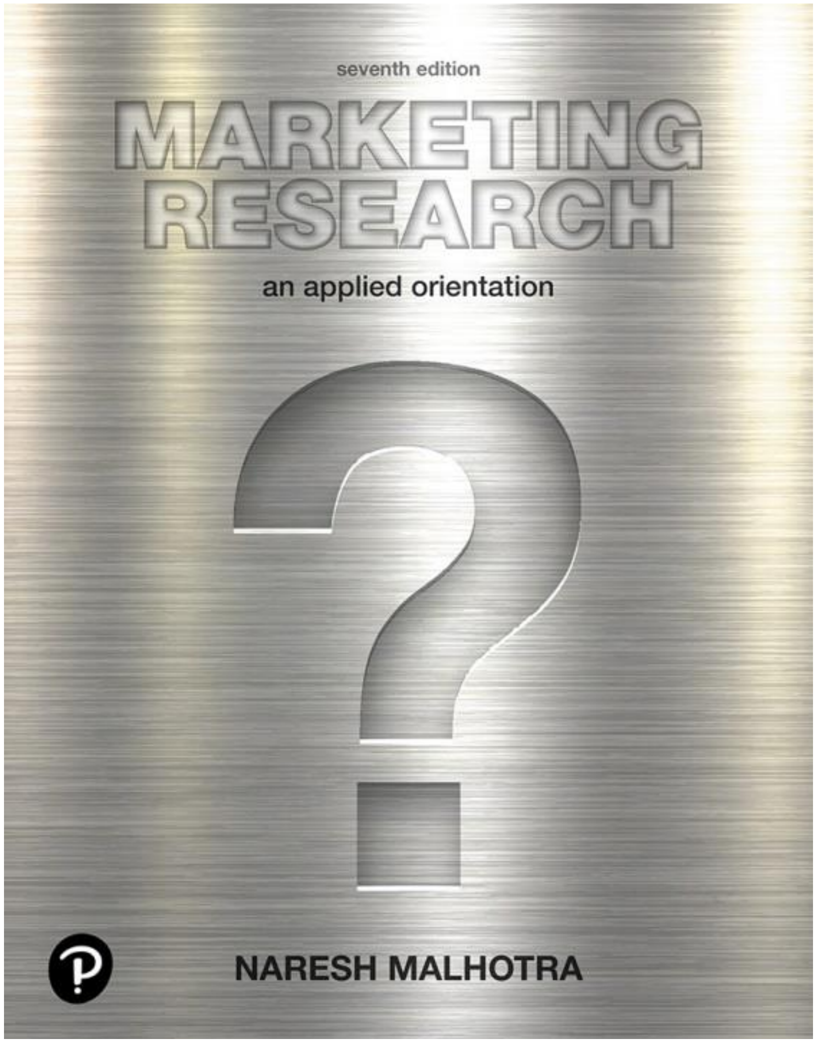
# Marketing Research: An Applied Orientation

Seventh Edition




## Chapter 7

Causal Research Design: Experimentation

# Concept of Causality

A statement such as "*X* causes *Y*"

A causal relationship is useful for making predictions about the consequences of changing circumstances or policies

Example: An advertising spending of ₹1 leads to ₹10 in sales per capita

# Conditions for Causality

- **Concomitant variation** is the extent to which a cause, *X*, and an effect, *Y*, occur together or vary together in the way predicted by the hypothesis under consideration.
- The **time order of occurrence** condition states that the causing event must occur either before or simultaneously with the effect; it cannot occur afterwards.
- The **absence of other possible causal factors** means that the factor or variable being investigated should be the only possible causal explanation.

# Evidence of Concomitant Variation between Purchase of Fashion Clothing and Education

**Table 7.1** Evidence of Concomitant Variation Between Purchase of Fashion Clothing and Education

| | Purchase of Fashion Clothing – Y | | |
|---|---|---|---|
| **Education – X** | **High** | **Low** | **Total** |
| High | 363 (73%) | 137 (27%) | 500 (100%) |
| Low | 322 (64%) | 178 (36%) | 500 (100%) |

# Purchase of Fashion Clothing By Income and Education

**Table 7.2** Purchase of Fashion Clothing by Income and Education

| Low Income | | | | High Income | | | |
|---|---|---|---|---|---|---|---|
| Purchase | | | | Purchase | | | |
| **Education** | **High** | **Low** | **Total** | **Education** | **High** | **Low** | **Total** |
| High | 122 (61%) | 78 (39%) | 200 (100%) | High | 241 (80%) | 59 (20%) | 300 (100%) |
| Low | 171 (57%) | 129 (43%) | 300 (100%) | Low | 151 (76%) | 49 (24%) | 200 (100%) |

The presence of association makes hypothesis more tenable but does not prove it.

