Chapter-III

Research Methodology
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RESEARCH METHODOLOGY

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RESEARCH METHODOLOGY

3. BACKDROP:
This chapter provides the detailed description of the objectives, scope, significance, research design and sources of primary and secondary data. It also describes sampling design, data collection method & procedure adopted for collecting data, division of questionnaire, validity and reliability of questionnaire, details of processing data. Finally it describes the particular details of statistical tests used for analysis of the data.

3.1 INTRODUCTION:
Research is a scientific (Kothari 2000) systematic search for pertinent information on a specific topic. The Advanced Learner’s Dictionary of Current English has given the meaning of research as “a careful investigation or inquiry especially through search for new facts in any branch of knowledge.” Research is considered as an endeavor to arrive at answers to intellectual and practical problems through the application of scientific methods for knowable universe. It simply means a search for facts. Moreover, it is an organized inquiry.

3.2 RESEARCH GAP:
After the in-depth literature review, it was found that various aspects of Work-Life Balance have been studied by different researcher from various countries. The variables such as demographic factors, career aspects and outcomes of Work-Life Balance were studied separately, whereas this study basically would combine various personal, organizational and family factors and their influence on Work-Life Balance of Bank employees working in public, private, foreign and co-operative banks all together. Hence it attempts to discover,
Research Methodology

- Work-life balance aspects of bank employees working in public, private, foreign and co-operative sector.
- Whether bank employees can manage their work-life.
- Different personal, family and organizational causes to the work-life imbalance.
- Support mechanism which helps to maintain the work-life balance.
- And to discover the relation between work-life balance and job satisfaction among bank employees.

On the basis of the said problem statements, the researcher has set the following objectives for the study:

3.3 **OBJECTIVES:**

1. To understand the concept of Work-Life Balance and background of banking sector jobs.
2. To study whether bank employees can balance their work/life
3. To study public, private, foreign and co-operative bank employees differ over work-life balance.
4. To study the factors influencing work-life balance.
5. To study the relationship between work-life balance and job satisfaction.
6. To present the model to study and predict the factors influencing work-life balance and outcomes.

3.4 **HYPOTHESIS:**

It is a supposition or explanation (theory) that is provisionally accepted in order to interpret certain events or phenomena, and to provide guidance for further investigation. A hypothesis may be proven correct or wrong, and must be capable of refutation. If it remains un-refuted by facts, it is said to be verified or corroborated.
Further from the statistical perspective it is an assumption about certain characteristics of a population. If it specifies values for every parameter of a population, it is called a simple hypothesis; if not, a composite hypothesis. If it attempts to nullify the difference between two sample means (by suggesting that the difference is of no statistical significance), it is called a null hypothesis.

Based on the objectives of the study the researcher hypothesizes the following:

1. Bank employees are unable to balance their work/life
2. Public, private, foreign and co-operative bank employees do not differ over work-life balance.
3. Personal, family and organization factors do not influence work-life balance.

3.5 SCOPE AND LIMITATIONS OF THE STUDY:
The present study of Work-Life balance in banking sector covers the employees from public, private, foreign and co-operative banks having their branches in Pune City in Maharashtra. It covers employees at each hierarchical level of the branches like – branch managers, officers from various departments and clerks and sub staff employed.

It does not cover
1. Unscheduled Banks
2. NABARD (National Bank for Agriculture and Rural Development)
3. Rural co-operative banks like state, district and primary co-operative banks
4. SCARBDs (State-Level Co-operative Agriculture and Rural Development Banks, PCARDBs (Primary Co-operative Agriculture and Rural Development Banks)
5. Regional Rural Banks
Further, it does not cover

1. Wholesale banking branches (serving to industrial clients)
2. Treasury
3. Para-banking activity branches such as leasing business, merchant banking etc.

It even does not cover hierarchy level like

1. Senior Management Grade – Scale IV: Chief Manager
2. Senior Management Grade Scale V: Assistant General Manager
3. Top Management Grade Scale VI: Deputy General Manager
4. Top Management Grade Scale VII: General Manager

3.6 SIGNIFICANCE OF THE STUDY:
India is fastest growing economy, having many opportunities in banking sector. These opportunities will expose them with the problems of stress and health related issues. Demanding careers will pose the question of Work-Life Balance which has to be addressed and resolved. The findings present study of work-life balance in banking sector will reveal the scenario of the employees from Public, private, foreign and co-operative banks which can be further used for policy decisions also as the case studies for the student of management.

