CHAPTER V

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CHAPTER V

RESEARCH METHODOLOGY

5.1. Introduction

5.1.1. Research in common parlance refers to a search for knowledge. It is a scientific and systematic search for pertinent information on a specific topic. In fact, research is an art of scientific investigation. Inquisitiveness is the mother of all knowledge and the method, which a man employs of the knowledge of whatever the unknown, can be termed as research. According to Clifford Woody “research comprises defining and redefining problems, formulating hypothesis or suggested solutions; collecting, organizing and evaluating data; making deductions and reaching conclusions; and at last carefully testing the conclusions to determine whether they fit the formulating hypothesis”. D Slesinger and M Stephenson in the Encyclopedia of Social Sciences define research as “the manipulation of things, concepts or symbols for the purpose of generalizing to extend, correct or verify knowledge, whether that knowledge aids in construction of theory or in the practice of art.” As such the term ‘research’ refers to systematic method consisting of enunciating the problem, formulating a hypothesis, collecting the facts or data, analyzing the facts and reaching certain conclusions either in the form of solutions towards the concerned problem or in certain generalizations for some theoretical formulation.

5.2. Objectives of this Research

5.2.1. The purpose of this research is to discover answers to questions through the application of scientific procedures. The main aim of research is to find out certain areas, which have not been treading by many in the field of industrial safety.
Most of the research work falls into a number of broad groupings:

- **Exploratory or formulative research.** These studies have the object of gaining familiarity with a phenomenon or to go into the subject with the aim of achieving new insight.

- **Descriptive research.** A particular individual, situation or a group is associated with certain characteristics. The aim of the research, which associates with portraying these characteristics accurately, falls in this category of research works.

- **Diagnostic research.** To determine the frequency with which something occurs or with which it is associated with something else.

- **Hypothesis-testing research.** This type of research work aims at testing casual relationship between variables.

5.2.2. The subject selected for research in this paper cannot be singularly classified in to any of the above mentioned categories. It is a combination of exploratory, and hypothesis-testing research work, with a bias towards formulative research.

5.2.3. Industrial safety is a subject of constant review with technological advancement and economic growth. Industry in the present environment is the largest contributor to human manifestations. It feeds millions, and facilitates social security. Neglect at any stage can be catastrophic. So the endeavor of the society at large and management experts is to review this aspect so that damage of any sort resulting into loss of human lives, incapacitation, and loss of industrial production can be obviated.

5.2.4. There are certain factors, which contributed for under taking this research. First and foremost was the desire to get intellectual joy of doing some creative work. Secondly there is the desire to be of service to the society. Thirdly, there
was the desire to face the challenge in solving the unsolved problem, and finally the desire to get a research degree and respectability.

5.2.5. This research work is an analytical research, wherein facts or information already available are analyzed to make critical evaluation of the material. However certain facets of this research work overlaps into applied research.

5.2.6. Approach adopted is quantitative in this research work. Here generation of data in the quantitative form is undertaken which can be subjected to rigorous quantitative analysis in a formal and rigid fashion. This is a survey research where a sample of population is studied to determine its characteristics.

5.3. Research Method

5.3.1. All the methods used in the conduct of research can be classified into two namely, library research, and field research. These can be tabulated and described thereafter as given in the Table 5.3.1. at the end of this chapter.

5.3.2. From the above, we can say that methods are more general. It is the methods that generate techniques. However, in practice, the two terms are taken as interchangeable and when we talk of research methods we do by implication, include research techniques as well (Marie Jodha, Morton Deutsch and Stuart W Cook, Research methods in social relationships).

5.3.3. Since the object of this research is to arrive at a solution for the given problem of industrial safety, the available data and the unknown aspects of the problem have to be related to each other to make a solution possible. For these following steps were taken: -

- Firstly all the methods which are concerned with collection of data were taken. They were used to collect data as per the requirement for the thesis.
Specifically these methods were used where the data already available were not sufficient to arrive at the required solution.

- Then statistical techniques were used for establishing a relationship between the data and unknowns.
- Thereafter evaluate the accuracy of the results obtained.

5.3.4. We have adopted a scientific method because of the following reasons:

1. It relies on empirical evidence.
2. It aims at formulating most general axioms or scientific theories.
3. It utilizes relevant concepts.
4. It is committed to only objective considerations.
5. It presupposes ethical neutrality.
6. It results into probabilistic predictions.
7. This methodology is known to all concerned for critical scrutiny and for use in testing the conclusions through replication.

