



Research Methodology

Chapter Six: Elements of Research Design

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Content

2

- The Lab Experiment
- Control and Manipulation of the Independent Variable
- Controlling the Contaminating Variables
- Internal Validity of Lab Experiments
- External Validity or Generalizability of Lab Experiments
- Types of Experimental Designs

Causal Analysis

3

To establish that variable X **causes** variable Y , *all three* of the following conditions should be met:

1. Both X and Y should covary [i.e., when one goes up, the other should also go up (or down)].
2. X (the presumed causal factor) should precede Y . In other words, there must be a time sequence in which the two occur.
3. No other factor should possibly cause the change in the dependent variable Y .

The Lab Experiment

4

- When a cause-and-effect relationship between an independent and a dependent variable of interest is to be clearly established, then all other variables that might contaminate or confound the relationship have to be tightly controlled.
- It is also necessary to manipulate the independent variable so that the extent of its causal effects can be established.
- The ***controls*** and ***manipulations*** are best done in an artificial setting (the laboratory), where the causal effects can be tested.

Control

5

- When we postulate cause-and-effect relationships between two variables X and Y , it is possible that some other factor, say A , might also influence the dependent variable Y .
- In such a case, it will not be possible to determine the extent to which Y occurred only because of X , since we do not know how much of the total variation of Y was caused by the presence of the other factor A .

Control cont.

6

- For instance, a Human Resource Development manager might arrange for special training to a set of newly recruited secretaries in creating web pages, to prove to the VP (his boss), that such training would *cause* them to function more effectively.
- However, some of the new secretaries might function more effectively than others, mainly or partly because they have had previous intermittent experience with the web.
- In this case, the manager cannot prove that the special training alone *caused* greater effectiveness, since the previous intermittent experience of some secretaries with the web is a contaminating factor.

Manipulation of the Independent Variable

7

- In order to examine the causal effects of an independent variable on a dependent variable, certain manipulations need to be tried.
- Manipulation simply means that we *create* different levels of the independent variable to assess the impact on the dependent variable.
- **Example:** Let us say we want to test the effects of lighting on worker production levels among sewing machine operators.

Manipulation of the Independent Variable cont.

8

- To establish cause-and-effect relationship, we must first measure the production levels of all the operators over a 15-day period with the usual amount of light they work with—say 60-watt lamps.
- We might then want to split the group of 60 operators into three groups of 20 members each, and while allowing one subgroup to continue to work under the same conditions (**control group**) as before (60-watt electric lightbulbs)

Manipulation of the Independent Variable cont.

9

- We might want to manipulate the intensity of the light for the other two subgroups (**experimental groups**), by making one group work with 75-watt and the other with 100-watt lightbulbs.
- After the different groups have worked with these varying degrees of light exposure for 15 days, each group's total production for these 15 days may be analyzed to see if the difference between the pre-experimental and the post-experimental productions among the groups is directly related to the intensity of the light to which they have been exposed.

Manipulation of the Independent Variable cont.

10

- In this case the independent variable, lighting, has been manipulated by exposing different groups to different degrees of changes in it.
- This manipulation of the independent variable is also known as the **treatment**, and the results of the treatment are called **treatment effects**.

Controlling the Contaminating Variables

11

□ **Matching Groups**

- One way of controlling the contaminating or “nuisance” variables is to match the various groups by picking the confounding characteristics and deliberately spreading them across groups.
- For instance, if there are 15 women among the 60 operators, then each group will be assigned 5 women, so that the effects of gender are distributed across the three groups.
- Likewise, age and experience factors can be matched across the three groups, such that each group has a similar mix of individuals in terms of gender, age, and experience.

Controlling the Contaminating Variables cont.

12

- Because the suspected contaminating factors are matched across the groups, we may take comfort in saying that variable X alone causes variable Y, if such is the result of the study.
- But here, we are not sure that we have controlled *all* the nuisance factors, since we may not be aware of them all.
- A safer bet is to randomize.

Controlling the Contaminating Variables cont.

13

□ **Randomization**

- Another way of controlling the contaminating variables is to assign the 60 operators randomly (i.e., with no predetermination) to the three groups.
- That is, every member would have a known and equal chance of being assigned to any of these three groups.
- For instance, we might throw the names of all the 60 operators into a hat, and draw their names.

Controlling the Contaminating Variables cont.

14

- The first 15 names drawn may be assigned to the first group, the second 15 to the second group, and so on, or the first person drawn might be assigned to the first group, the second person drawn to the second group, and so on.
- By thus randomly assigning members to the groups we would be distributing the confounding variables among the groups equally.

Controlling the Contaminating Variables cont.

15

- **Advantages of Randomization**
- Compared to randomization, matching might be less effective, since we may not know all the factors that could possibly contaminate the cause-and-effect relationship in any given situation, and hence fail to match some critical factors across all groups while conducting an experiment.
- Randomization, however, will take care of this, since *all* the contaminating factors will be spread across all groups.

Internal Validity of Lab Experiments

16

- ***Internal validity*** refers to the confidence we place in the cause-and-effect relationship.
- To what extent does the research design permit us to say that the independent variable A **causes** a change in the dependent variable B?
- In lab experiments where cause-and-effect relationships are substantiated, internal validity can be said to be high.

Factors Affecting Internal Validity

17

- Even the best designed lab studies could be influenced by factors that might affect the internal validity of the lab experiment.
- That is, some confounding factors might still be present that could offer rival explanations as to what is causing the dependent variable.
- These possible confounding factors pose a *threat to internal validity*.

Factors Affecting Internal Validity cont.

