

6. Critical: - Critical scrutiny of the procedures used and the methods employed is crucial to a research inquiry.

The process of investigation must be foolproof & free from any drawbacks. The process adopted & the procedures used must be able to withstand critical study, this can only be possible with the use of appropriate use of statistical methods.

Objectives of Research:

1. Categorization: - It involves forming a typology of objects, events or concepts. This can be useful in explaining what 'Things' belong together & how. One of the main problems is to decide on the most useful methods of categorization, depending on the reasons for attempting the categorization in the first place.

2. Explanation: - There are many events & issues which we don't fully or even partly, understand. The objective of providing an explanation of particular phenomena has been a common one in many forms of research.

3. Prediction: - On the basis of an explanation of a phenomenon it is often possible to make a prediction of future events related to it.

4. Sense of Understanding: - whilst explanation & prediction can reveal the inner workings of phenomena's, i.e., what happens & when, they don't always provide a sense of understanding of phenomena- how or why they happen. A complete study of phenomenon will require a wider study of the processes which surround the phenomenon & influence it or cause it to happen.

5. Control: - A good level of understanding of a phenomenon might lead to the possibility of finding a way to control it.

6. Evaluation: - It is making judgments about the quality of objects or events. Quality can be measured either in an absolute sense or on a comparative basis.

All these objectives of research can be achieved by using the appropriate method of research.

Process of Research and use of statistical method:

Research process consists of a number of closely related activities. These activities can be performed in logical and systematic method by the use of well selected statistical method. But such activities overlap continuously & don't follow a strictly prescribed sequence.

1. Formulating the research problem.

2. Extensive literature survey.

3. Developing the hypothesis.

4. Preparing the research design.

5. Determining sample design.

6. Collecting the data.

7. Execution of the project.

8. Analysis of data.

9. Hypothesis testing.

10. Generalizations & Interpretation, and

11. Preparation of the report or presentation of the results, i.e., formal write-up of conclusion reached.

1. Formulating the Research Problem: - The first step in research is formulating a research problem. It is rightly said that: "a problem well defined is half-solved".

Essentially two steps are involved in formulating the research problem

(i) Understanding the problem thoroughly

(ii) Rephrasing the same into meaningful terms from an analytical point of view.

2. Extensive Literature Survey: - Once the problem is formulated, the next step is to down a brief summary. For this the researcher should understand extensive literature survey connected with the problem. It is compulsory for a research work writing a thesis for a Ph.D. Degree to write a synopsis of the topic & submit it to the necessary committee of the research for approval.

3. Development of Working Hypotheses: - Now the researcher should state in clear terms the working hypothesis. It is tentative assumption made in order to draw out & test its logical or empirical consequences. The role of the hypothesis is to guide the researcher by delimiting the area of research & keep him on the right track.

4. Preparing the Research Design: - Research design is the conceptual structure within which research should be conducted. It specifies the statistical methods & procedures for conducting a particular study. The function of research design is to provide for the collection of relevant evidence with minimal expenditure of effort, time & money.

(i) Exploratory Research: - It focuses on the discovery of ideas & based on the secondary data. **(ii) Descriptive Research: -** It is undertaken when the researcher wants to know the characteristics of certain groups such as age, educational level, income, occupation etc.

(iii) Casual Research: - It is undertaken when the researcher is interested in knowing the cause & effect relationship beetween/within variables.

5. Determining Sample Design:- All the items under consideration in any field of inquiry constitute a 'Universe' or 'Population'. This type of inquiry involves a great deal of time, money & energy. Researcher must decide the way of selecting a "sample" or the sample design. A sample design is a definite plan determined before any data are actually collected for obtaining a sample from a given population.

(i) Planned sampling: - when population elements are selected for inclusion in the sampling based on the simplicity of access.

(ii) Simple Random Sampling:- It is also known as chance sampling or probability sampling where each & every item in the population has an equal chance of inclusion in the sample & each one of the possible samples, in case of finite universe, has the same probability of being selected.

(iii) Systematic Sampling: - Where an element of randomness is introduced by using random numbers to pick up with which to start. This procedure is useful when sampling frame is available in the form of a list.

(iv) Stratified Sampling: - In this technique, the population is stratified into a numbers of non-overlapping sub-populations or strata & sample items are selected from each stratum.
(v) Quota Sampling: - In stratified sampling the cost of taking random samples from individual strata is often so expensive that interviewers are simply given quota to be filled from different strata, the actual selection of items for sample being left to the interviewer's judgment. This is called Quota sampling.

(vi) Cluster Sampling & Area Sampling: - Cluster sampling involves grouping the population & then selecting the groups in the sample. Area sampling is especially helpful to make the field interviewing more Efficient since interviewer can do many interviews at each location.

(vii) Multi-Stage sampling: - This technique is meant for big inquiries extending to considerably large geographical area like an entire country.

(viii) Sequential Sampling: - This design is usually adopted under acceptance sampling plan in the context of statistic quality control.

Thus we can say that to have more correct results and thereby drawing more correct inferences the sample can be taken with the use of statistical methods.

(6.) Collecting the Data: - The researcher has to decide whether he has to collect primary data or secondary data, because sometimes, it is based on both data.