# Definitions and Concepts

- **Independent variables** (treatments) are variables or alternatives that are manipulated and whose effects are measured and compared, e.g., price levels.
- **Test units** are individuals, organizations, or other entities whose response to the independent variables or treatments is being examined, e.g., consumers or stores.
- **Dependent variables** are the variables which measure the effect of the independent variables on the test units, e.g., sales, profits, and market shares.
- **Extraneous variables** are all variables other than the independent variables that affect the response of the test units, e.g., store size, store location, and competitive effort.

# Experimental Design

An **experimental design** is a set of procedures specifying:

- the test units and how these units are to be divided into homogeneous subsamples,
- what independent variables or treatments are to be manipulated,
- what dependent variables are to be measured; and
- how the extraneous variables are to be controlled.

# Real Research: Coupons

- An experiment was conducted to test the effects of the face value of coupons on the likelihood of coupon redemption, controlling for the brand usage. 280 shoppers who were entering or leaving a mall were randomly assigned to two treatment groups. One group was offered 15 Rs. coupons and the other 50 Rs. coupons. During the interview, the respondents answered questions about which brands they used and how likely they were to cash coupons of the given face value the next time they shopped.

- Independent variable, dependent variable
- Extraneous variable, test unit

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# Validity in Experimentation

- **Internal validity** refers to whether the manipulation of the independent variables or treatments actually caused the observed effects on the dependent variables. Control of extraneous variables is a necessary condition for establishing internal validity.
- **External validity** refers to whether the cause-and-effect relationships found in the experiment can be generalized.
  - To what populations, settings, times, independent variables, and dependent variables can the results be projected?

# Extraneous Variables (1 of 2)

- **History** refers to specific events that are external to the experiment but occur at the same time as the experiment.
- **Maturation** (*MA*) refers to changes in the test units themselves that occur with the passage of time.
- **Testing effects** are caused by the process of experimentation. Typically, these are the effects on the experiment of taking a measure on the dependent variable before and after the presentation of the treatment.
- The **main testing effect** (*MT*) occurs when a prior observation affects a latter observation.

# Extraneous Variables (2 of 2)

- In the **interactive testing effect** (IT), a prior measurement affects the test unit's response to the independent variable.
- **Instrumentation** (I) refers to changes in the measuring instrument, in the observers, or in the scores themselves.
- **Statistical regression** effects (SR) occur when test units with extreme scores move closer to the average score during the course of the experiment.
- **Selection bias** (SB) refers to the improper assignment of test units to treatment conditions.
- **Mortality** (MO) refers to the loss of test units while the experiment is in progress.

# Controlling Extraneous Variables

- **Randomization** refers to the random assignment of test units to experimental groups. Treatment conditions are also randomly assigned to experimental groups.
- **Matching** involves comparing test units on a set of key background variables before assigning them to the treatment conditions.
- **Statistical control** involves measuring the extraneous variables and adjusting for their effects through statistical analysis.
- **Design control** involves the use of experiments designed to control specific extraneous variables.