18

The following are the seven major threats to internal validity:

- 1. History Effects:** Certain events or factors that would have an impact on the independent variable–dependent variable relationship might unexpectedly occur while the experiment is in progress, and this history of events would confound the cause-and-effect relationship between the two variables, thus affecting the internal validity.
- 2. Maturation Effects:** Cause-and-effect inferences can also be contaminated by the effects of the passage of time. Examples of maturation processes could include *growing older, getting tired, feeling hungry, and getting bored.*

Factors Affecting Internal Validity cont.

19

3. **Testing Effects:** Frequently, to test the effects of a treatment, subjects are given what is called a *pretest* (say, a short questionnaire eliciting their feelings and attitudes).
 - ▣ That is, first a measure of the dependent variable is taken (the pretest), then the treatment given, and after that a second test, called the *posttest*, administered. The difference between the posttest and the pretest scores is then attributed to the treatment.
 - ▣ However, the very fact that respondents were exposed to the pretest might influence their responses on the posttest, which would adversely impact on internal validity.

Factors Affecting Internal Validity cont.

20

- 4. **Instrumentation Effects:** For instance, an observer who is involved in observing a particular pattern of behaviors in respondents before a treatment might start concentrating on a different set of behaviors after the treatment.
 - ▣ In organizations, instrumentation effects in experimental designs are possible when the pretest is done by the experimenter, treatments are given to the experimental groups, and the posttest on measures such as performance is done by different managers.

Factors Affecting Internal Validity cont.

21

4. Instrumentation Effects:

- ▣ For instance, one manager might measure performance by the final units of output, a second manager might take into account the number of rejects as well, and a third manager might also take into consideration the amount of resources expended in getting the job done!

Factors Affecting Internal Validity cont.

22

5. **Selection Bias Effects:** A bias in the selection of the subjects might contaminate the cause-and-effect relationships and pose a threat to internal validity as well.
6. **Statistical Regression:** The effects of statistical regression are brought about when the members chosen for the experimental group have extreme scores on the dependent variable to begin with.
7. **Mortality:** When the group composition changes over time across the groups, comparison between the groups becomes difficult, because those who dropped out of the experiment may confound the results.

External Validity or Generalizability of Lab Experiments

23

- **External validity** refers to the extent of generalizability of the results of a causal study to other settings, people, or events.
- In other words, if we do find a cause-and-effect relationship after conducting a lab experiment, can we then confidently say that the same cause-and-effect relationship will also hold true in the organizational setting?

The Field Experiment

24

- **A field experiment**, as the name implies, is an experiment done in the natural environment in which work goes on as usual, but treatments are given to one or more groups.
- The experimental and control groups in the field experiment could be made up of the people working at several plants within a certain radius, or from the different shifts in the same plant, or in some other way.

Types of Experimental Designs

25

The following are some of the commonly used experimental designs in research:

- True Experimental Designs
- Quasi-Experimental Designs
- Double-Blind Studies
- Ex Post Facto Designs

Types of Experimental Designs cont.

26

- **True Experimental Designs**

- A true experimental design is the one that has three key components:

1. Pre-post test design.
2. Treatment and control groups.
3. Random assignment of subjects to groups.

Types of Experimental Designs cont.

27

□ True Experimental Designs

Group	Pretest	Treatment	Posttest
Experimental group	O_1	X	O_2
Control group	O_3		O_4

Types of Experimental Designs cont.

28

□ **Solomon Four-Group Design**

- To gain more confidence in internal validity in experimental designs, it is advisable to set up two experimental groups and two control groups for the experiment.
- One experimental group and one control group can be given both the pretest and the posttest. The other two groups will be given only the posttest.

Types of Experimental Designs cont.

29

□ Solomon Four-Group Design

Group	Pretest	Treatment	Posttest
1. Experimental	O_1	X	O_2
2. Control	O_3		O_4
3. Experimental		X	O_5
4. Control			O_6

Types of Experimental Designs cont.

30

□ **Quasi-Experimental Designs**

- A quasi-experimental design has much the same components as a regular experiment, but is missing one or more key components.
- **Example:** Does smoking during pregnancy leads to low birth weight? It would be unethical to randomly assign one group of mothers packs of cigarettes to smoke.
- The researcher instead asks the mothers if they smoked during pregnancy and assigns them to groups after the fact.

Types of Experimental Designs cont.

31

□ Quasi-Experimental Designs

Group	Pretest score	Treatment	Posttest score
Experimental group	O_1	X	O_2

Group	Treatment	Outcome
Experimental group	X	O_1
Control group		O_2

Types of Experimental Designs cont.

32

□ **Double-Blind Studies**

- When extreme care and rigor are needed in experimental designs as in the case of discovery of new medicines that could impact on human lives, blind studies are conducted to avoid any bias that might creep in.
- For example, pharmaceutical companies experimenting with the efficacy of newly developed drugs in the prototype stage ensure that the subjects in the experimental and control groups are kept unaware of who is given the drug, and who the placebo.

Types of Experimental Designs cont.

33

□ **Ex Post Facto Designs**

- An ex post facto research design is a method in which groups with qualities that already exist are compared on some dependent variable.
- Also known as "after the fact" research, an ex post facto design is considered quasi-experimental because the subjects are not randomly assigned - they are grouped based on a particular characteristic or trait.

Types of Experimental Designs cont.

34

□ **Ex Post Facto Designs**

- For example, a researcher is interested in how weight influences self-esteem levels in adults. So the participants would be separated into differing groups (underweight, normal weight, overweight) and their self esteem levels measured.
- This is an ex post facto design because a pre-existing characteristic (weight) was used to form the groups.