The two methods are available for collecting the data they are

(i) Observation: - This method implies the collection of information by way of investigator's own observation, without interviewing the respondents.

(ii) Survey: - In most of the decision making and marketing research, field surveys are commonly used to collect primary data from the respondents. It can be:

(a) Through Personal Interviews.

(b) Through Telephone Interviews.

(c) By Mailing of Questionnaires.

(d) By Rating scales.

(7.) Execution of the Project: - The researcher should see that the project is executed in a systematic manner & in time.

(8.) Analysis of Data: - The analysis of data requires a number of closely related operations such as Statistical inferences. This step involves appropriate statistical methods to analyze the data collected, so that the inferences are more accurate and can be generalized. The widely use methods are mean, median, mode, Standard Deviation, 't' –test, F-test, One way & Two way ANOVA etc. Thus analysis of data means widely used statistical methods in research.

(9.) Hypothesis Testing: - The researcher has to test the hypotheses, various statistical methods, such as chi-square test, t-test, F-test have been developed by statisticians for the purpose of testing the hypotheses formulated.

(10.) **Generalization & Interpretation: -** If a hypothesis is tested & upheld several times, it may possible for the researcher to arrive at generalization. If the researcher had no hypothesis to start with, he might seek to explain his findings on the basis of some theory, i.e. interpretations.

(11.) Preparation of the Report: - At the end of the report, appendices should be enlisted in respect of all technical data. Establishment of categories, the application of these categories to raw data through coding, tabulation & then drawing conclusion.

Collection of Data:

The data can be collected in two widely used methods:

(1) Census Method

(2) Sample Survey Method

1. Census Method: - If detail information regarding every individual person or item of a given universe is collected, then the enquiry will be complete enumerations. It is also called the Census. For exp, during the census of population, information in respect of each individual person residing in India is collected this method gives information from each & every unit of the population with greater accuracy.

2. Sample Survey Method: - If proposed investigation is done only on a part taken out of universe, then it will be known as sample survey, this part of the universe is known as sample.

Sampling:

Sampling may be defined as the selection of some part of an aggregate or totality on the basis of which a judgment or inference about the aggregate or totality is made. It is the process of obtaining information about an entire population by examining only a part of it.

Sample Design:

In the theory of finite population sampling, a sampling design specifies for every possible sample its probability of being drawn. Mathematically, a sampling design is denoted by the function P(S) which gives the probability of drawing a sample S. P(S) is give by,

P(S)=qNsample(S) * (1-q) {(Npop-Nsample(S)}

Where,

q = Probability of being included in the sample for each element.

Nsample(S) = Total no. of elements in the sample S.

Npop = Total no. elements in the population (before sampling commenced).

Sampling Procedure:

1. Define the universe: - The Universe has two types

(i) Finite Universe: - where number of items is certain.

(ii) Infinite Universe: - where number of items are uncertain.

2. Specify the Sampling Unit: - A decision has to be taken concerning a sampling unit before selecting sampling. For example, Sampling unit may be geographical one such as state, district, city etc. or a construction unit such as house, flat etc.

3. Identify the Sampling Frame: - It is also known as the source list from which sample is to be drawn. It contains the names of all items of a universe.

4. Specify the Sampling Method: - The sampling methods indicate how the sample units are selected.

5. Determine the Sample Size (n):- The decision about the number of elements to be chosen i.e. no. of observations in each sample (n) of the target population.

6. Select the Sample: - It is the final step in the sampling Process to select the suitable sample.

Thus we can say that generalization of results can be more accurate when the sample is more representative, and the representative sample can be chosen by the use of appropriate statistical methods.

Conclusion: - The purpose of the statistical method is to provide an overview of the research design of the study. Design of study means to choose a most suitable technique to solve the problem under investigation. No doubt, the nature of the study determines the most appropriate statistical methods to be used by investigator to achieve the goal but wrong selection of technique may prove the study unscientific so this is very crucial step in the field of research. In this regard we can say a good research can only be possible by the use of appropriate statistical methods at every step of the research. Methods of collecting, summarizing, analyzing, and interpreting variable numerical data in research are all involves statistical methods and techniques. Statistical methods can be contrasted with deterministic methods, which are appropriate where observations are exactly reproducible or are assumed to be so. While statistical methods are widely used in the life sciences, in economics, and in agricultural science, they also have an important role in the physical sciences in the study of measurement errors, of random phenomena such as radioactivity or meteorological events, and in obtaining approximate results where deterministic solutions are hard to apply.

References:

1. Harris, I.C.W., 'Encyclopaedia of Educational Research', The Macmillan Co. New York
2. Best, John W. (1977), '*Research in Education'* Indian reprint, New Delhi, Prentice Hall of India Pvt. Ltd.
3. Grrett, H. E. (2005). *Statistics in Psychology and Education*. New Delhi: Paragon International Publisher.
4. Koul, L. (2002). *Methodology of Educational Research*. New Delhi: Vikas Publishing House.
5. Sharma, R.A. (2002), '*Advanced Statistics in Education and Psychology'* R. Lall Book Depot, Meerut.
6. Saxena, N.R., Mishra, B.K., & Mohanty, R.K., '*Fundamentals of Educational Research'* R. Lall Book Depot, Meerut.