3.7 PILOT STUDY FOR NEED OF THE STUDY:
The Researcher had conducted a pilot survey to know whether a study is viable in terms need for the on Work-Life Balance on the sample of 100 working in Banks with a structured questionnaire, and found the following:

- almost 87% of the people feel their job makes them feel too tired to do the things that need attention at home.
- they feel having a good day on the job makes them a better companion at home.
- 50% of the people feel that their personal and family worries and problems distract them when they are at work.
This pilot study provided the basis for understanding the need of work-life balance practices/polices in the bank employees.

3.8 RESEARCH DESIGN:
The research design is the blueprint for fulfilling objectives and answering questions. According to Clifford Woody research comprises “defining and redefining problems, formulating hypothesis or suggested solutions; collecting, organizing and evaluating data; making deduction and reaching conclusions; and at last carefully testing the conclusions to determine whether they fit the formulating hypothesis.” Research is really a method of critical thinking. Burns and Grove (2001) define Research methodology as the total strategy, from the identification of the problem, to the final plans for data gathering and analysis.

The present study of Work-Life balance in banking sector focuses to study the phenomena and characteristics associated with employees working in different types of banks and understanding the causes of the work-life imbalance, how they are able to balance, what factors help them to maintain the balance in work-life activities as well as the relationship between work-life balance and job satisfaction of these bank employees. The following table in which highlighted sentences describes the research design as per Donald Cooper and Pamela S Schindler, J.K. Sharma in Business Research Methods.

<table>
<thead>
<tr>
<th>Category</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>The degree to which the research question has been crystallized</td>
<td>Exploratory study</td>
</tr>
<tr>
<td></td>
<td><strong>Formal study ( begins with a hypothesis and involves precise procedures and data source specification)</strong></td>
</tr>
<tr>
<td>The method of data collection</td>
<td>Monitoring</td>
</tr>
<tr>
<td></td>
<td><strong>Communication study (the researcher questions</strong>)</td>
</tr>
<tr>
<td>Category</td>
<td>Options</td>
</tr>
<tr>
<td>----------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>The power of the researcher to produce</td>
<td><strong>Experimental</strong></td>
</tr>
<tr>
<td>effects in the variables under study</td>
<td><strong>Ex-post facto (investigators have no control over the variables, they can only report what has happened or what is happening)</strong></td>
</tr>
<tr>
<td>The purpose of the study</td>
<td><strong>Reporting (provides a summation of data, often recasting data to achieve a deeper understanding or to generate statistics for comparison)</strong></td>
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<tr>
<td></td>
<td>Descriptive</td>
</tr>
<tr>
<td></td>
<td>Causal</td>
</tr>
<tr>
<td></td>
<td>• Explanatory</td>
</tr>
<tr>
<td></td>
<td>• Predictive (Study attempts to predict an effect on one variable by another variable while holding all other variables constant.)</td>
</tr>
<tr>
<td>The time dimension</td>
<td><strong>Cross-sectional studies (are carried out once and represent a snapshot of one point in time)</strong></td>
</tr>
<tr>
<td></td>
<td>Longitudinal studies</td>
</tr>
<tr>
<td>The topical scope-breadth and depth of the study</td>
<td><strong>Case</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Statistical study (attempt to capture a population’s characteristics by making inferences from a sample’s characteristics. Hypotheses are tested quantitatively.)</strong></td>
</tr>
<tr>
<td>The research environment</td>
<td><strong>Field setting (actual environmental conditions)</strong></td>
</tr>
<tr>
<td></td>
<td>Laboratory research</td>
</tr>
<tr>
<td></td>
<td>Simulation</td>
</tr>
<tr>
<td>The participant’s perceptions of research</td>
<td><strong>Actual routine (Participants perceive no deviations from everyday routines)</strong></td>
</tr>
<tr>
<td>activity</td>
<td>Modified routine</td>
</tr>
</tbody>
</table>
The present study of Work-Life balance in banking sector begins with the formal hypothesis of discovering whether the bank employees are able to balance work/life, do different types of the bank employees differ in the balancing work/life. What are different causes and support mechanism do they adapt to? And is there any relation between work/life balance and job satisfaction among these employees. The researcher has used the structured questionnaire to solicit the responses from the bank employees from public, private, foreign and co-operative banks. The variables under study like gender, hierarchy, career stage, daily chores, stress at organization, workload, impact of work to home, impact of home to work, supervisory support, workholism, family and spousal support, job satisfaction etc. where investigator have no control over the variables, can only report what has happened or what is happening. The researcher will provide a summation of data, and recasts data to achieve a deeper understanding or to generate statistics for comparison and attempt to predict an effect on one variable by another variable while holding all other variables constant and present the current status of the phenomena. It was a statistical study which attempts to capture a population’s characteristics by making inferences from a sample’s characteristics. Hypotheses are tested quantitatively from the primary data received from employees of different sector banks and participants did not perceive any deviations from their everyday routines.

