

DATA INTERPRETATION AND REPORT WRITING

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Introduction

THE MAJOR purpose of scientific research is to establish causal laws in order to explain and predict the phenomena under investigation. Establishment of such laws is not an easy task as it requires, at a minimum, reliable and valid facts or data. To obtain reliable and valid facts or data it is mandatory to follow explicit rules to determine the degree of relative truth of any item of information. Ascertaining the exact nature of a fact and deciding just what determines whether a bit of information is a fact are extremely complex problems.¹

Social scientists as also the members of legal profession are daily confronted with numerous facts. The proceedings in courts more often than not revolve around questions of fact. Battles in courts are won on the basis as to which party is able to establish its claims regarding facts under discussion. Lawyers question each other about facts and sometimes it becomes difficult for the judges to determine the reality. In social sciences too, establishing a fact is an important goal of research, though determining what is a fact again is not easy. Since social facts are complex and intermixed with so many other factors, their identification, isolation and interpretation becomes a pretty difficult task. It requires a great deal of sustained and determined effort and also knowledge of the particular field to establish facts.

Before we discuss the processes involved in interpreting data or facts, let us first know what is a fact.² A fact is a reliable and valid piece of information.³ According to William J. Goode and Paul K. Hatt, “[a] fact is regarded as an *empirically verifiable observation*.”⁴ A fact could

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1. Sanford Labovitz and Robert Hagedorn, *Introduction to Social Research* 1 (McGraw-Hill Book Company, Inc., New York, 1976).

2. We are using the word “fact” instead of “data” as the former is a more generalised concept. Data refers to more concrete and empirical observations.

3. *Supra* note 1 at 2.

4. *Methods in Social Research* 8 (McGraw-Hill Book Company, Inc., New York, 1952).

be a behaviour (e.g., the members of a bar association voted for electing a president), an attitude (e.g., lawyers are opposed to curtailment of freedom), a law (e.g., a government servant cannot keep two wives) or even a statistic⁵ (e.g., the rate of population growth in India is 22 per thousand). It is important for a fact that its repeated observations should yield similar results. This is termed as the reliability criterion of a fact. Secondly, observations of a fact should actually yield measures of what they are supposed to measure. This is termed as the validity criterion. Further, a theory is not a fact; a hypothesis is not a fact either. Nor is the fact a proposed relationship or condition. "A fact is a well documented item of information."⁶

The basic theme of scientific research or investigation is, what is the basis for accepting or rejecting something as a fact? This aspect is crucial to decision and policy making in business and government as also in pronouncing judgments in the court.

Nature of Evidence

How are facts established? As Labovitz and Hagedorn observe, there are three common bases for establishing facts: (1) Authority (e.g., teacher, parent or expert says it is so, and you accept it); (2) intuition;⁷ (e.g., you just know it is so, such as when you believe in the existence of a god or believe in the superiority of a particular approach to raising children); and (3) logic (e.g., it follows according to specified rules).⁸ But these methods, as should be clear to readers, can lead us to false conclusions. Scientists have, therefore, developed their own criteria for establishing facts which are labelled as the scientific methods.

The scientist systematically collects data, undertakes tests for their internal consistency and subjects them to empirical examination. Only then he pronounces a statement or a relation as a fact. In other words, scientific information is based on reliable and valid observation. A scientist does not believe in giving metaphysical explanations which are propositions that cannot be tested. To say, for example, that people are poor because God wills it, or that punishment is essential for character building in children, or that reading difficult subjects improves intelligence, is to talk metaphysically. Science as such is not concerned with them. This does not mean that a scientist would necessarily spurn such statements, rule them out of life, say they are not true, or claim them as

5. The word "statistic" refers to data. The two are used interchangeably.

6. *Supra* note 2 at 2.

7. Fred N. Kerlinger refers to this method as a *a priori* method. See his *Foundation of Behavioral Research* 7 (Holt, Rinehart and Winston, New York, 1964).