5.3.5. The idea behind the whole exercise was to encourage a rigorous, impersonal mode of procedure dictated by demand of logic and objective procedure. This method implies an objective, logical and systematic method, i.e., a method free from personal bias or prejudice, a method to ascertain demonstrable qualities of phenomenon capable of being verified, a method wherein the researcher is guided by rules of logical reasoning, a method wherein the investigation proceeds in an orderly manner and a method that implies internal consistency.

5.3.6. Necessary training was taken in gathering materials and arranging or card-indexing them, participation in field work when required, and also training in techniques for collection of data appropriate to particular problems, in the use of
statistics, questionnaires and controlled experimentation and in recording evidence, sorting it out and interpreting it.

5.3.7. The proposed research work is with the aim of analyzing the procedures adopted by industries and factories, measures both statutory and non statutory provide by the government and efficacy of the controlling authorities. These aspects are to be seen in the light of future environment. Systems and procedures adopted by factories, its critical evaluation and futuristic appraisalhave been given bias.

5.3.9. The research topic relates to industrial safety management, which is dynamic and alive. It will explore the shortcomings if any and reasons thereof. It would attempt to analyze whether concrete steps have been taken in this direction to acknowledge, identify and cover these loopholes or whether they still remain unattended posing as grave security risks. The paper will also analyze industrial safety thinking over the years including the psyche right from ancient times and discuss future options.

5.3.10. The study encompasses the safety management at both macro level as well as micro level. The industrial safety takes a new serious turn with the ‘chemical, biological, nuclear ‘ dimension and global terrorism being added to it. Such issues do invite public debate with advent of better technologies of media and mass communication.

5.4. Research Process

5.4.1. The process adopted for this research work consists of a number of closely related activities, which can at best be shown, with the help of a chart. The chart indicates that the research process consists of number of closely related activities, which overlap continuously rather than following a strictly prescribed sequence. These steps are neither mutually exclusive nor separate and distinct.
5.4.2. Formulating the research problem
5.4.2.1. Considering the magnitude and impact of industrial accidents on the growth and development of a nation and economic conditions of worker and employers, the general area of interest has been taken as the aspect of *Industrial Safety*. The next challenge was formulation of this general topic into a specific problem. For this essentially two steps were involved, viz., understanding the problem thoroughly, and rephrasing the same into meaningful terms from the analytical point of view.

5.4.3. Understanding the research problem
5.4.3.1. Understanding the problem was done by discussing this aspect with colleagues, industrial workers, trade union leaders, personal managers, and with those having expertise in the matter. For this, help was sought from guide who was well experienced in this matter who had a plethora of experience and several research problems in mind.

5.4.4. Extensive literature survey
5.4.4.1. Once the problem has been formulated a synopsis of the topic was written and submitted for approval. At this juncture extensive literature survey connected with the problem was undertaken. At the same time all available literature were examined to get acquainted with the selected problem. Review was done of conceptual literature and the empirical literature. The basic outcome of this review was the knowledge as to what data and other materials are available for operational purposes, which will facilitate in specifying research problem in a meaningful context.

5.4.5. Development of a working hypothesis
5.4.5.1. The next step involved is working out a hypothesis. Working hypothesis is a tentative assumption made in order to draw out and test its logical and
empirical consequences. This is a very important step in the research process. They also affect the manner in which tests must be conducted in the analysis of data and indirectly the quality of data, which is required for the analysis. Hypothesis should be very specific and limited to the piece of research in hand because it has to be tested. The role of the hypothesis is to guide the researcher by delimiting the area of research and to keep him on the right track. It sharpens his thinking and focuses attention on the more important facets of the problem. It also indicates the type of data required and the type of data analysis to be used.

5.4.5.2. In social research it is not possible to cover all the aspects of the subject. Therefore, the researcher has to identify various aspects of the subject. By formulating a working hypothesis considerable data can be collected. We can form certain ideas about the location of destination. There are various ways of reaching the destination and in this process we make mistakes, change routes, and try the principal of ‘trial and error’. Through the collection of data and their classification we are able to form an idea about our destination.