3.9 POPULATION:
A research population is also known as a well-defined collection of individuals or objects known to have similar characteristics. All individuals or objects within a certain population usually have a common, binding characteristic or trait.

A research population is generally a large collection of individuals or objects that is the main focus of a scientific query. It is for the benefit of the population
that researches are done. However, due to the large sizes of populations, researchers often cannot test every individual in the population because it is too expensive and time-consuming.

In this study all “Bank employees” forms the population for the research.

3.10 SOURCES OF SECONDARY DATA:
While primary data will be collected through questionnaires, depth interview, and observation; The secondary data will be obtained through

1. Internal Sources - These are within the organization
2. External Sources - These are outside the organization

Internal Sources of Data:
If available, internal secondary data may be obtained with less time, effort and money than the external secondary data. In addition, they may also be more pertinent to the situation at hand since they are from within the organization. The internal sources include

1. Publications and Reports- It gives information about the bank and their policies etc.
2. Internal Experts- These are people who are heading the various departments. They can give an idea of how a particular thing is working.

In addition to this, ample data will also be available outside the banks.

External Sources of Data:
External Sources are sources which are outside the banks in a larger environment. Collection of external data is more difficult because the data have much greater variety and the sources are much more numerous.
External data can be divided into following classes.

a) Government Publications - Government sources provide an extremely rich pool of data for the researchers. In addition, many of these data are available free of cost on internet websites. There are number of government agencies generating data. These are:

1. Registrar General of India - It is an office which generates demographic data. It includes details of gender, age, occupation etc.
2. Central Statistical Organization - This organization publishes the national accounts statistics. It contains estimates of national income for several years, growth rate, and rate of major economic activities. Annual survey of Industries is also published by the CSO. It gives information about the total number of workers employed, production units, material used and value added by the manufacturer.
3. Planning Commission - It provides the basic statistics of Indian Economy.
4. Reserve Bank of India - This provides detailed information banking sector. It also publishes numerous useful articles and finance reports.
5. Labour Bureau - It provides information on skilled, unskilled, white collared jobs etc.
6. National Sample Survey - This is done by the Ministry of Planning and it provides social, economic, demographic, industrial and agricultural statistics.

b) Non Government Publications - These include publications of various industrial and trade associations, such as

1. Various chambers of commerce
2. The Bombay Stock Exchange (it publishes a directory containing financial accounts, key profitability and other relevant matter)
3. Various Associations of Press Media.
4. Confederation of Indian Industries (CII)

c) **International Organization** - This will include,

1. The International Labour Organization (ILO) - It publishes data on the total and active population, employment, unemployment, wages and consumer prices

### 3.11 PRIMARY DATA:
Data collected from first-hand-experience is known as primary data. It is more reliable, authentic and objective. Therefore its validity is greater than secondary data. A research can be conducted without secondary data but a research based on only secondary data is least reliable and may have biases because secondary data has already been manipulated by human beings. In statistical surveys it is necessary to get information from primary sources and work on primary data: for example, the statistical records of female population in a country cannot be based on newspaper, magazine and other printed sources. One such sources are old and secondly they contain limited information as well as they can be misleading and biased.

In this study primary data will be collected through structured questionnaire and depth-interview of employees working in different types of banks at different hierarchy.