8. *Supra* note 2 at 2.

meaningless. It simply means that as a scientist he is not concerned with them. In short, scientific investigation is concerned with things or facts that can be publicly observed and tested. If propositions or questions do not contain implications for such public observation and testing, they are not scientific questions.⁹

Interpretation of Data

Interpretation of data is a very important step in any scientific investigation. Before data can be analysed and interpreted it has to be collected and presented in a manageable form. The researcher then breaks down the data into constituent parts in order to obtain answers to research questions hypothesised in terms of relations concerning phenomena. The analysis of research data, however, does not by itself provide the answers to research questions. As Kerlinger observes: "Interpretation of the data is still necessary. To interpret is to explain, to find meaning. In most cases it is difficult or impossible to explain raw data: one must first analyse the data and then interpret the results of the analysis."¹⁰

Before discussing interpretation of data it would be pertinent to have some idea about the analysis of data. "Analysis is the ordering, the breaking down of data into constituent parts in order to obtain answers to research questions."¹¹ According to Selltiz and others, "[i]t is the purpose of analysis to summarize the completed observations in such a manner that they yield answers to the research questions."¹²

Taking an example from judicial arena, suppose a researcher hypothesises a relation between unemployment and crime, he collects relevant data from records and reports and, then he must so order, break down and manipulate the data that he can obtain an answer to the question: Does the rise in unemployment rate increase the rate of crime? Actually, ordering and breaking down the data should be planned very early in the research, *i.e.*, when definitions and hypotheses are being worked about the problem or phenomenon. Once this is done, then in the actual analysis phase of the research, only mechanical analytic manipulations are required.

The process of analysis may not be difficult, but it requires on the part of the researcher a familiarity and background of the problem

9. *Supra* note 7 at 6.

10. *Id.* at 603.

11. *Ibid.*

12. Claire Selltiz, Marie Jahoda, Morton Deutsch and Stuart W. Cook, *Research Methods in Social Relations* 386 (Revised one-volume ed. Holt, Rinehart and Winston, New York, 1964).

through all the stages it has passed, which he alone is likely to possess. These final stages of investigation are least easy to discuss in general terms. According to C.A. Moser, "[n]o two surveys are alike in their problems of analysis and interpretation and the only rules one can lay down with any confidence are those of statistical methodology; these, however, are the province of statistical text books."¹³

Analysis of data with the help of statistical techniques can be done in most of the surveys which produce numerical data. In other cases, it can be described by the researcher only if he has sufficient background of the problem of inference or interpretation.

According to Kerlinger, "[i]nterpretation takes the results of analysis, makes inferences pertinent to the research relations studied, and draws conclusions about these relations. The researcher who interprets research results searches them for their meaning and implications."¹⁴ This is usually done in two ways. First, the relations within the research study and its data are interpreted. This is the more frequent use of the term "interpretation" but is narrower in scope. Here interpretation and analysis of data are closely interlinked. As Kerlinger observes, "[o]ne almost automatically interprets as one analyzes."¹⁵ If a researcher computes coefficient of correlation, he almost immediately infers the existence of a relationship between two variables and draws out its significance for the research problem as he orders, breaks down and manipulates the data. Second, the broader meaning of research data is also sought by comparing the results and inferences drawn within the data to theory and to results of other such investigations. As Selltitz and others observed, "[i]t is the purpose of interpretation to search for the broader meaning of these answers by linking them to other available knowledge."¹⁶ The researcher seeks the meaning and implications between his own research findings and conclusions and those of other researchers.

In judicial field also, the judges perform these two tasks. A judge while pronouncing a judgment in a particular case not only comments about the nuances and special circumstances of that case but also tries to generalise by linking it to the broader social and historical issues relating to that particular society. He may give suggestions that may have implications for conduct of social behaviour and as to how problems should be tackled on a macro level.

13. *Survey Methods in Social Investigation* 288 (The E.L.B.S. and Heinemann Educational Books Ltd., London, 1967).

14. *Supra* note 7 at 603.

15. *Ibid.*

16. *Supra* note 12.

Interpreting relationships

In any research endeavour, the purpose is to study relationships between variables affecting the phenomena. The study of relationship between two or more variables is straightforward so long as one is content merely to state the extent and direction of the association. The difficulties, however, arise when one tries to probe its meaning to make cause-effect inferences. Tables, charts and statistical techniques can help us depict a relationship between two variables, say, the incomes of lawyers (I) and the extent (measured by a suitable index) of their conservatism (C). One can use coefficient of correlation¹⁷ to explain this relationship. But what does this measure tell us? The coefficient tells us as to what extent the two variables move together—an increase or decrease in one being associated, on average, with an increase or decrease in the other; it tells us nothing about cause and effect.

