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Measuring Reception of Advertising Endeavors through Quantitative Metrics

Sayak Pal [a, *], Nitesh Tripathi [b], Sharmila Kayal [c], Swati Agarwal [c]

[a] Symbiosis International (Deemed University), Pune, India
[b]St. Xavier's University, Kolkata, India
[c]Adamas University, Kolkata, India

Abstract

Selecting an appropriate quantitative research method for analyzing advertisements can be challenging. It would require carefully identifying the advertising metrics, categorizing variables, and, most importantly, selecting an appropriate statistical method. However, it is imperative because the study of advertisements often correlates with the study of consumers from different mediums, especially when measuring the variables and their relationship to audio-visual advertisements. Quantitative research for advertising can be bifurcated into sections and subsections of different kinds, depending on the nature of the study and type of data; for example, there can be two different types of metrics that are useful in the quantitative analysis of advertising; they are categorized into theoretical and applied metrics. Sometimes, it is enough to apply simple methods like mean, median, and mode to analyze and conclude the data; however, on some occasions, the nature of the study compelled the researcher to apply complex methodologies like mean deviation, standard deviation, correlation, regression, etc. The study provides guidelines for researchers dealing with qualitative data for analyzing advertisements, with examples that make the methods comprehensible.

Keywords: advertisement, quantitative techniques, statistical analysis, advertising research.

1. Introduction

Advertising research considers numerous factors and variables to achieve accuracy, reliability, and validity. Quantitative and qualitative data collection methods can help measure and evaluate data derived from the variables relating to all three categories of advertising: display advertising, classified advertising, and classified-display advertisements for print media advertising (newspaper and magazine advertisements). These methods are also useful in measuring the variables and their relationship to audio-visual advertisements (television, radio, and film advertisements). The measurement of such variables is called mapping, which is defined as "objects on one set onto the objects of another set." While applying the mapping in advertising research, one set can be the consumers, audience, or symbols, while the other set can be the numerals. Advertising research primarily deals with the creative and communicative variables that fall under the broader spectrum of marketing research. This is why advertising research covers not only audience-centric variables but also consumer-centric variables (Dayal, 2017). Vance Packard, in 1957, referred to advertising as "hidden persuaders," which makes advertising omnipotent and omnipresent (Packard, 1957). Advertisements are also called "sellers of dream" and often referred to as "running business without advertising is like winking a girl in the dark" (Dayal, 2017).

[*] Corresponding author
E-mail addresses: swatiagch@gmail.com (S. Agarwal)

Another integral part of advertising research is copy research, which focuses on measuring the effectiveness of advertising messages (Dominick, Wimmer, 2003).

Nature of Advertising Research

Research has always been a scientific study. However, advertising research often lacks a scientific approach to measuring variables, precision, variability, and reliability (Dayal, 2017). For example, when we are making an assumption about a situation like a bowl is half empty or half full with clear soup, we are either being positively or negatively biased on our assumption. However, the moment we measure the quantity of clear soup in the bowl with the help of a scientific method, we can arrive at a logical conclusion with a quantitative outcome. Advertising research has gone through a series of progression and has become sophisticated over the years. Despite applying neuroscience, big data, eye tracking, structural equation modeling, survey data, field experiments, and other modern and sophisticated analysis techniques in analyzing the market, the understanding of consumer consumption is still not entirely comprehensible. Instead of complex and complicated analysis, qualitative analysis sometimes helps analyze advertising effectiveness before, during, and after the exposure (Belk, 2017).

The significant qualitative methods applicable to analyze the impact of an advertisement include in-depth interviews, focus group discussions, observations, projective techniques, and netnography (Belk et al., 2012; Kozinets, 2015). Among these qualitative data collection methods, the most common method is the focus group discussion, which is relatively quick and inexpensive and also helps in retrieving qualitative data in a natural setup. However, this method comes with a few biases, like individual dominating discussions, moderator bias, groupthink, and other distortions (Catterall, Maclaran, 2006).

For example, television advertisements and their audience perception can be measured in both qualitative and quantitative ways, where one of the most common methods of qualitative data collection is in-depth interviews (Zhou, Russell 2004, 2009). In-depth interviews are one of the commonly used ethnographic techniques that not only help in understanding the impact of advertising on consumers but also help identify the takeaways of the consumer (Belk, 2017).

One variation of an in-depth interview, under the qualitative data collection method, is called the projective technique, which enables the researcher to insert variation within the process. There are a few projective techniques that are common to the researchers, like word association, shopping list projective, image association, collage construction, storytelling, drawing, cartoon caption test, psychodrama, dream elicitation, thematic apperception test, metaphor elicitation, symbol matching, etc. (Coulter, 2006; Zaltman, Robin, 1995).

Advertisement research often involves experimental research design to test the variables and their influences to determine the factors that influence sales (Caballero, Solomon, 1984; Greco, Swayne, 1992). Causal research enables a researcher to determine the relationship between the advertisement and the consumers. In contrast, experimental research design is an appropriate methodology that helps in justifying the relationships (Vargas et al., 2017).

In experimental research, a researcher often manipulates or controls one of the causal variables while observing the corresponding differences in the outcome (Nisbett, Wilson, 1977). There can be one example of such circumstances where a researcher might want to control or manipulate one of the variables, like when a researcher wishes to find out the consumption pattern of the consumers on the point of purchase advertisements by conducting a survey asking people whether they would purchase a particular product after being exposed to the point of purchase advertisement and then analyze the result based on the responses collected from the participants.

Quantitative analysis of advertising research

There can be two different types of metrics that are useful in the quantitative analysis of advertising; they are categorized into theoretical and applied metrics. The theoretical metrics deal with the theories, techniques, and methods, while applied metrics apply those theories, techniques, and methods to find out possible solutions to the research problems (Dayal, 2017). The applied metrics can further be categorized into Descriptive and inferential metrics, while each of these categories has a number of statistical tests under them, which depend on the nature of the data and the variables.

Variables are considered essential in quantitative data collection when measuring relationships. The variables, primarily, can be changed and have two values. An example of a variable can be a person's age, height, weight, consumption of food, income, blood group, occupation, etc., which can be different from another person. Variables are also a result of logical groupings of attributes. For example, if we consider gender as a variable, then male, female, and third gender can be the attributes. Studies try to measure the relationship between the variables by collecting data through quantitative methods, and the longer the list of variables, the longer time it would require for the researcher in data collection.