### 3.12 SAMPLING DESIGN:
This step in planning the research project is to identify the target population (those people, events, or records that contain the desired information and can answer the measurement questions) and then determine whether a sample or a census is desired. Taking a census requires that the researcher examine or count
all elements in the target population (which is impossible in present study as according to the data presented on RBI site there are approximately 10 lakh employees working in banking sector in India) and sample examines a portion of the target population, and the portion must be carefully selected to represent that population. The sample was comprised of employees all types ie. public, private, foreign and co-operative banks as well as all hierarchical level of bank branches.

3.12.1 Sample Selection:
The process of selecting a sufficient number of elements from the population is known as sampling. The following sample was selected for this study:

The sampling unit:
- Bank employees from public, private, foreign and co-operative banks.
- Bank employees from all cadre ie. Branch managers, Officers and Clerk, Sub-staff from different branches.
- Bank employees of all age groups.
- Bank employees including male and female irrespective of their experience (tenure of work).
- Bank employees willing to participate in survey.

3.12.2 Sample Size:
Holloway and Wheeler (2002) indicate that sample size does not influence the importance or quality of the study and in quantitative research sample should be such that the results of the sample study can be applied, in general, for the universe with a reasonable level of confidence. Keeping both the arguments in view, researcher has calculated sample size as follows:

\[ n = \frac{z^2 \cdot s^2}{e^2} \]

Where,
- \( n = \) Sample Size
- \( z = \) Standard Score of Level of Confidence (95 %)

i.e. 1.96 In this case
\[ s = \text{Standard Deviation} = \frac{\text{Range}}{6} = \frac{5-1}{6} = \frac{4}{6} = 0.67 \]
\[ e = \text{tolerable error (considered as 7\%)} \]

Therefore,
\[ n = \frac{(1.96)^2 \times (0.67)^2}{(0.0049)^2} \]
\[ = \frac{1.720}{0.0049} = 351 \]

Value of Z is taken from the statistic normal table and is equal to 1.96.

By using this formula, the value of the sample size should be 351, researcher had distributed 700 questionnaire, only 362 were received back and found 340 questionnaires to be useful for the study. 22 were rejected due to incomplete information.

So the investigator has taken the sample size = 340.

3.12.3 Sampling Strategy:
A sample strategy is designed that would be representative of people from various cadre of hierarchy and from all types of banks ie. Public sector, private sector, foreign banks and multi-state scheduled banks (co-operative banks).

To tackle the problem of under-representing, quota is applied across the entire sample. The following table shows target sample according to gender and cadre:

**Table 3.2 : Sampling Strategy**

<table>
<thead>
<tr>
<th>Gender/Cadre</th>
<th>Managers</th>
<th>Officers</th>
<th>Clerks and Other Support Staff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>25</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>Female</td>
<td>25</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>50</strong></td>
<td><strong>100</strong></td>
<td><strong>200</strong></td>
</tr>
<tr>
<td><strong>Grand Total</strong></td>
<td><strong>350</strong>zahl</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The List of Banks to be included in the study is as follows:

Table 3.3: List of Banks in the Study

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Name of the Bank</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>State Bank of India</td>
</tr>
<tr>
<td>2</td>
<td>State Bank of Hyderabad</td>
</tr>
<tr>
<td>3</td>
<td>State Bank of Patiala</td>
</tr>
<tr>
<td>4</td>
<td>State Bank of Bikaner and Jaipur</td>
</tr>
<tr>
<td>5</td>
<td>Punjab National Bank</td>
</tr>
<tr>
<td>6</td>
<td>Canara Bank</td>
</tr>
<tr>
<td>7</td>
<td>Bank of India</td>
</tr>
<tr>
<td>8</td>
<td>Bank of Baroda</td>
</tr>
<tr>
<td>9</td>
<td>Bank of Maharashtra</td>
</tr>
<tr>
<td>10</td>
<td>Central Bank of India</td>
</tr>
<tr>
<td>11</td>
<td>HDFC</td>
</tr>
<tr>
<td>12</td>
<td>Axis Bank</td>
</tr>
<tr>
<td>13</td>
<td>ICICI</td>
</tr>
<tr>
<td>14</td>
<td>Kotak Mahindra Bank</td>
</tr>
<tr>
<td>15</td>
<td>IndusInd Bank</td>
</tr>
<tr>
<td>16</td>
<td>Standard Chartered Bank</td>
</tr>
<tr>
<td>17</td>
<td>Citibank</td>
</tr>
<tr>
<td>18</td>
<td>HSBC</td>
</tr>
<tr>
<td>19</td>
<td>Yes Bank</td>
</tr>
<tr>
<td>20</td>
<td>Royal Bank of Scotland</td>
</tr>
<tr>
<td>21</td>
<td>Abhyudaya co-operative Bank</td>
</tr>
<tr>
<td>22</td>
<td>The Cosmos Co-operative Bank</td>
</tr>
<tr>
<td>23</td>
<td>Bharati Sahakari Bank</td>
</tr>
<tr>
<td>24</td>
<td>Shamarao Vithal Co-operative Bank</td>
</tr>
<tr>
<td>25</td>
<td>Saraswat Co-operative Bank Limited</td>
</tr>
</tbody>
</table>
3.13 DATA COLLECTION:
Kothari (2000) indicates that, in dealing with any real life problem it is often found that data at hand are inadequate and hence, it becomes necessary to collect data that are appropriate.