5.4.5.3. Working hypotheses are a set of suggested tentative solutions of explanation of a research problem, which may or may not be the real solutions. The task of research is to test and establish such hypothesis. Hypothesis should be clearly and precisely stated in simple terms, they should be testable, limited in scope, and state relationship between variables. They should be amenable to testing within reasonable time and should be consistent with most of the known facts.

5.4.6. Sources of Hypothesis.

- General character.
- Scientific theories.
• Analogies.
• Personal experiences.

5.4.7. Formulation of hypothesis
5.4.7.1. Based on the focus of study following hypothesis has been formulated: -
   (a) Industrial safety in the present environment is procedural, systematic and effective.
   (b) The idea of industrial safety is adequate and is effectively implemented.
   (c) Unsafe actions and unsafe conditions are the basic cause of accidents.

5.4.8. Specific Question

5.4.8.1. After formulation of general statement the next step is to frame specific question. For the research work the specific question formulated is as given below: -

   “Do we have a sound industrial safety policy and are they effectively implemented and how is it related on the ground in the factories and do these provisions require changes and improvements?”

5.4.9. Testing of Hypothesis

5.4.9.1. After analyzing the data the researcher is in a position to test the hypothesis. The hypothesis may be tested through various tests, such as Chi-square test, t – Test, F – test etc, depending upon the nature and object of
research enquiry. Hypothesis testing will result in either accepting the hypothesis or rejecting it.

5.4.9.2. In this research work,

(a) **Hypothesis.** "Do we have a sound industrial safety policy and are they effectively implemented and how is it related on the ground in the factories and has it been able to reduce accidents by 10% progressively and do these provisions require changes and improvements?"

(b) **Tests of Significance.** Let us assume that:

(i) Null Hypothesis is \( H_0 = P = P_0 \geq 0.10 \). i.e. Claimable: then alternate hypothesis \( H_1 = P < 0.10 \).

(ii) Under the assumption that \( H_0 \) is true, we formulate a test statistic.

\[
Z = \frac{x - \mu}{\text{SE}(x)}
\]

*Which is approximately distributed normally*

(c) The SE of \( x \) is calculated as SD / \( \sqrt{n} \).

(d) SE of \( x \) (incidence rate (IR)) and SE of \( x \) (days charged / injury) is calculated for the level of significance given as 10\%. 
(e) The critical value of Z at 10 \% level of significance is found out and tested.

5.4.10. **Tools.** For the purpose of research following tools were utilized:

- In depth analysis and study of literature available on the subject.

- Formulation of questionnaire.

- Use of questionnaire method for collection of data.

- Interview method adopted for filling up voids observed in the response to the questionnaire.

- Additional data to be obtained by discussions with officers, staff, workers, and trade union.

- Collection of secondary data from journals and publications.

- Collation of data.

- Analysis of data.

- Drawing deductions.

5.4.11. **Methodology.**

5.4.11.1. The research is inductive and deductive. The research can be categorized as a case study design. It has to critically analyse the achievements and failures. Moreover there is a need to evaluate the present level of industrial
safety preparedness from the ‘follow up’ of data analysis. A detailed document and textual analysis has been carried out of books, manuscripts, journals, magazines, newspaper articles, official documents and seminar papers pertaining to the research topic. The objective of the historical analytical research is ‘interpretation of present evidence by discovering past trends, regarding facts, events and attitudes, by demarcating the lines of development of theory and practice’.

5.4.11.2. The methodology used in formulation of this dissertation is most qualitative and to a very small portions quantitative. The research depends on the primary sources as well as the secondary sources.

5.4.11.3. Primary data includes interviews, reports, and feedback from the questionnaires. Questionnaire has been prepared and structured as to reveal the information related to chances of misshapenness/accidents/breakdowns and other failures, their causes and remedial measures taken by the management.

5.4.11.4. The secondary data comprises of compilation of already published material; in the form of books, magazines, periodicals, papers, reports, seminar material, newspapers, and yearbooks. The matter has been collected from home and sources abroad so as to present a viewpoint from all angles.

5.5. Research design

5.5.1. In order to formulate the research design the under mentioned questions were answered:-

✔ What is the study about? The study is about industrial safety management.
✔ Why is the study being made? The study is being made to analyse the industrial safety in the current perspective so as to reduce industrial accidents.
✔ Where will the study be carried out? The study will be carried out in selected industries, selected industrial areas and certain industrialised regions of the country.
✓ What type of data is required? The data required is in the form of primary as well as secondary data. These relate to the industrial accidents, which have taken place in the selected factories and the causes.