In the above example, the problem is how to interpret the correlation between I and C. Suppose we find a positive correlation, does it mean that lawyers develop pro-conservative leanings as their incomes rise, perhaps because they come increasingly into contact with conservative-minded persons or because they get more and more satisfied with the *status quo*. One could also interpret by saying that being conservative helps lawyers get on in the world and thus lead to higher incomes. Which is the cause and which is the effect? It is quite possible that neither of these explanations may be true. The two may seem to be related because of their association with a third variable individually, say age (A). As the age of lawyers increases, they tend to be more conservative as also have higher earning capacity. In such a case, the correct explanation would be that I and C are related because each is influenced by A.

A statistical measure like correlation simply gives no clues regarding influence of A on I and C. It merely states that I and C are or are not correlated and, while researchers are perfectly entitled to their own interpretation as to cause and effect, it is quite fallacious to suppose that the coefficient of correlation itself is supporting evidence.

Interpreting cause and effect relationship

Since statistical analysis by itself is not sufficient enough to indicate the nature of relationship between the two variables, it becomes necessary for us to go deeper and study the factors that explain or affect the nature

17. The positive coefficient of correlation means that changes in one variable either increases or decrease in value are accompanied by an increase or decrease in the value of the other variable. A negative correlation indicates 'that increase in the value of one variable is accompanied by decrease in the value of other variable and *vice-versa*.

of causality. As Sanford Labovitz and Robert Hagedorn say, "[c]ause, in one way or another, is central to the goal of establishing scientific laws. In general terms, causation refers to the factors that make designated phenomena happen or change."¹⁸ We know, for example, tuberculosis is caused by tubercle bacillus and long periods of drinking may produce cirrhosis of the liver. In social sciences, the precise causes of events are not unequivocally established as there may be a number of factors affecting simultaneously a phenomenon. Some people may, for example, point out that lack of parental control is the cause of student indiscipline. In many cases it may be seen that college authorities may behave autocratically or some politicians and vested elements may, incite them for indulging in acts of indiscipline. Quite possibly all these factors may be acting simultaneously also. Student indiscipline appears to be an extremely complex phenomenon and is not caused exclusively by any one of the above mentioned factors.

When we try to interpret cause and effect relationship, three criteria need to be taken into account before drawing final conclusions. These are association, time priority and non-spurious relation.

Association—In scientific circles it is widely accepted that if two or more variables are not associated, one cannot be the cause of the other. For example, fatness cannot be said to be a cause of intelligence, nor is income a cause of height. These two sets of variables are assumed to be non-related, though in some isolated cases small statistical relation may exist between them.

Existence of association between two variables is necessary for establishing a causal relation. If someone were to say that high IQ and crime are related, but it is also found that people with low IQ also commit crime, obviously intelligence is not a cause of criminality.

Whenever we say that two variables are associated, two things have to be taken into account. The first is magnitude, that is, the extent or strength of the association. For example, the rate of lung cancer among smokers is estimated to be eleven times greater than among non-smokers. Although not a sufficient condition for establishing causation, the greater the magnitude of the association between smoking and lung cancer, with more confidence can one interpret that the relation is truly causal. In many cases, however, high magnitude alone may not be a sufficient condition for a causal interpretation. It may be observed that greater the number of policemen in a society, greater is the incidence of crime. The data may substantiate this relation but obviously the interpretation is wrong. If the population is increasing, the number of policemen will increase and so also crime. We cannot, therefore, say that the more the policemen, the higher the crime rate in society.

18. *Supra* note 1 at 3.

The second characteristic which helps the investigator in establishing association is consistency. If under several diverse conditions and from one study to another the relation persists, one can interpret with confidence the existence of the causal relation between the two variables. For example, one of the major arguments supporting the notion that lung cancer is caused by smoking is that the relation is maintained in study after study. The relation exists (1) in prospective studies (e.g., the smoking habit of people is studied to see who develops cancer) as well as in retrospective studies (e.g., old hospital records are checked); (2) in different localities, such as countries, regions within a country, and rural and urban areas; (3) in studies of rats as well as studies of people; (4) among different ethnic and racial groups; (5) among females as well as males; and (6) from one time period to another.¹⁹

The magnitude of an association should be treated as only one of the indications of causality. Consistency is also important. We test consistency in different situations so as to eliminate the possibility of other factors (variables) affecting the phenomenon.