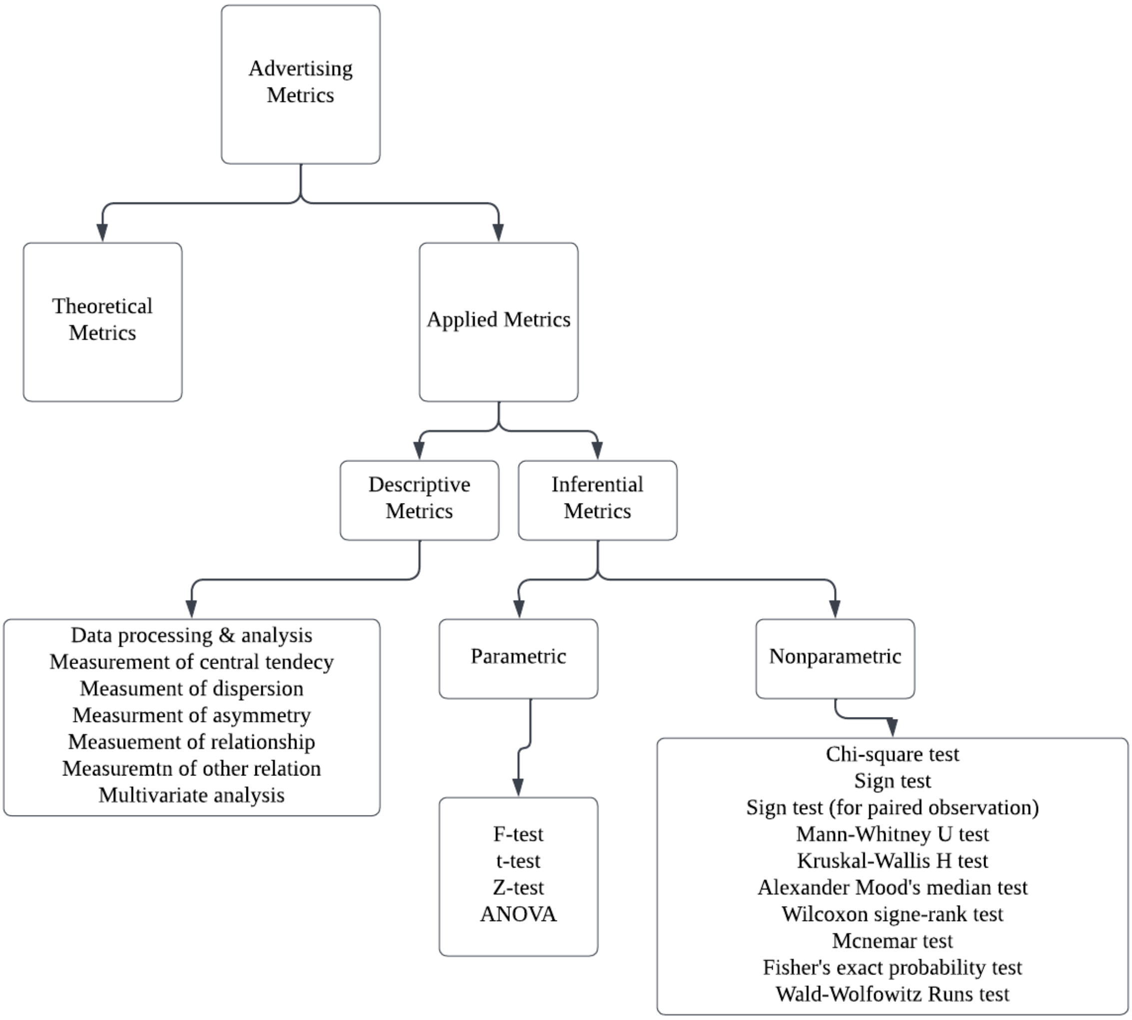

Fig. 1. Advertising metrics for quantitative data analysis in advertising research
Source: Concepts proposed by Manoj Dayal in his book Media Metrics: An Introduction to Quantitative Research in Mass Communication, 2017.

Variables can be defined as "measurable factors through a process of operationalization. It will convert difficult concepts into easily understandable concepts, which then can be measured empirically." Variables can be of different types, such as "Independent and dependent variables," "Active and attribute variables," "Continuous, discrete, and categorical variables," "Extraneous variables," and "Demographic variables" (Kaur, 2013).

These varieties of variables (Figure 2) make it easier for the researcher to collect data that is apt for the study. Independent variables are not affected by other variables. For example, when you are surveying consumers to understand whether their consumption is affected by a surrogate advertisement, the independent variable can be the age of the respondents. On the other hand, dependent variables are dependent on other variables. An example could be that the ratings of an advertisement would be different between the participants of a controlled group and the experimental group. Continuous variables are known for taking up an infinite set of values. An example could be the body weight of the consumers when you are trying to measure their eating habits proportional to the exposure to direct-action advertisements.

Discrete variables consider the values that are countable. For example, when you are trying to measure the impact of public service advertisements on television on a household, where the number of people residing in the household is measured as ten or less. Categorical variable considers components like age group, religion, sex, educational qualification, etc.

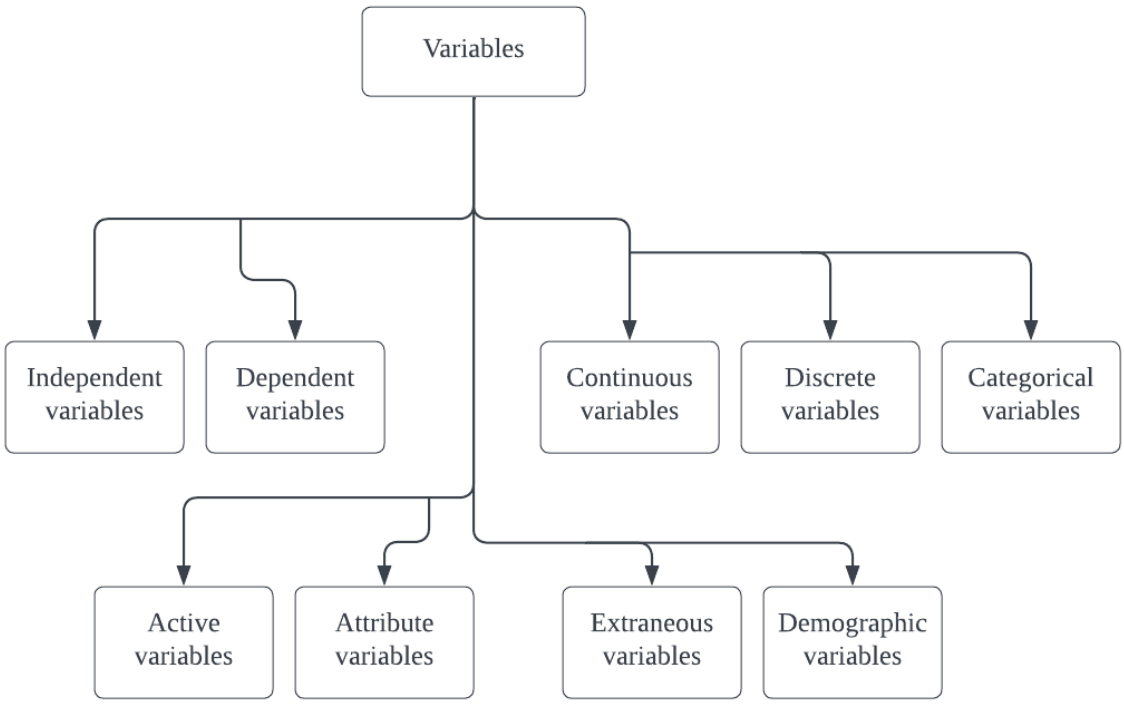

Fig. 2. Types of variables
Source: 'Variables in research' by S. P. Kaur, published in the Indian Journal of Research and Reports in Medical Sciences, 2013.

An example can be the understanding of the male and female ratio when you are trying to understand the increase in sales of a garment brand after running repetitive advertisements on television. Active variables are the variables that are manipulated by the researcher. An example of an active variable is the number of advertisements shown to a control group. Attribute variables remain stagnant during the study. An example could be measuring daily weight loss/gain after exposure to an advertisement promoting fitness. The extraneous variable is a variable that the researcher is not studying but affects the dependent variable considered in the study. For example, you are studying the consumption habits of a set of consumers based on their income level; however, age and location also affect consumption, which can be considered extraneous variables. Demographic variables include demographic components such as age, income level, location, gender, etc. An example of the demographic variable can be studying the exposure of product advertisements on television for urban population.

After understanding the nature and types of variables, the study of measurement becomes imperative. The measurement can be defined as assigning objects, observations, or events, abiding by a set of rules. The segregation of measurement is applied when these objects, observations, or events represent a selective category (Schaw, 2006).

The discussion about measurement and its concept can be traced back to the work of Stevens in 1966, as he proposed four types of scales: Nominal, Ordinal, Interval, and Ratio scale (Borgatta, Bohrnstedt, 1980). For advertising research, all four of these scales are applicable to various perspectives. The nominal scale is applied when there is a question of name or gender appears. For example, when you are asking participants about their gender or the name of the brand they prefer. The ordinal scale helps in arranging the responses in a certain order, such as the numeric ranking, maximum-minimum, high-low, primary education, secondary education, higher secondary education, etc. For example, when you are typing to measure the educational qualification of the participants or the maximum and minimum number of consumptions of a product in an average month. The interval scale helps to measure the difference between two variables when the difference is equal and meaningful. An example of this scale can be the difference in temperature. The ratio scale includes true zero and the uniform intervals between two variables.