# A Classification of Experimental Designs (1 of 5)

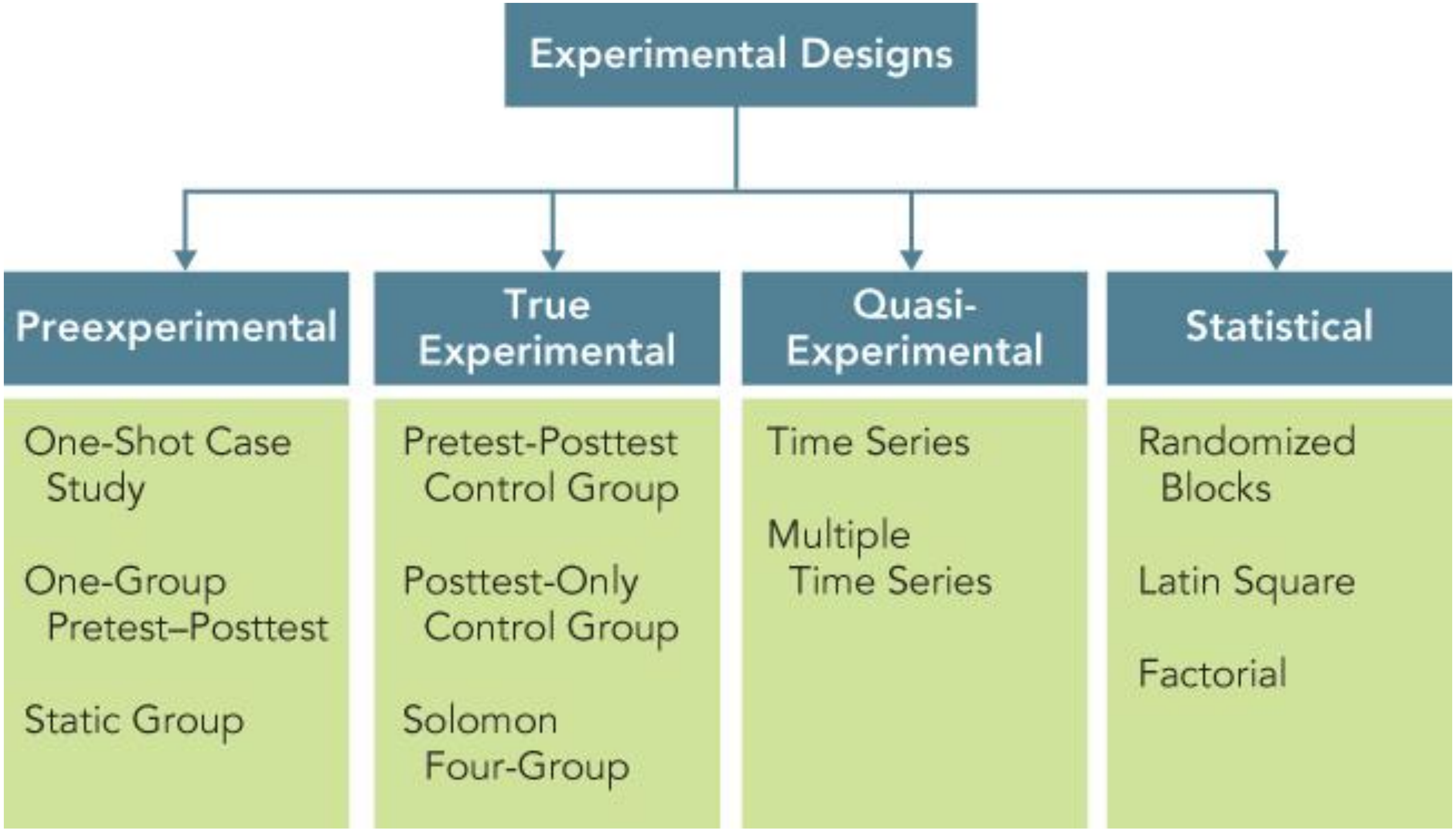
- **Pre-experimental designs** do not employ randomization procedures to control for extraneous factors:
  - the one-shot case study, the one-group pretest-posttest design, and the static-group.
- In **true experimental designs**, the researcher randomly assign test units to experimental groups and treatments to experimental groups:
  - the pretest-posttest control group design, the posttest-only control group design.

# A Classification of Experimental Designs (2 of 5)

- **Quasi-experimental designs** result when the researcher is unable to achieve full manipulation of scheduling or allocation of treatments to test units but can still apply part of the apparatus of true experimentation:
  - time series and multiple time series designs.
- A **statistical design** is a series of basic experiments that allows for statistical control and analysis of external variables:
  - randomized block design, Latin square design, and factorial designs.

# A Classification of Experimental Designs (3 of 5)

**Figure 7.1** A Classification of Experimental Designs



# One-Shot Case Study

$X \quad O_1$

- A single group of test units is exposed to a treatment *X.*
- A single measurement on the dependent variable is taken ($O_1$).
- There is no random assignment of test units.
- The one-shot case study is more appropriate for exploratory than for conclusive research.