Time priority—Another difficulty in establishing association relates to time sequence. To be able to establish causal relation, the independent variable must either occur first or change prior to dependent variable. We assume that independent variable is the causal factor that produces the effect on dependent variable. In the previous example, smoking is considered by many to be the independent variable that causes lung cancer (dependent variable). The time priority assumption is based on the commonsense notion that an event in future cannot determine an event in the past or present. It is the fire (independent variable) that causes smoke (dependent variable) and not *vice versa*; or proper training leads to success in legal profession.

In many instances, however, time priority is difficult to determine. Although technology and urbanisation are related (technologically advanced countries tend to be highly urbanised), it is far from established whether technology changes prior to changes in urbanisation, or *vice versa*.²⁰ Do individuals with high socio-economic status join community organisations (like Rotary, Lions or Giants) as a result of their status, or do they get high status from participating in their activities?

Logic helps us to some extent in establishing time priority sequence: A child can read a book only after he learns the alphabets and not *vice versa*. Logical arguments help us in setting up time priority effectively. Besides logic, one's observation, knowledge of theory and data analysis ability help in proper interpretation of time priority criteria in establishing causal relations.

19. *Id.* at 6.

20. *Id.* at 7.

Non-spurious relation—We interpret causal relation between two variables as non-spurious only after it is proved that no other variables affect it. As discussed earlier, relation between I and C can be maintained only if changes in I are accompanied by changes in C and no other factor like A affects this relationship.

Eliminating effects of other variables is a difficult proposition in social sciences and is possible only in experiments and through a process of “randomisation”. Otherwise effect of other variables may influence results and in such situations spuriousness of the relation cannot be assessed.

There are three rough guides for the researcher in interpreting that a relation is non-spurious. First, a time priority should be established regarding the third variable, because to explain a relationship a variable must occur prior in time to both independent variables. Second, theory may help determine the relevance of the control variables. Theory suggests which control variables may be relevant by indicating how they may affect the original relation. Finally, previous empirical research is an important guide to selection of variables (control) which affect the relation. Other research findings give some indication of how and to what extent the independent and dependent variables have been influenced by selected potential control variables.²¹

Concluding remarks

Interpretation of data, as we have discussed earlier, is easy when its nature is quantitative or statistical. It becomes difficult to interpret relations when data under analysis are qualitative. But whatever the nature of data, the task of interpretation falls squarely on the shoulders of the researcher himself. Some researchers take the view that their job merely is to present results in logical and convenient form, leaving it to the readers to draw their own conclusions. For descriptive surveys it may hold good, but for exploratory and other indepth studies, this view seems to be entirely mistaken. As Moser says, “[m]ost readers of a research report, fellow scientists or laymen, lack the tune and perhaps the will power to go through tables and pick out the crucial results. But even, if they had both, it would be wrong to leave the interpretation entirely to them. There is after all more to a research than can be seen from the tables, and the researcher in interpreting his results is inevitably—and rightly—influenced by all that has gone before, by his acquaintance with the raw material behind the figures and by his own judgment. While every reader is entitled to draw his own conclusions the writer of the survey report should not shirk the duty of giving his own.”²²

21. *Id.* at 11.

22. *Supra* note 13 at 300.

The researcher must give his interpretations with a view to bring out the hidden and important aspects of his data. Some like to play safe by confining themselves within the limits justified by data. There is room surely in every research report for the research worker's own ideas and speculations and he must inevitably develop theories and hunches to strengthen his contribution to the development of his discipline or area of interest.

By way of conclusion we may add that the task of interpretation of data in social sciences is made difficult by the fact that researcher, more often than not, has no control over the phenomena under investigation. Many variables that affect phenomena may escape his attention or he may not be able to exactly measure magnitude of their impact. Last but not the least, interpretation of data is complicated by the fact that human beings study human beings and this creates possible bias in establishing relations between variables and in causes of events. How events are observed, recorded and interpreted is related to, among other factors, a person's beliefs, opinions, attitudes and training. We see things through "tainted glasses" based on socialisation in our environments. Our perceptions are selective and thus sometimes ignore important aspects of phenomena.²³ This is observed in courts where for the same facts the plaintiff and defendant give different interpretations by quoting authorities and judgments in their support.