Examples of such measurements can be the crime rate, employment rate, etc. The application of nominal and interval scales is higher in advertising research compared to the ordinal and ration scales (Dayal, 2017).

The statistical tools for advertising research vary across distinctive directions, descriptive and inferential statistics, based on the nature of data and their analysis (Figure 3). The descriptive statistical methods are again classified into six distinct categories: 'data processing,' 'measurement of central tendency,' 'measurement of dispersion,' 'measurement of asymmetry,' 'measurement of relationship,' and 'multivariate analysis.' Data processing includes the data in editing, coding, classifying, tabulating, and generally explaining the tables. This is the reason it is called a bridge between data collection and interpretation for a study (Dayal, 2017).

For example, when you collect data from a population who are exposed to a health-related advertisement, and then you aim to measure the changes in their attitude towards a healthier lifestyle, you need to collect the raw data from the population through the selected samples (if the population size is infinite), and refine the data to eliminate the unwanted interferences before applying statistical methods for analysis. Measurement of central tendencies helps in summarizing the data points with meaningful outcomes. In a data set, it has been observed that the data has a tendency to form cultures around the central value. This particular behavior of data is called central tendency. The statistical methods (mean, median, and mode) help in describing the data set with the help of one single value and also enable comparing one data set with another (Prasad, 2023). For example, you want to find out the central tendency for a set of data collected from audiences who are regular consumers of breakfast cereals and have also been exposed to the advertisements that promote such breakfast cereals on television. The measurement of central tendencies will help in describing the distribution of the entire data around the central tendency.

Measurement of central tendencies alone is not adequate to explain a set of data as two data sets may have the same mean but with completely different characteristics. Therefore, to understand the variability of data, measurement of dispersion is required (Manikandan, 2011).

The measurement of dispersion is again segregated into mean deviation, standard deviation & variance, range, and quartile deviation (Figure 3). For example, you are trying to find out the age of the people who are consumers of a beverage brand, and the dispersion of data can be measured with the help of the method. Skewness is used as a measure of distortion or asymmetry in a symmetric distribution as it measures the deviation of random variables. Three types of skewness can be observed in a set of data: positive skewed (Mean > Median > Mode), zero skewed (Mean = Median = Mode), and negative skewed (Mean < Median < Mode) (Prasad, 2023). An example can be when you are trying to find out the consumption of buyers (for a sample) towards a particular product, and the data is found to be lower in most of the cases while higher in a few cases; the curve would be positively skewed, while the opposite circumstances (with most of the responses are on the higher side and a few on the lower side) would create a curve that is negatively skewed. The zero skewed is a situation where the values are equally distributed across both sides of the curve, and in this case, there are equal numbers of higher and lower consumptions observed across the buyers.

The directional or cause-and-effect relationship between the variables can be measured through the technique of either correlation or regression (Prasad, 2023). For example, while measuring the consumer's consumption of a health drink before and after exposure to a call-to-action advertisement, the relationship between the independent variable and dependent variable can be measured to understand the advertisement's effectiveness on the consumer. Measurement of relationships is further divided into two distinctive categories: correlation measures the strength of the relationship between two variables, while regression defines the relationship between one dependent and one or more than one independent variable. There are different methods of calculating the correlation: "Pearson product-moment correlation," "Spearman rank-order correlation" etc., and different methods of calculating regression: "Method of least squares," "Simple linear regression," "Multiple linear regression analysis," "Polynomial regression," "Logistic regression," "Nonlinear regression," etc. (Runhua, Conrad, 2009). The multivariate analysis, under descriptive statistics, is applied to a situation when we try to identify the association between more than two variables (Bartlett, 1947).

For example, you are trying to find out the association between the consumption of alcohol and the surrogate advertisement on television and poster advertisements (displaying the bottle of alcohol) on the hoarding of the liqueur shop. Descriptive statistics helps analyze the data based on the sample taken out from the population, whereas inferential statistics helps generalize the findings based on the sample to the population (Allua, Thompson, 2009).

For example, when you are trying to find out specific behavioral changes among consumers because of the exposure to a social advertisement from one group of samples to another group of samples, then inferential statistics become useful. Inferential statistics is further categorized into two significantly different categories: parametric tests and non-parametric tests. Parametric tests in advertising research are used to investigate the given parameters of a sample and its equality with another sample (Dayal, 2017). Parametric tests measure the variables at the ratio and interval levels (Allua, Thompson, 2009). Nonparametric tests are called distribution-free or assumption-free statistics (Dayal, 2017) and are measured at nominal and ordinal levels (Allua, Thompson, 2009).

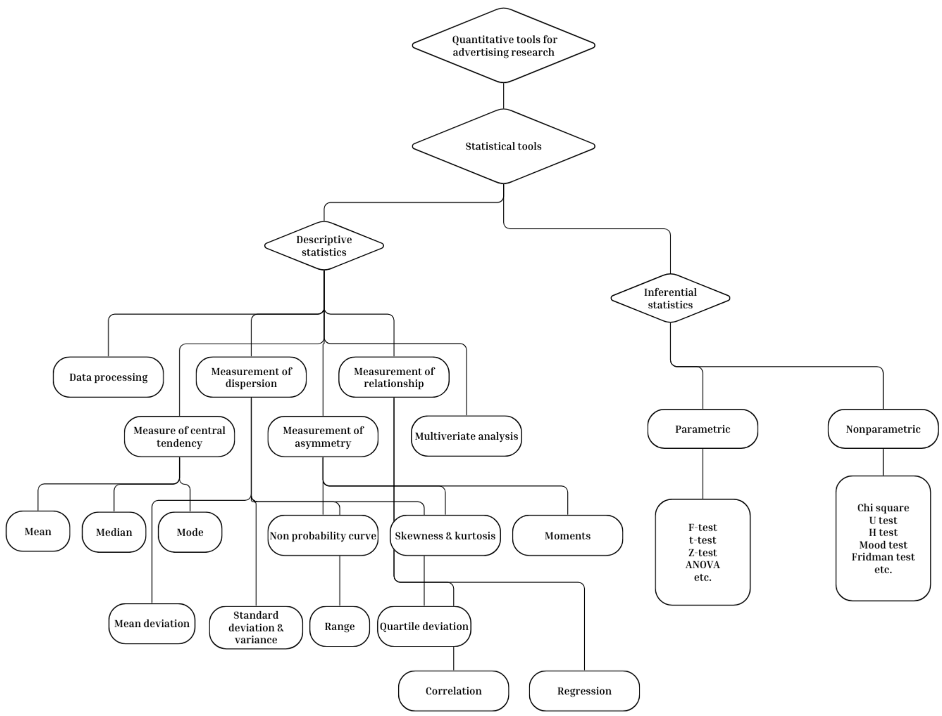

Fig. 3. Quantitative tools for advertising research
Source: Concepts proposed by Manoj Dayal in his book Media Metrics An Introduction to Quantitative Research in Mass Communication, 2017.

2. Materials and methods

The research work attempts to discuss the quantitative methods for conducting research on advertisements. The objective of the study is to find the appropriate method for analysing an advertisement with the help of quantitative techniques. To attain the objective of the research, literature review method is used to understand the different available techniques. Thus, with the help of qualitative analysis, the existing methods are studied and analysed.