3.13.1 Method of Data Collection:
According to Saunders et al (2007) there are many ways in which the data can be collected: performing interviews, using questionnaires, or conducting experiments. According to Uma Sekaran (2000) projective tests can also be employed where respondents are asked to write a story, complete a sentence or describe their reactions to pictures. According to Kothari (2000) primary data can be collected by any one or more of the following ways:

1. By observation
2. Through personal interview
3. Through telephone interview
4. By mailing of questionnaires
5. Through schedules

Every method has its own merits and demerits. Thus it is important to give attention to the choice of the data collection method. In this context Dr. A.K. Bowley very aptly remarks, that in collection of statistical data commonsense is the chief requisite and experience the chief teacher.

3.13.2 Collection of data through questionnaires:
According to C.R. Kothari (2009) this method of data collection is quite popular, particularly in case of big enquiries. It is being adopted by private individuals, research workers, private and public organizations and even by governments. Questionnaires claim the following merits:
1. There is low cost even when the universe is large and is widely spread geographically.
2. It is free from the bias of the interviewer; answers are in respondents own words.
3. Respondents have adequate time to give well thought out answers
4. Respondents, who are not easily approachable, can also be reached conveniently.
5. Large samples can be made use of and thus the results can be made more dependable and reliable.

Main demerits of administering questionnaires are - low rate of return of duly filled in questionnaires, possibility of ambiguity, omission of replies and slowest of all.

As researcher wanted to collect the data which was structured and wanted reach out maximum number of employees of the bank located in various places and from different types of banks ie. Public, private, foreign, co-operative banks without any bias and this tool gave the freedom to the researcher as also can be filled in with greater convenience of the respondents, so structured questionnaire was prepared and administered to solicit the responses from the respondents.

3.13.3 Data Collection Procedure:
In order to obtain necessary information, researcher needed to administer the questionnaire from various branches of different types of banks ie. Public, private, foreign and co-operative. Researcher contacted branch managers and enquired for the time availability of all the staff and then visited the branches. Sometimes researcher explained questions in questionnaire and kept the questionnaire with the respondents and collected them next day.
3.13.4 Structure of Questionnaire:
The questionnaire was comprised of 4 parts:

PART-I : General information (measured using multiple options/ choice, dichotomous scale)

1. Demographic information - Name, Mobile no. and Email Id, Gender, Age, Marital Status, No. of dependents, Age group of children and parents, Family type, working spouse
2. About employment - Type of bank, hierarchy level, career stage, number of working days, number of working hours, commuting time
3. About responsibilities at home and the frequency of these activities. Taking care of parents/ children, Cleaning/dusting, Cooking, buying grocery, Teaching kids, support mechanism for daily chores
5. Ability to balance work-life
6. Level of difficulty in balancing work-life

PART-II: Factors influencing work-life (measured using Likerts 5 point scale having 1=Never.. 5=Always)

1. Interference of Work on Home
2. Interference of Home on Work
3. Social life within organization
4. Social life outside organization
5. Workholism
6. Supervisory support
7. Spousal and Family support
PART-III: Outcome of work-life balance (measuring satisfaction level using Likerts 5 point scale having 1=strongly disagree... 5=strongly agree)