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# One-Group Pretest-Posttest Design

$0_1 \quad X \quad 0_2$

- A group of test units is measured twice.
- There is no control group.
- The treatment effect is computed as $0_2 - 0_1$.
- The validity of this conclusion is questionable since extraneous variables are largely uncontrolled.

# Static Group Design

| | | |
|---|---|---|
| EG: | $X$ | $0_1$ |
| CG: | | $0_2$ |

- A two-group experimental design.
- The experimental group (EG) is exposed to the treatment, and the control group (CG) is not (or current ad).
- Measurements on both groups are made only after the treatment.
- Test units are not assigned at random – selection bias, mortality
- The treatment effect would be measured as $0_1$ - $0_2$.

# True Experimental Designs: Pretest-Posttest Control Group Design

| | | | | |
|---|---|---|---|---|
| EG: | $R$ | $0_1$ | $X$ | $0_2$ |
| CG: | $R$ | $0_3$ | | $0_4$ |

- Test units are randomly assigned to either the experimental or the control group.
- A pretreatment measure is taken on each group.
- The treatment effect (TE) is measured as: $(0_2 - 0_1) - (0_4 - 0_3)$.
- Selection bias is eliminated by randomization.
- The other extraneous effects are controlled as follows:

  $0_2 - 0_1 = TE + H + MA + MT + IT + I + SR + MO$

  $0_4 - 0_3 = H + MA + MT + I + SR + MO = EV$ (Extraneous Variables)
- The experimental result is obtained by:

  $(0_2 - 0_1) - (0_4 - 0_3) = TE + IT$
- Interactive testing effect is not controlled.

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# Posttest-Only Control Group Design

EG : $R \quad X \quad 0_1$

CG : $R \qquad\quad 0_2$

- The treatment effect is obtained by:

  $TE = 0_1 - 0_2$

- Except for pre-measurement, the implementation of this design is very similar to that of the pretest-posttest control group design.
  - Selection bias and mortality

# Quasi-Experimental Designs: Time Series Design

$$O_1 \quad O_2 \quad O_3 \quad O_4 \quad O_5 \quad X \quad O_6 \quad O_7 \quad O_8 \quad O_9 \quad O_{10}$$

- There is no randomization of test units to treatments.
- The timing of treatment presentation, as well as which test units are exposed to the treatment, may not be within the researcher's control.
  - Major weakness: failure to control history

# Multiple Time Series Design

$$\text{EG}: \; O_1 \; O_2 \; O_3 \; O_4 \; O_5 \; X \; O_6 \; O_7 \; O_8 \; O_9 \; O_{10}$$

$$\text{CG}: \; O_1 \; O_2 \; O_3 \; O_4 \; O_5 \; \phantom{X} \; O_6 \; O_7 \; O_8 \; O_9 \; O_{10}$$

- If the control group is carefully selected, this design can be an improvement over the simple time series experiment.
- Can test the treatment effect twice: (a) against the pretreatment measurements in the experimental group, and (b) against the control group.

# Statistical Designs

**Statistical designs** consist of a series of basic experiments that allow for statistical control:

- The effects of more than one independent variable can be measured.
- Specific extraneous variables can be statistically controlled.
- Economical designs can be formulated when each test unit is measured more than once.

The most common statistical designs are the randomized block design, the Latin square design, and the factorial design.

# Randomized Block Design (1 of 2)

- **Problem:** The impact of humor on advertising effectiveness
- RBD useful when there is only one major external variable, such as store size, that might influence the dependent variable.
- The test units are blocked, or grouped, on the basis of the external variable.
- By blocking, the researcher ensures that the various experimental and control groups are matched closely on the external variable.