3. Discussion

Data Processing in advertising research

Data processing includes several stages, such as data editing, data coding, classifying data, tabulating data, and generally explaining the data. In quantitative research, hypotheses are used through deductive reasoning, while data analysis considers the data to pass through the research question or hypothesis, the objectives of the research, and the theories to form a conclusion (Dayal, 2017). J. N. Sharma, in his book "Research Methodology: The Discipline and Its Dimensions Law," 2007, and C. R. Kothari, in his book "Research Methodology: Methods and Techniques," 2004, explained data analysis as processing that helps in generalization and testing hypotheses, that is closely associated with the data processing. Data processing is considered a bridge between the collection and interpretation of data (Sharma, 2007; Kothari, 2004). For each one of the stages of data analysis (Figure 4), the raw data is modified to form a meaningful conclusion).

Data editing is basically turning the raw data into meaningful information by eliminating errors and omitting repetitions. There are two types of data editing widely applicable in the area of advertising: 'Filed editing' and 'central editing.' While field editing takes place at the time of data collection, central editing is applicable once the data collection is over (Dayal, 2017).

For example, when you try collecting consumer data on their daily consumption habits of FMCG products through consumer surveys, the raw data can be collected and edited during the time of data collection and also edited at the same time, while the same data can be edited after the data collection process is over. The coding of edited data is essential for placing the units into their respective categories. Coding also involves applying codes and symbols to the data to reduce their numbers significantly and fitting them into categories. Based on the nature of the data, there can be 'numeric,' alphabetic,' and 'zero' coding that can be assigned to a set of data (Dayal, 2017).

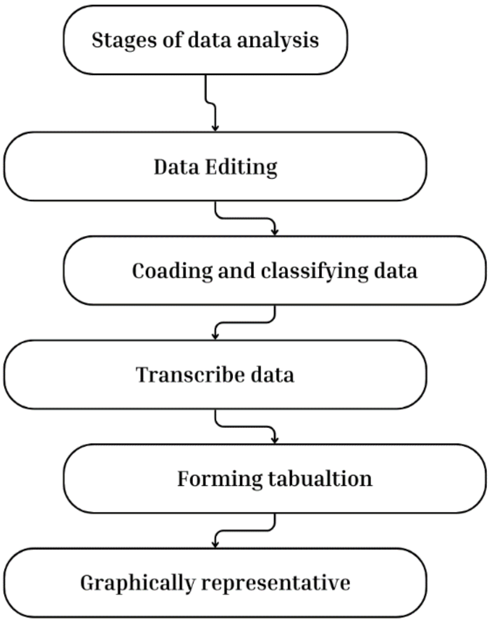

Fig. 4. Stages of data analysis (Source: Concepts proposed by Manoj Dayal in his book Media Metrics An Introduction to Quantitative Research in Mass Communication, 2017)

For example, when a researcher is trying to find out the acceptance of a new deodorant in the market, 'numeric' coating can be the rating of the acceptance form 1–3 (where 1 denotes the accepted, 2 denotes the undecided and 3 stands for rejected). Similarly, an 'alphabetic' coating can be applied to identify the gender (a for male, b for female, c for transgender, etc.). 'Zero' coding refers to identifying the responses into dual categories; for example, if you are asking the participants whether they like the test of the health drink, the answers will be coded into 1 and 2 (where 1 is denoted as yes, and 2 is denoted as no).

Classification of data is necessary when a researcher is dealing with a large set of data. In most cases, data is grouped according to their homogeneity and classified according to the attributes and class intervals (Dayal, 2017; Riffe et al., 2019). For example, when you are assessing the perspective of consumers after they are exposed to an indirect action advertisement based on their gender, the collected data can be categorized based on the gender of the participants. The same samples can be grouped according to numerical classifications, like height, age, etc. Transcription is the previous stage of the data tabulation, where data is transferred to the datasheet to limit the shuffling process between the observation and responses (Dayal, 2017).

For example, a consumer survey has been conducted to identify the variables that cause the consumer to increase or decrease their consumption of certain products, and 500 responses are considered for analysis. The transfer of data on the datasheet will help in summarizing the data for all those responses and reduce the effort of the researcher to browse through individual responses. Tabulation helps align the data collected from the datasheet into rows and columns. Tabulation includes the time and space in arranging the data in a meaningful way that makes it easily comprehensible (Dayal, 2017).

Tables can be created based on the homogeneity of the data into various categories. For example, a researcher has collected data from consumers to understand the changes in their behavior after they are exposed to an advertisement on the usage of sanitary napkins, and the tables are made based on gender (for example, female, male, third gender, etc.) and age group (for example, >15, 16-25, 26-35, 36-45, etc.) of the participants, etc. Graphical representation of data has the benefit of presenting the data in an interesting and eye-catching way. It makes a large quantity of data understandable for the readers and also helps in detailed comparison between datasets, measuring central tendencies, estimation, interpretation, and evaluation. There are a number of options available to present data in graphical format: 'vertical bar graph,' 'horizontal bar graph,' 'pie graph,' 'line graph,' 'pictogram,' 'frequency polygon,' 'cumulative frequency graph,' 'ogive,' etc. (Dayal, 2017; Wimmer, Dominick, 2006). For example, a researcher has collected data from 1000 samples on their consumption of cigarettes after being exposed to a public service advertisement displaying the harmful impact of smocking. The changes in the consumption of cigarettes pre-and-post exposure to the advertisement can be illustrated beautifully through bar graphs or line graphs in a study.

Measurement of Central tendencies: application in advertising research

Measurement of central tendency is nothing but the statistical average that is well accepted in studies concerning advertising research, as the studies often try to find a single figure that would describe the entire figure (Gupta, 2001). Mean is basically the calculation of the average, and for advertising research, the arithmetic mean is mainly applied rather than the harmonic and geometric mean. Arithmetic mean is the most popular method of getting a single value out of the observations (Dayal, 2017). For arithmetic mean, the sum of values is divided by the number of values in a set. For geometric mean, the Nth observation of the root of the set of values. The harmonic mean is basically the reciprocal of the arithmetic mean (Chakrabarty, 2021; Ramachandran et al., 2016; Jacquier et al., 2019).

4. Results

Mean

The formula for calculating the sample mean ($\bar{X}$):56

$\bar{X} = (\Sigma X) / N$

Where:

$\bar{X}$ (X bar) represents the sample mean

X represents the observations (score)

N represents the total number of observations

Σ represents the summation of

An example would be the calculation of the mean purchase of a set of consumers for a toothpaste brand. If there are 10 consumers and the accumulated scores for the consumers are 120, then the sample mean would be $\bar{X} = (\Sigma X) / N$ ($\Sigma X = 120$, and $N = 10$), $\bar{X} = 12$.

Mean for unclassified data-

For the unclassified data along with frequencies, the formula of sample mean would be $\bar{X} = (\Sigma f X) / N$. For example, the number of observations for a set of consumers on their purchasing habits of cookies over three months (consumer 1: 4 per month, consumer 2: 5 per month, consumer 3: 4 per month, consumer 4: 8 per month, consumer 5: 6 per month). The sample mean would be $(\Sigma\, 4\times3 + 5\times3 + 4\times3 + 8\times3 + 6\times3)/ 5 = 16.2$.

Mean for classified data

The formula remains the same for calculating the sample mean of classified data along with frequencies: $\bar{X} = (\Sigma f X) / N$. However, the X is calculated as the mid-value of the class. For example, the data on the frequency distribution of television advertisers and their successful advertisements are given (0-10 with a frequency of 15 for advertiser A, 10-20 with a frequency of 8 for advertiser B, 20-30 with a frequency of 14 for advertiser C, 30 - 40 with a frequency of 10 for advertiser D, and 40-50 with a frequency of 16 for advertiser E). The mid-value calculation of advertisers A, B, C, D, and E would be $(0 + 10 /2) = 5$, $(10 + 20 /2) = 15$, $(20 + 30 /2) = 25$, $(30 + 40 /2) = 35$, and $(40 + 50 /2) = 45$. Therefore, the $\Sigma f X$ for advertisers A, B, C, D, and E would be $(15 \times 5) + (8 \times 15) + (14 \times 25) + (10 \times 35) + (16 \times 45) = 1615$, and the total number of frequencies for advertisers A, B, C, D, and E would be $(15 + 8 + 14 + 10 + 16) = 63$. And the $\bar{X}$ would be $1615 / 63 = 25.63$.