Report Writing

The research work is not complete until the report has been written. The hypothesis and findings of study, howsoever brilliant and original they may be, are of little importance unless they are communicated to others. Many social scientists seem to view report writing as one of the unpleasant tasks and thus defeat the very purpose for which enquiry is undertaken. The research report, which is the last stage of enquiry, conveys to interested persons the whole result of the study in sufficient details so that the reader may comprehend the data and determine for himself the validity of the conclusions.

While writing a report "the important point to be kept in mind is its function. *"The purpose of a report is not communication with oneself but communication with the audience."*²⁴ This requires awareness of the clientele. A report for social scientists will be different in many ways from one intended for administrators, while the one for general public would be different from the earlier two. Whatever the audience, two broad questions should be considered in planning the report : (1) What

23. *Supra* note 1 at 19.

24. *Supra* note 12 at 442.

does this audience want or need to know about the study ? (2) How can this information be presented?

In order to present a correct perspective of the research undertaken, the report must contain the following points :

A. Introduction :

- (1) Concise and clear-cut statement as to the nature of the study.
- (2) Aims.
- (3) Sources of information (including persons consulted and materials used).
- (4) Scope of study.

B. Brief statement of working hypotheses which guided the study, including explicit definitions of units and concepts used.

C. Brief statement of techniques followed in the study :

- (1) Types of observations used along with the conditions under which they are made.
- (2) Types of schedules formulated.
- (3) Types of case history data secured, their sources and manner of presentation.
- (4) Sampling procedures and conditions of selection.
- (5) Statistical procedures, sources of statistical data and conditions under which they were obtained.
- (6) Types of scaling techniques used.

D. Brief description of experimental treatment of data and techniques used in experiments.

E. Major findings of study.

F. Major conclusions reached about findings.

G. Special remarks :

- (1) Problems encountered in gathering the data, classifying them and analysing them.
- (2) Possible discrepancies in data collected.
- (3) Suggestions to subsequent investigators on same topics in the same context.

H. Bibliographical references found useful in study.

I. Appendices which might include sample questionnaires, sample inter views and the like.²⁵

25. This presentation has been adopted from Pauline V. Young, *Scientific Social Surveys and Research* 489-90 (Prentice Hall of India Private Ltd., New Delhi, 1968).

The features outlined above tell us about the process of writing a research report. We shall, however, be discussing these features of report writing under four broad headings : Statement of the problem, research design and procedures, results, and implications.

Statement of the problem

The first step in any scientific research process is a precise formulation of the question to be investigated. As Cook *et al.*, say, "[e]nough background should be given to make clear to the reader why the problem was considered worth investigating."²⁶ Since a social science audience is likely to be more interested in contributions to general knowledge of human behaviour than in the solution of a specific practical problem, the report to such an audience usually stresses the relevance of the investigation to some aspect of theory relating to that particular area, be it sociology, psychology, political science or law.

All studies, it should be recognised, are not concerned with theoretical issues primarily; practical considerations have their own importance and relevance in the research process. In fact many studies in social sciences are conducted without the guidance of a theory. If this be the case, there is no need to conceal this fact, as some social scientists do, fearing that it may lead to downgrading of their research effort.

Statement of the problem should include not only the practical or theoretical importance of the research undertaken but also a brief summary of other relevant research, so that the study may be seen in a broader context. The hypotheses of the study, if any, are formulated, operational definitions of the concepts should be lucidly explained. The connections among these elements should be made clear, that is the logical sequence of ideas arising from the existing theory and relevant research findings to the hypotheses and concepts of the study.

Research design and procedures

The reader needs to be told in detail how the study was carried out; how was it designed; is it a case study, survey, or does it involve an experiment; how measurements were taken; if the data were collected by means of questionnaires or interviews, exactly what kind of questions were asked; what difficulties were faced by the researcher during interviews or while filling in questionnaires; if some investigators were collecting data, what instructions were given to them ?

It is also essential to inform the reader as to how the observations or replies to questions were translated into measures of the variables with which the study is concerned.