# Randomized Block Design (2 of 2)

**Table 7.4** An Example of a Randomized Block Design

| | | Treatment Groups | | |
|---|---|---|---|---|
| **Block No.** | **Store Patronage** | **Commercial A** | **Commercial B** | **Commercial C** |
| 1 | Heavy | A | B | C |
| 2 | Medium | A | B | C |
| 3 | Low | A | B | C |
| 4 | None | A | B | C |

Note: A, B, and C denote three test commercials, which have, respectively, no humor, some humor, and high humor.

https://online.stat.psu.edu/stat503/lesson/4/4.1

# Latin Square Design (1 of 2)

- Allows the researcher to statistically control two non-interacting external variables as well as to manipulate the independent variable.
- Each external or blocking variable is divided into an equal number of blocks, or levels.
- The independent variable is also divided into the same number of levels.
- A Latin square is conceptualized as a table (see Table 7.5), with the rows and columns representing the blocks in the two external variables.
- The levels of the independent variable are assigned to the cells in the table.

# Latin Square Design (2 of 2)

**Table 7.5** An Example of Latin Square Design

| | Interest in the Store | | |
|---|---|---|---|
| **Store Patronage** | **High** | **Medium** | **Low** |
| High | B | A | C |
| Medium | C | B | A |
| Low and none | A | C | B |

Note: A, B, and C denote the three test commercials, which have, respectively, no humor, some humor, and high humor.

# Factorial Design (1 of 2)

- Is used to measure the effects of two or more independent variables at various levels.
- A factorial design may also be conceptualized as a table.
  - https://online.stat.psu.edu/stat503/lesson/5/5.1
- In a two-factor design, each level of one variable represents a row and each level of another variable represents a column.

# Factorial Design (2 of 2)

**Table 7.6** An Example of a Factorial Design

| | Amount of Humor | | |
|---|---|---|---|
| **Amount of Store Information** | **No Humor** | **Medium Humor** | **High Humor** |
| Low | A | B | C |
| Medium | D | E | F |
| High | G | H | I |

# A Classification of Experimental Designs (4 of 5)

**Table 7.3** Sources of Invalidity of Experimental Designs

| Source of Invalidity | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **History** | **Maturation** | **Testing** | **Internal Instrumentation** | **Regression** | **Selection** | **Mortality** | **External Interaction of testing and X** |
| Design | | | | | | | | |
| *Preexperimental designs:* | | | | | | | | |
| One-shot case study | − | − | | | | − | − | |
| X O | | | | | | | | |
| One-group pretest–posttest design | − | − | − | − | ? | | | − |
| O X O | | | | | | | | |
| Static group comparison | + | ? | + | + | + | − | − | |
| X O | | | | | | | | |
| *True experimental designs:* | | | | | | | | |
| Pretest–posttest control | + | + | + | + | + | + | + | − |
| R O X O | | | | | | | | |
| R O O | | | | | | | | |

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# A Classification of Experimental Designs (5 of 5)

## [**Table 7.3** Continued]

| | History | Maturation | Testing | Internal Instrumentation | Regression | Selection | Mortality | External Interaction of testing and X |
|---|---|---|---|---|---|---|---|---|
| Posttest-only control group design | + | + | + | + | + | + | + | + |
| R X O | | | | | | | | |
| R O | | | | | | | | |
| *Quasi-experimental designs:* | | | | | | | | |
| Time series | − | + | + | ? | + | + | + | − |
| O O O X O O O | | | | | | | | |
| Multiple time series | + | + | + | + | + | + | + | − |
| O O O X O O O | | | | | | | | |
| O O O O O O | | | | | | | | |

Note: A + indicates a relative advantage, whereas a − indicates a relative disadvantage.

# Laboratory Versus Field Experiments

**Table 7.7** Laboratory Versus Field Experiments

| **Factor** | **Laboratory** | **Field** |
| --- | --- | --- |
| Environment | Artificial | Realistic |
| Control | High | Low |
| Reactive error | High | Low |
| Demand artifacts | High | Low |
| Internal validity | High | Low |
| External validity | Low | High |
| Time | Short | Long |
| Number of units | Small | Large |
| Ease of implementation | High | Low |
| Cost | Low | High |

# Marketing Research & Social Media

- Laboratory type of experiments can also be conducted in virtual space such as Second Life (www.secondlife.com).
- All of the experimental designs that we have discussed in this chapter can also be implemented within the context of the real social world.
- As compared to the field, experimentation in social media (real and virtual) offers the advantages of ease of implementation and lower cost. The internal validity may be satisfactory but external validity will not be as high as that of field experiments.