Median

The median refers to the mid-value of a distribution. Calculation of the median would require arranging the values in the observation in ascending or descending order and using the formula M

= (N + 1 / 2)th value to calculate the median. Here, M is represented as the Median, and N is the total number of observations (Dayal, 2017).

For example, a researcher observes the frequency of newspaper ads on jewelry for five consecutive weeks to calculate the median, and the observations are 5, 15, 8, 12, and 9. The values need to be arranged in ascending order, which makes the distribution 5, 8, 9, 12, and 15. The application of the formula M = (N + 1 / 2) th value would be: M = (5 + 1 / 2), therefore M = 3rd value from the observation, which is 9. The arrangement of the observations in descending order would also provide the same median.

Median for frequency distribution

Calculating the median for frequency distribution involves two stages. First of all, the N / 2 is calculated from the dataset, and if the *cf* is not present in the correspondent dataset, then the median would be the corresponding X of the immediately greater value of *cf*. Therefore, the equation for calculating the median for frequency distribution is $cf \geq N / 2$. (where *cf* is cumulative frequency, and N is the sum of frequencies) For example, the Frequency of television advertisements on the latest cell phone captured by different television channels for a week, and the observations are listed below:

Table 1. Imaginary dataset to calculate the median for frequency distribution

Cell phone advertisements for a week (X)	12	14	17	19	21
Number of television channels (*f*)	3	4	6	5	2

The first stage is to calculate the N / 2 by calculating *cf*.

Table 2. Table showing the arrangement of data and the cumulative frequencies

X	*f*	C*f*
12	3	3
14	4	(3 + 4) = 7
17	6	(7 + 6) = 13
19	5	(13 + 5) = 18
21	2	(18 + 4) = 22
	ΣN = 20	

Notes: ΣN = 20

Therefore, the N / 2 = 20 / 2 = 10

From the datasheet, 10 is not present; therefore, the immediate greater value 13 is considered, and the median for the dataset is correspondent X, which is 17.

Mode

Calculation on mode in a distribution refers to the highest number of frequencies. In a simple distribution, the mode is considered the value that occurs most frequently in a distribution (Dayal, 2017; Singh, 1986). Mode, in a distribution, can also be referred to as the value where the concentration of the items is heaviest (Gupta, 2011). For example, the number of ads for a brand is observed and recorded for twelve months, and the frequencies from January to December are 10, 8, 16, 11, 8, 9, 13, 7, 8, 11, 8, 10. The mode here will be 8 as the value has occurred four times (highest) in the distribution.

Mode for frequency distribution

For a frequency distribution, M_o = highest number of frequencies

For example, the conversion of consumers is captured for the advertisements on a website for a week, and the observations are recorded in a tabular format below:

Table 3. Imaginary dataset to calculate the mode for frequency distribution

Conversion of consumer (X)	10	11	12	13	14	15	16	17
Number of web advertisements (*f*)	8	7	9	12	8	5	6	8

Here, the mode is 12, as it has the highest number of conversions.

For a classified frequency distribution, the following formula will be applied to calculate the mode:

$M_o = l + [f_m – f_1 / (f_m – f_1) + (f_m – f_2)] \times h$

Where:

M_o stands for Mode

l stands for the lower limit of the modal class

f_m stands for frequency of the modal class

f_1 stands for frequency of class preceding the modal class

f_2 stands for frequency of class succeeding the modal class

h stands for the width of the modal class

For example, the reach of advertisements among the consumers is captured in range (lower to upper) for a week, and the observations are recorded in a tabular format below:

Table 4. Imaginary dataset to calculate the mode for classified frequency distribution

Conversion of consumer (X)	55-60	60-65	65-70	70-75	75-80	80-85
Number of web advertisements (f)	5	8	9	10	8	7

Where:

The modal class for higher frequency is 70-75, as it has the highest frequency (10) among the set.

$l = 70$

$f_m = 10$

$f_1 = 9$

$f_2 = 8$

$h = 5$

Therefore, the mode will be calculated as:

$l + [f_m – f_1 / (f_m – f_1) + (f_m – f_2)] \times h$

$M_o = 71.67$

Measurement of dispersion: application in advertising research

In statistics, the word dispersion means the scatteredness, spread, or variation of data. There are a few methods that help in measuring the dispersion of data: mean deviation, standard deviation, variance, range, interquartile range, and semi-range. However, not all these methods are useful in advertising research (Dayal, 2017).

Mean deviation

Mean deviation is basically the arithmetic mean of the absolute deviation of values. It is called average deviation and is denoted by MD, or AD, or δ (delta). Mean deviation is the average deviation between the values or items in a distribution (Mangal, 1987).

Mean deviation for 'simple distribution, 'unclassified distribution,' or 'ungrouped distribution'

The formula for calculating mean deviation for 'simple distribution, 'unclassified distribution,' or 'ungrouped distribution' is $\delta = \Sigma \mid d \mid / N$, where d is further calculated by applying the formula of $X - \bar{X}$.

Where,

δ represents the mean deviation

d is calculated by subtracting $\bar{X}$ from X

N represents the number of observations

For example, a leading newspaper publishes multiple classified advertisements a day, and this behavior was recorded for six consecutive days with the values as 12, 9, 8, 8, 7, 10

Here,

$\bar{X} = (12 + 9 + 8 + 8 + 7 + 10) / 6$

$\bar{X} = 9$

$d = (12 – 9), (9 – 9), (8 – 9), (8 – 9), (7 – 9), (10 – 9)$

$d = 3, 0, -1, -1, -2, 1$

$\Sigma \mid d \mid = (3 + 0 + 1 + 1 + 2 + 1)$

Σ | d | = 8

Therefore, the formula for mean deviation for 'simple distribution, 'unclassified distribution,' or 'ungrouped distribution' δ = Σ | d | / N would be applied,

Where:

Σ | d | = 8

N = 6

δ = 1.33

Mean deviation for frequency distribution

The mean deviation for frequency distribution is also called the deviation of grouped data. This method helps calculate the deviation of the frequency data, which are often presented in tabular form (Dayal, 2017).

The formula for calculating the mean deviation of frequency distribution is a little different from the simple distribution: δ = Σ | ƒ d | / N

For example, the mean deviation needs to be calculated for the number of advertisements telecasted in a month on a toothpaste brand for different television channels. The frequency distributions are listed below:

Table 4. Imaginary dataset to calculate the mean deviation for frequency distribution

Number of television channels (X)	3	4	5	6	7	8
Number of television advertisements in a month (ƒ)	4	7	3	5	6	2

To calculate the mean deviation in the above frequency distribution, we need to apply the formula δ = Σ | ƒ d | / N

Now,

Σ | ƒ d | = Here the frequencies (ƒ) need to be multiplied by the number of X to calculate the ƒX (Table 5).

N = total number of frequencies are (4 + 7 + 3 + 5 + 6 + 2) = 27

Table 5. Calculation of ƒ, ƒX, d, | d |, and | ƒ d | from the data set illustrated in Table 4

X	ƒ	ƒX	d = (X - $\bar{X}$)	| d |	| ƒ d |
3	4	12	3 – 5.3 = – 2.3	2.3	9.2
4	7	28	4 – 5.3 = – 1.3	1.3	9.1
5	3	15	5 – 5.3 = – 0.3	0.3	0.9
6	5	30	6 – 5.3 = – 0.7	0.7	3.5
7	6	42	7 – 5.3 = – 1.7	1.7	10.2
8	2	16	8 – 5.3 = – 2.7	2.7	5.4
	N = 27	Σ ƒX = 143			Σ| ƒ d | = 38.3

Notes: $\bar{X}$ = (ΣƒX / N), the X should also need to be arranged in the ascending order.