1. Job satisfaction
2. Career Satisfaction
3. Health
4. Life satisfaction
5. Quality time with family
6. Free time for self
7. Time for friends, hobbies, etc.
8. Salary

PART-IV: Suggestion for banks to improve the work-life policies

3.13.5 Questionnaire Development:
The questionnaire was developed taking the references from all existing literature and the major references are as follows:

1. Dr. Ajay Chauhan, “A Study of Work-Life Balance of B-School Faculty in Delhi region”


3.1.3.6 Validity and Reliability of Questionnaire:

The questionnaire consisted of several questions regarding the different aspects of this research as given above. Before the questionnaire was finalized a pilot study had been conducted to check the validity and reliability of the same. Validity was tested using focused interview and group discussions and the Cronbach’s alpha was used as an indicator of the reliability of the questionnaire and the Cronbach alpha was found to be 0.87. Cronbach's alpha will generally increase as the inter-correlations among test items increase, and is thus known as an internal consistency estimate of reliability of test scores. Because inter correlations among test items are maximized when all items measure the same construct, Cronbach's alpha is widely believed to indirectly indicate the degree to which a set of items measures a single unidimensional latent construct.

3.14 PROCESSING OF DATA:

Processing and analyzing data involves a number of closely related operations which are performed with the purpose of summarizing the collected data and organizing these in a manner that they answer the research questions (objectives).
The Data Processing operations are:

1. Editing - a process of examining the collected raw data to detect errors and omissions and to correct these when possible.

2. Classification - a process of arranging data in groups or classes on the basis of common characteristics. Depending on the nature of phenomenon involved, the data was classified according to attributes.

3. Tabulation - Tabulation is the process of summarizing raw data and displaying the same in compact form for further analysis. It is an orderly arrangement of data in columns and rows.

4. Tabulation is essential because:
   - It conserves space and reduces explanatory and descriptive statement to a minimum.
   - It facilitates the process of comparison.
   - It facilitates the summation of items and the detection of errors and omissions.
   - It provides the basis for various statistical computations.

To avoid possible errors in the calculation and analysis Researcher had made it sure to get the completely filled questionnaire. In case of any unfilled data out of oversight, while discussing with the respondents, researcher made attempt to understand their stand, and filled the necessary details.

The Data received was coded according to the option ticked.

3.15 **STATISTICAL ANALYSIS OF THE DATA:**
Data input was being of 340 bank employees and having different variables under study, its analysis was done using IBM SPSS Statistics 20.0
Various tests applied were as follows:

1. **Frequency distribution** - A frequency distribution is an arrangement of the values that one or more variables take in a sample. Each entry in the table contains the frequency or count of the occurrences of values within a particular group or interval, and in this way, the table summarizes the distribution of values in the sample.

2. **Graphs and charts** - A picture is worth a thousand words. This is certainly true when you're presenting and explaining data. Information communicated in tables can be misunderstood, a graph or a chart, help people understand data quickly.

3. **Cross tabs** - Cross tabulation (or crosstabs for short) is a statistical process that summarizes categorical data to create a contingency table. They are heavily used in survey research, business intelligence, engineering and scientific research. They provide a basic picture of the interrelation between two variables and can help find interactions between them.

4. **χ² test** - A chi-squared test, also referred to as chi-square test or $\chi^2$ test, is any statistical hypothesis test in which the sampling distribution of the test statistic is a chi-squared distribution when the null hypothesis is true. Also considered a chi-squared test is a test in which this is asymptotically true, meaning that the sampling distribution (if the null hypothesis is true) can be made to approximate a chi-squared distribution as closely as desired by making the sample size large enough. The chi-square (I) test is used to determine whether there is a significant difference between the expected frequencies and the observed frequencies in one or more categories.
5. **Kruskal-Wallis test of normality** - The Kruskal–Wallis one-way analysis of variance by ranks (named after William Kruskal and W. Allen Wallis) is a non-parametric method for testing whether samples originate from the same distribution. It is used for comparing two or more samples that are independent, and that may have different sample sizes, and extends the Mann–Whitney U test to more than two groups. The parametric equivalent of the Kruskal-Wallis test is the one-way analysis of variance (ANOVA). When rejecting the null hypothesis of the Kruskal-Wallis test, then at least one of sample stochastically dominates at least one other sample. The test does not identify where this stochastic dominance occurs or for how many pairs of groups stochastic dominance obtains. Dunn's test would help analyze the specific sample pairs for stochastic dominance. Since it is a non-parametric method, the Kruskal–Wallis test does not assume a normal distribution of the residuals, unlike the analogous one-way analysis of variance. If the researcher can make the more stringent assumptions of an identically shaped and scaled distribution for all groups, except for any difference in medians, then the null hypothesis is that the medians of all groups are equal, and the alternative hypothesis is that at least one population median of one group is different than the population median of at least one other group.