26. *Supra* note 12 at 444.

Similarly, how and why a particular sampling procedure was used needs to be told to the audience. These details would enable people in estimating the probable limits of generalisability of the findings. The number and characteristics of the subjects on which findings are based should be clearly stated so that the reader can draw his own conclusions about the applicability of the findings to other groups.

Statistical techniques, if any, used in the analysis of data, along with their limitations, and how they are used to interpret data, should be elaborated in clear terms.

Results

The basic rule observed in presenting all scientific research findings is to give all the evidence relevant to the research questions asked, even if, as it may happen, the results are not in accord with researcher's hypotheses. This is the cardinal rule of all scientific reporting. The scientific researcher has to go by dictates of his findings and interpret data accordingly even if it may go against his views or prevailing scientific paradigms.

When it comes to final presentation of data, the researcher may find that all of it may not be relevant to the research questions asked. Some of the tables worked out in the course of analysis may appear to be irrelevant and consequently should not find a place in the report. The basic question is, how does one decide what is relevant? The guidance comes primarily from the research problem and from the hypotheses, if any, with which the study was concerned as also from one's knowledge of theory and experience of the area of study.

A point to be carefully understood is that "[d]uring the course of the investigation, a more adequate statement of the problem itself may be developed, new hypotheses may emerge, unforeseen relationships may appear. Therefore, while the original formulation provides the basic point of reference for the report, there must also be room to include subsequent developments."²⁷

Where statistical techniques are used to explain findings, the level of significance should also be indicated to the reader to draw relevant conclusions. The report ordinarily contains tables, charts or graphs either alongside findings or in the appendices which are considered significant.

Implications of findings

Many reports contain a bare statement of the findings which usually

27. *Id.* at 447.

do not convey enough meaning. The reader is interested in their implications, for example, general understanding of human behaviour in case of social and behavioural sciences. Discussion of these implications is sometimes combined with the presentation of the data or it is placed in a separate section. Implications of findings normally emphasise the following three points :

First, the researcher must state how inferences drawn from his findings in this particular situation are expected to apply in similar circumstances. The inferences may be at a level quite close to data or may involve considerable abstraction. Sometimes abstraction is resorted to for linking it with available theory in the area, especially if it is partially developed. Or, the implications may be related to other studies in which the specific phenomena are different but can be understood in terms of the same principle.

Second, the researcher must also state the limitations or difficulties in generalising implications of his research. He must clearly emphasise various characteristics or shortcomings of his sample so that readers may draw conclusions in their context.

Third, "the discussion on implications of the findings will usually include relevant questions that are still unanswered or new questions raised by the study, perhaps with suggestions for the kinds of research that would help to answer them."²⁸

Summary

It is normal practice to conclude the report with a brief summary, restating in barest outline the problem, the procedures, the major findings, and the major conclusions drawn from them.

Style

A word about the style of the report. A report must of necessity have basic qualities like accuracy and clarity. The report may not be written in a highly literary style but should convey to the reader in precise and simple terms, the basic purpose, objectives and characteristics. The words and sentences should be so chosen that the researcher's ideas are clearly and concisely revealed to the audience.

The style of the report, of course, will vary from one researcher to another, but it is clear that it must combine simplicity with the use of technical language. Often researchers use words or jargon which the concerned audience is not familiar with. This should be avoided as far as possible and preparation of a rough draft before finalising the report

28. *Id.* at 449.

will immensely help weed out unnecessary paragraphs, sentences, difficult and technical words. Sometimes, the help of a fellow colleague may prove a boon in finalising the report since he may, as an outsider, point out some obvious omissions and commissions that may have escaped the attention of the researcher.

In legal field, report writing can be compared with final writing of judgment by the judges. In fact what has been described in preceding paragraphs applies to major aspects of writing a judgment. A judge has to write judgment in the light of issues framed, the arguments put forth by both the parties as well as laws relating to that particular case. Judgments, written with the kind of audience in mind, with all the precautions referred to above, are highly appreciated. A judge, while interpreting in narrow confines of a particular case, also tries to link the findings with issues and problems on a wider scale facing the society, and in this process he generalises like any other social scientist.

Judicial pronouncements as such have great importance for people since many a time their impact determines the future course of legal, political and even economic history of the society.