Now that the Σ | ƒ d | and N are found, the mean deviation of the frequency distribution for the above values (Table 4) would be easier and would calculate as:

δ = 38 / 27

δ = 1.41

Standard deviation

Standard deviation is one of the widely used methods of analyzing deviations. It was formulated in 1894 by Karl Pearson and is also called 'root mean square deviation' or 'second-moment dispersion' (Dayal, 2017). The deviations can be calculated for population, which is denoted by σ (sigma), and sample standard deviation is denoted by s (Ghosh, 2023). A higher standard deviation means the dispersion from the man is higher, and a lower standard deviation means the values are concentrated near the central tendency or mean (Dayal, 2017).

Standard deviation for 'simple distribution, 'unclassified distribution,' or 'ungrouped distribution'

The formula to calculate the population standard deviation for 'simple distribution, 'unclassified distribution,' or 'ungrouped distribution' is $\sigma = \sqrt{\Sigma d^2 / N}$

Where,
σ stands for standard deviation
d is calculated by subtracting $\bar{X}$ from X
N stands for the number of observations

For example, the standard deviation needs to be calculated for the number of weekly push advertisements for a popular website, and the weekly observations are recorded as 15, 12, 11, 9, 7, and 6.

Here,
$\bar{X} = (15 + 12 + 11 + 9 + 7 + 6) / 6$
$\bar{X} = 10$
$d = (15 - 10), (12 - 10), (11 - 10), (9 - 10), (7 - 10), (6 - 10)$
$d = 5, 2, 1, -1, -3, -4$
$d^2 = 5^2, 2^2, 1^2, -1^2, -3^2, -4^2$
$\Sigma d^2 = 25 + 4 + 1 + 1 + 9 + 16$
$\Sigma d^2 = 56$
$N = 6$
$\sigma = \sqrt{\Sigma d^2 / N}$
$\sigma = \sqrt{56/6}$
$\sigma = 3.05$

Standard deviation for frequency distribution -

The formula for calculating standard deviation for frequency distribution is a little different: $\sigma = \sqrt{\Sigma f d^2 / N}$

Here, the d is calculated by combining their corresponding frequencies.

For example, the number of television advertisements for each day of the week are captured for seven different channels, and the observations are illustrated in the table below:

Table 6. Imaginary dataset to calculate the standard deviation for frequency distribution

Number of television channels (X)	1	2	3	4	5	6	7
Number of television advertisements in a week (f)	22	18	20	21	16	12	10

Now,
$\sqrt{\Sigma f d^2}$ = Here, the frequencies (f) need to be multiplied by the number of X to calculate the fX (Table 7).

N = total number of frequencies are (4 + 7 + 3 + 5 + 6 + 2) = 27

Table 7. Calculation of f, fX, d^2, and, fd^2, from the data set illustrated in Table 6

X	f	fX	d = (X - $\bar{X}$)	d2	fd2
1	22	22	1 – 3.56 = – 2.56	6.55	144.1
2	18	36	2 – 3.56 = – 1.56	2.43	43.74
3	20	60	3 – 3.56 = – 0.56	0.31	6.2
4	21	84	4 – 3.56 = 0.44	0.19	3.99
5	16	80	5 – 3.56 = 1.44	2.07	33.12
6	12	72	6 – 3.56 = 2.44	5.95	71.4
7	10	70	7 – 3.56 = 3.44	11.83	118.3
	N = 119	Σ fX = 424			Σ fd2 = 420.85

Notes: $\bar{X} = (\Sigma f X / N)$, the X should also need to be arranged in the ascending order.

Now that the $\Sigma f d^2$ and N are calculated, the standard deviation of the frequency distribution for the above values (Table 6) would be:

$\sigma = \sqrt{420.85 / 119}$
$\sigma = 1.88$

Range

Calculation of range is one of the easiest ways to measure the variance; however, this only considers the extreme values and neglects the values in between. The range is calculated through the subtraction of the lower value from the upper value (Dayal, 2017).

The formula for calculation of range for 'simple distribution, 'unclassified distribution,' or 'ungrouped distribution' is R = L – S

Where,

R stands for the range

L stands for the largest value

S stands for the smallest value

Range for 'simple distribution, 'unclassified distribution,' or 'ungrouped distribution'

For example, the range needs to be calculated for the number of hoardings at five different locations, and the numbers are noted as 6, 12, 20, 22, and 30.

Here,

$R = 30 – 6$

$R = 24$

Quartile deviation

Quartile deviation helps in indicating the absolute measure of dispersion. The 'coefficient of quartile deviation' is calculated by dividing the quartile deviation by the average value (Dayal, 2017).

The formula for calculating the coefficient of quartile deviation is

Coefficient of quartile deviation = $(Q_3 – Q_1 / 2) / (Q_3 + Q_1 / 2)$

Coefficient of quartile deviation = $Q_3 – Q_1 / Q_3 + Q_1$

Where,

Q_1 is calculated as (N + 1 / 4) th item

Q_2 is calculated as 3 × (N + 1 / 4) th item

N is the total number of observations

For example, the price of a newspaper advertisement per sq. cm for seven days is identified and recorded as Rs. 500/-, Rs. 200/-, Rs. 300/-, Rs. 400/-, Rs. 400/-, Rs. 600/-, and Rs. 800/-.

To calculate the quartile deviation, the data sets are required to be arranged in ascending order, before applying the formula.

Therefore,

Q_1 is calculated as (N + 1 / 4) th item

Q_1 = (7 + 1 / 4) th item

Q_1 = 2 th item

Q_1 = Rs. 300/- or 300

Q_3 is calculated as 3 × (N + 1 / 4) th item

Q_3 = 3 × (7 + 1 / 4) th item

Q_3 = 6 th item

Q_3 = Rs. 600/- or 600

Therefore, the quartile deviation is $Q_3 – Q_1 / 2$

Quartile deviation = (Rs. 600/- – Rs. 300/-)

Quartile deviation = Rs. 300/- or 300

The coefficient of quartile deviation would be $Q_3 – Q_1 / Q_3 + Q_1$

Coefficient of quartile deviation = 600 – 300 / 600 + 300

Coefficient of quartile deviation = 0.33

Measurement of relationship: application in advertising research

Measurement of relationship is basically the technique to measure the directional or cause-and-effect relationship between two variables (Dayal, 2017). For advertising research, both directional and cause-and-effect scenarios appear when considering the connection between two variables. For example, when a Facebook advertisement is considered for its effectiveness, then the relationship between page conversion and positive comments might help in understanding the effectiveness of that Facebook advertisement. In another case, sales of a product increase because of a direct-action advertisement, which indicates a cause-and-effect relationship between the advertisement and the sales volume.

Correlation

Correlation stands for mutual relationship and is often referred to as correlativity, covariance, interrelation, mutuality, interrelation, relationship, association, etc. One of the most widely used among these is covariance, which indicates that the changes in the values of one variable initiate the changes in the values of another variable (Dayal, 2017). Correlation has its applicability in a wide range of applications that help in gathering information about the distribution of samples (Godfrey, 1980). The correlation coefficient is the numerical value of correlation, which calculates the extent, or degree and direction of correlation among the variables (Dayal, 2017).