6. **Mann-Whitney test** - the Mann–Whitney U test (also called the Mann–Whitney–Wilcoxon (MWW), Wilcoxon rank-sum test, or Wilcoxon–Mann–Whitney test) is a nonparametric test of the null hypothesis that two populations are the same against an alternative hypothesis, especially that a particular population tends to have larger values than the other. It has greater efficiency than the t-test on non-normal distributions, such as a mixture of normal distributions, and it is nearly as efficient as the t-test on normal distributions. The Wilcoxon rank-sum
test is not the same as the Wilcoxon signed-rank test, although both are nonparametric and involve summation of ranks.

Assumptions and formal statement of hypotheses
Although Mann and Whitney developed the MWW test under the assumption of continuous responses with the alternative hypothesis being that one distribution is stochastically greater than the other, there are many other ways to formulate the null and alternative hypotheses such that the MWW test will give a valid test.\[2\]

A very general formulation is to assume that:

1. All the observations from both groups are independent of each other,

2. The responses are ordinal (i.e. one can at least say, of any two observations, which is the greater),

3. The distributions of both groups are equal under the null hypothesis, so that the probability of an observation from one population (X) exceeding an observation from the second population (Y) equals the probability of an observation from Y exceeding an observation from X. That is, there is a symmetry between populations with respect to probability of random drawing of a larger observation.

4. Under the alternative hypothesis, the probability of an observation from one population (X) exceeding an observation from the second population (Y) (after exclusion of ties) is not equal to 0.5. The alternative may also be stated in terms of a one-sided test, for example: \( P(X > Y) + 0.5 \) \( P(X = Y) > 0.5 \).
5. Logistic Regression- Logistic Regression, or Logit Regression, is a type of probabilistic statistical classification model. It is also used to predict a binary response from a binary predictor, used for predicting the outcome of a categorical dependent variable (i.e., a class label) based on one or more predictor variables (features). That is, it is used in estimating the parameters of a qualitative response model. The probabilities describing the possible outcomes of a single trial are modeled, as a function of the explanatory (predictor) variables, using a logistic function. Frequently (and subsequently in this article) "logistic regression" is used to refer specifically to the problem in which the dependent variable is binary—that is, the number of available categories is two—while problems with more than two categories are referred to as multinomial logistic regression or, if the multiple categories are ordered, as ordered logistic regression.

6. Logistic regression measures the relationship between a categorical dependent variable and one or more independent variables, which are usually (but not necessarily) continuous, by using probability scores as the predicted values of the dependent variable.

7. ROC curve - ROC curve, is a graphical plot which illustrates the performance of a binary classifier system as its discrimination threshold is varied. It is created by plotting the fraction of true positives out of the total actual positives (TPR = true positive rate) vs. the fraction of false positives out of the total actual negatives (FPR = false positive rate), at various threshold settings. TPR is also known as sensitivity or recall in machine learning. The FPR is also known as the fall-out and can be calculated as one minus the more well known specificity. The ROC curve is then the sensitivity as a function of fall-out. In general, if both of the probability distributions for detection and false alarm are known, the ROC curve can be generated by plotting the Cumulative Distribution
Function (area under the probability distribution from -inf to +inf) of the detection probability in the y-axis versus the Cumulative Distribution Function of the false alarm probability in x-axis.

ROC analysis provides tools to select possibly optimal models and to discard suboptimal ones independently from (and prior to specifying) the cost context or the class distribution. ROC analysis is related in a direct and natural way to cost/benefit analysis of diagnostic decision making.

### 3.16 CONCLUSION:

Having described all the research methodology in detail, the next chapter will provide the analysis of data processed results in detail.