Correlation can be segregated into three distinctive categories:

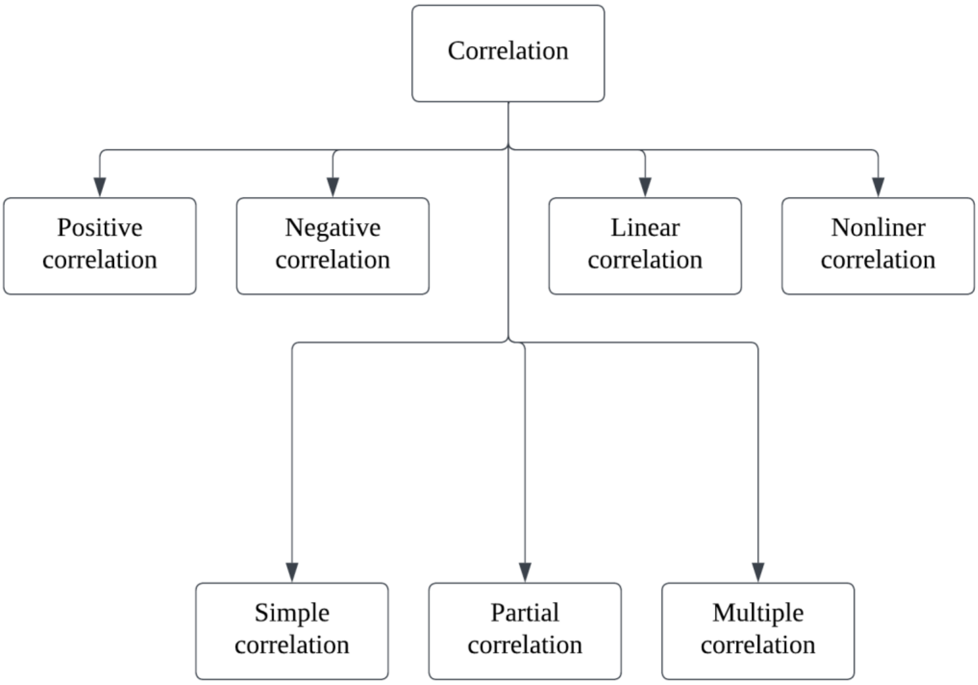

Fig. 5. Types of correlation. Adopted from the concepts proposed by Manoj Dayal in his book Media Metrics An Introduction to Quantitative Research in Mass Communication, 2017)

Positive correlation

A positive correlation indicates a direct relationship between the variables. The relationship defined in positive correlation can also be explained as when one variable increases, another variable also increases (Dayal, 2017). + 1 is considered the perfect positive correlation that shows the highest positive relationship between the variables (Mukaka, 2012).

For example, the correlation is required to be calculated between the Facebook advertisements and the number of shares of those advertisements on Facebook by the users. The observations are noted below:

Facebook advertisements: 11, 15, 20, 22, 24, 26, 30

Advertisements shared on Facebook: 14, 20, 23, 24, 26, 32, 40

The formula for the calculation of correlation is:

$r = \Sigma (X_i - \bar{X}) \times (Y_i - \bar{Y}) / \sqrt{} \Sigma (X_i - \bar{X})^2 \times (Y_i - \bar{Y})^2$

r stands for correlation coefficient

X_i stands for the values of the variable X

Y_i stands for the values of the variable Y

$\bar{X}$ stands for the mean of the values of the variable X

$\bar{Y}$ stands for the mean of the values of the variable Y

Therefore,

r = 0.96

Negative correlation

A negative correlation indicates the varying of the variables in opposite directions. In this type of correlation, when one variable increases, the other one decreases (Dayal, 2017). – 1 is considered the perfect negative correlation that shows the negative most relationship between the variables (Mukaka, 2012).

For example, you are trying to find out the relationship between Instagram advertisements and the number of shares of those advertisements on Instagram by the users. The observations are noted below:

Instagram advertisements: 25, 30, 40, 55, 75

Advertisements shared on Instagram: 45, 40, 30, 15, 10

The formula for the calculation of correlation would be the same:

$r = \Sigma (X_i - \bar{X}) \times (Y_i - \bar{Y}) / \sqrt{\Sigma (X_i - \bar{X})^2 \times (Y_i - \bar{Y})^2}$

Therefore,

$r = -.1$

Simple correlation, Partial correlation, Multiple correlation

Simple, partial, and multiple correlations are different from one another based on the number of variables they consider. For simple correlation, the number of variables is only two. The partial correlation can consider more than two variables; however, only two of those variables would change while others would stay constant. The multiple correlation also considers more than two variables; however, in this case, all the variables change or vary constantly and simultaneously (Dayal, 2017).

Linear and Nonlinear correlation

Linear correlation indicates the changes between the variables in the same proportion (Dayal, 2017). The linear relationship between the dependent and independent variables leads to the linear regression model (Wang, Zhang, 2011). In nonlinear correlation, the changes between the variables are disproportionate (Dayal, 2017). The nonlinear relationship between the variables leads to the nonlinear regression model (Wang, Zhang, 2011).

Table 8. Correlation coefficients and their values (from Perfectly positive correlation to Perfectly negative correlation). Adopted from the concepts proposed by Manoj Dayal in his book Media Metrics An Introduction to Quantitative Research in Mass Communication, 2017)

Description	Correlation Coefficient
Perfectly positive correlation	+ 1
Very highly positive correlation	From + 0.90 to + 1.00
Highly positive correlation	From + 0.70 to + 0.90
Moderately positive correlation	From + 0.40 to + 0.70
Low positive correlation	From + 0.20 to + 0.40
Very low positive correlation	From + 0.00 to + 0.20
Zero positive correlation	00
Very low negative correlation	From – 0.00 to – 0.20
Low negative correlation	From – 0.20 to – 0.40
Moderately negative correlation	From – 0.40 to – 0.70
Highly negative correlation	From – 0.70 to – 0.90
Very highly negative correlation	From – 0.90 to – 1.00
Perfectly negative correlation	– 1

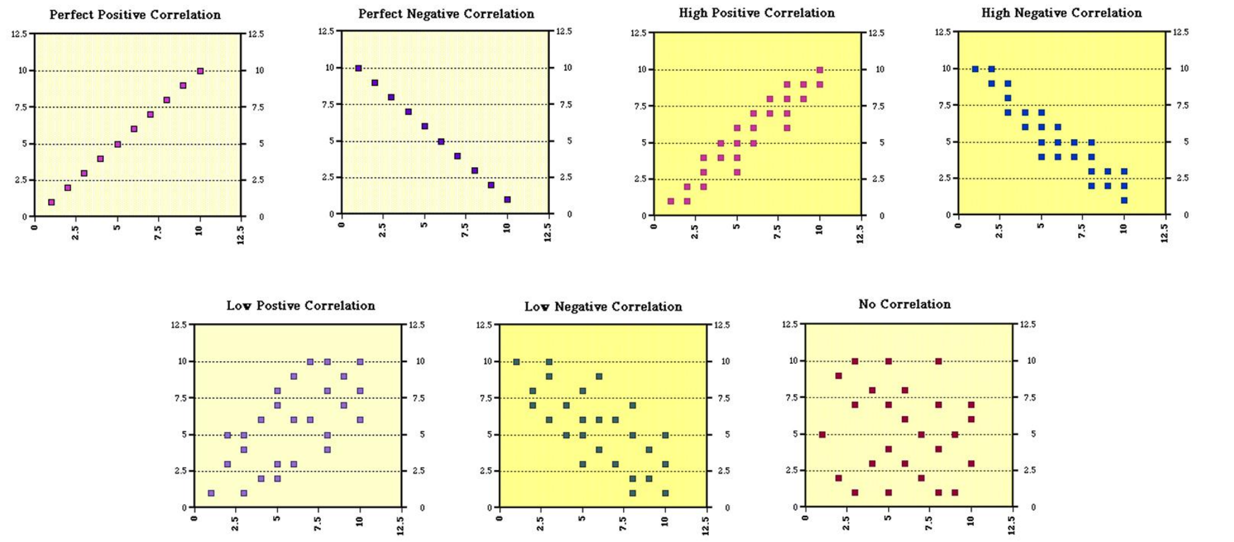

Fig. 6. Correlation coefficients and their values on scatter diagrams (from perfect positive correlation to perfect negative correlation (RCUB, 2023)

The values of the correlation coefficient are the indicators that describe the relationship between the variables. Based on the values, the correlation coefficients can be categorized into thirteen different categories (Table 8), ranging from the 'perfectly positive correlation' to 'perfectly negative correlation,' leading its way through the 'zero positive correlation.'

Regression

The correlation helps in comparing two variables, where regression talks about the cause of the changes among the variables. In 1877, Sir Francis Galton was the first one to use the term regression while he was measuring the height of sons and their fathers. The finding of the study was interesting as he found that although short fathers have short sons and tall fathers have tall sons, the average height of the sons of a group of tall fathers is lower than the average height of the sons from a group of short fathers. Francis Galton called the connecting line the 'regression line,' which is later on termed the 'estimating line' (Dayal, 2017). The regression equation is primarily used to define the cause and effect between the variables. Regression helps to investigate how changes in the values of one variable impact the changes in the value of another variable (Sykes, 1993).

For example, if you want to find out the changes in sales of a garment brand because of social media advertisements, regression analysis would help. The data for the sales of the garment brand (denoted by 1 per thousand units in a week) is denoted as X, and the number of advertisements in a week is denoted as Y, which is given below.

$X = 4, 6, 8, 10, 12$

$Y = 7, 9, 11, 10, 13$

For regression of Y on X: $Y = a + bX$

Where $b = N \times \Sigma XY - (\Sigma X) \times (\Sigma Y) / N \times \Sigma X^2 - (\Sigma X)^2$

and $a = \Sigma Y - b \times \Sigma X / N$

For regression of X on Y: $X = a + bY$

Where $b = N \times \Sigma XY - (\Sigma X) \times (\Sigma Y) / N \times \Sigma Y^2 - (\Sigma Y)^2$

and $a = \Sigma X - b \times \Sigma Y / N$

Table 9. Calculation of Σ (X, Y, X^2, Y^2 and XY) from the above data set

X	Y	X^2	Y^2	XY
4	7	16	49	28
6	9	36	81	54
8	11	64	121	88
10	10	100	100	100
12	13	144	169	156
$\Sigma X = 40$	$\Sigma Y = 50$	$\Sigma X^2 = 360$	$\Sigma Y^2 = 520$	$\Sigma XY = 426$

Now, to obtain two regression analyses, the data on X, Y, X^2, Y^2 and XY needs to be plotted in the formula:

For Y on X:

$Y = a + bX$, where the values of a and b would be required; therefore

$b = N \times \Sigma XY - (\Sigma X) \times (\Sigma Y) / N \times \Sigma X^2 - (\Sigma X)^2$

$b = 2130 - 2000 / 1800 - 1600$

$b = 0.65$

and, $a = \Sigma Y - b \times \Sigma X / N$

$a = 50 - 26 / 5$

$a = 4.8$

Therefore, $Y = 4.8 + 0.65 \times X$

For X on Y:

$X = a + bY$, where the values of a and b would again be required

$b = N \times \Sigma XY - (\Sigma X) \times (\Sigma Y) / N \times \Sigma Y^2 - (\Sigma Y)^2$

$b = 2130 - 2000 / 2600 - 2500$

$b = 1.3$

and, $a = \Sigma X - b \times \Sigma Y / N$

$a = 40 - 65 / 5$

$a = -5$

Therefore, $X = -5 + 1.3 \times Y$

Multivariate analysis: application in advertising research

Multivariate analysis (MVA) is a technique that allows the analysis of the changes in the values of multiple variables simultaneously (Dayal, 2017). Data from multivariate analysis includes the observations from several variables for multiple objects or individuals (Chatfield, 2018). Multivariate analysis can be of two types: dependent methods and independent methods. The dependent methods contain both independent and dependent variables, which include techniques like 'multiple regression analysis,' 'multiple discriminant analysis,' 'multiple ANOVA,' and 'canonical correlation analysis.' The independent method allows data with multiple variables without dependency. The methods to calculate the MVA under the independent method are: 'factor analysis,' 'cluster analysis,' 'multidimensional scaling analysis,' and 'latent structure analysis' (Dayal, 2017).

Following are the formulas for a few multivariate analyses that are often used in the field of advertising research:

Multiple regression analysis -

If there are three variables X_1, X_2, and X_3, then the equation would be

$X_1 = a_{1.23} + b_{12.3} X_2 + b_{13.2} X_3$

Now, the values of the $a_{1.23}$, $b_{12.3}$, $b_{13.2}$ can be obtained from

$\Sigma X_1 = Na_{1.23} + b_{12.3} \Sigma X_2 + b_{13.2} \Sigma X_3$

$\Sigma X_1 X_2 = a_{1.23} + b_{12.3} \Sigma X_{2\ 2} + b_{13.2} \Sigma X_2 . X_3$

$\Sigma X_1 X_3 = a_{1.23} \Sigma X_3 = b_{12.3} \Sigma X_2 . X_3 + b1_{3.2} X_{2\ 3}$

Multiple discriminant analysis -

Under multiple discriminant analysis, let us consider three variables X_1, X_2, and X_3, which would forming the equation like

$Y = W_1 X_1 + W_2 X_2 + W_3 X_3$

Parametric and Non-parametric tests: application in advertising research

Parametric tests are used to measure the given parameters to determine whether two samples are equal or not. Non-parametric tests are useful for micro-focused areas in social science like advertising research (Dayal, 2017). Parametric tests are used if the data is normally distributed, there is homogeneity between the variables, the data present a linear relationship, and it shows independence. The non-parametric tests are useful for the set of data that do not follow the normal distribution, and smaller sample size (Pandey, 2020). When comparing parametric tests with non-parametric tests, three major areas are to be considered: 'significance level,' 'power,' and 'versatility' (Anderson, 1961).

Table 10. Variation between parametric and non-parametric tests, based on the variables. (DATAtab, 2024)

Variables	Parametric tests	Non-parametric tests
One sample	Sample t-Test	Wilcoxon test for one sample
Two dependent samples	Paired Sample t-Test	Wilcoxon Test
Two independent samples	Unpaired Sample t-Test	Mann-Whitney U Test
More than two independent samples	One Factorial ANOVA	Kruskal-Wallis Test
More than two dependent samples	Repeated measures ANOVA	Friedman Test
Correlation between two variables	Pearson Correlation	Spearman Correlation

The selection between the parametric and non-parametric tests would become easier if the nature and number of variables were properly identified. The parametric and non-parametric tests differ based on 'one sample,' 'two dependent samples,' 'two independent samples,' 'more than two independent samples,' 'more than two dependent samples,' and 'correlation between two variables' (Table 10).

5. Conclusion

Selecting an appropriate quantitative research method for analyzing advertisements often becomes challenging for researchers as it would require carefully identifying the advertising metrics, categorization of variables, and, most importantly, selecting an appropriate statistical method. While researchers may get confused between descriptive and inferential statistics, one should remember that descriptive statistics works on the sample taken out from the population, and inferential statistics helps generalize the findings based on the sample to the population. The most common struggle is to select an appropriate test for the data collected for the study, where a list of available tests for both descriptive and inferential statistics under quantitative research comes up. Sometimes, it is enough to apply simple methods like mean, median, and mode to analyze and conclude the data; however, on some occasions, the nature of the study compelled the researcher to apply complex methodologies like mean deviation, standard deviation, correlation, regression, etc. Under inferential statistics, the methods are decided based on the distribution of data, where the parametric tests like F-test, t-test, Z-test, ANOVA, etc., are applied if the data is normally distributed and the non-parametric tests like Chi-square, U-test, H-test, Mood tests, Fridman test, etc. are used if the data is not normally distributed. There are differences in the parametric and non-parametric tests based on the nature of the variables as well. The tests of any kind under quantitative methodology to analyze a piece of advertisement or a series of advertisements and their impact over a period of time would depend on the objective of the research; therefore, a researcher needs to identify the objectives of the study before randomly selecting a quantitative method or a number of quantitative methods for the study.

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