✓ Where can the required data be found? The required data can be found in journals, magazines, previous research work, industrial analysis, workshops, factory floors, labour tribunals, ESI courts, trade union circulation etc.

✓ What period of time will the study include? The study will be for the period 1994 – 2003.

✓ What will be the sample design? Multi stage cluster sampling.

✓ What technique of data collection will be used? The techniques of collection of data will be :-
  ➢ In depth analysis and study of literature available on the subject.
  ➢ Formulation of questionnaire.
  ➢ Use of questionnaire method for collection of data.
  ➢ Interview method adopted for filling up voids observed in response to the questionnaire.
  ➢ Additional data to be obtained by discussions with officers, staff, workers, and trade union.
  ➢ Collection of secondary data from journals and publications.

✓ How will the data be analyzed? The analysis of data requires a number of closely related operations such as establishment of categories, the application of these to raw data through coding, tabulation and then drawing statistical inferences. Through the use of statistical tests we can establish whether such a difference is a real one or is the result of random fluctuations. Similarly, the technique of analysis of variance can help in analyzing.
In what style the report will be prepared? The report will be prepared in written form.

5.5.2. Preparing research design

5.5.2.1. After having formulated the research problem the next step was to prepare a research design, i.e., the conceptual structure within which research would be conducted. This facilitates research to be as efficient as possible yielding maximal information, i.e., collection of maximum information with minimal expenditure of effort, time and money. The research design thought for this research work is non-experimental hypothesis testing. Following considerations went into the preparation of research design: -

a) The means of obtaining information;

b) The availability of skills of the researcher;

c) Explanation of the way in which selected means of obtaining information will be organized and reasoning leading to the selection;

d) The time available for the research; and

e) The cost factor relating to the research.

5.5.3. Determining sample design

5.5.3.1. All the items under consideration in any field of inquiry constitute a ‘universe’ or ‘population’. In sample design a definite plan was determined before any data are actually collected for obtaining a sample from a population. Sampling adopted for this research is cluster sampling. This involved grouping the population and then selecting the groups or clusters rather than individual elements for inclusion in the sample. However here ensuring a large sample attained the accuracy. This approach makes the sampling procedure relatively easier and increases the efficiency of fieldwork, especially in case of personal interviews. As the subject matter involved big inquiries extending to a considerably large geographical area within the parameters multi-stage sampling
was used. This was done by first taking into account the industrial areas and selected type of industries.

5.5.4. Collection of data
5.5.4.1. For the purpose of research the data at hand was found inadequate, and hence it became necessary to collect data that are appropriate. There are several ways of collecting the appropriate data, which differ considerably in context of money costs, time and other resources at the disposal.

5.5.4.2. Primary data was collected through survey. This was done by the following ways:

- **By observation.**
- **Through interviews.** Interviews were done through two stages, firstly through telephone interviews, which involved contacting the respondents on telephone, itself. Thereafter amongst the selected respondents answers were sought to a set of pre-conceived questions through personal interviews.
- **By mailing questionnaire.** Questionnaires were mailed to respondents with a request to return after completing the same. Before applying this method a pilot study for testing the questionnaire was conducted which reveals weakness if any of the questionnaire.

5.5.5. Execution of the project
5.5.5.1. This is a very important step in the research process. If the execution of the project proceeds on correct lines, the data to be collected would be adequate and dependable. To ensure this, actions taken were:

- Survey was done by structured questionnaires;
- For machine processing coding was done on the data;
- Occasional field checks were made for accuracy;
- A careful watch was kept for unanticipated factors;
Where ever respondents did not cooperate personal interview, and telephone interview where ever possible was conducted;

In other cases with the help of experts, vigorous efforts were made for securing response.

5.5.5.2. While selecting and framing hypothesis it was seen that the hypothesis posses following characteristics:

✓ It is clear and precise, so that the inferences drawn on its basis can be taken as reliable.

✓ It is capable of being tested, for this prior study was made on the subject. According to C William Emory in his book Business Research Methods, hypothesis “is testable if other deductions can be made from it which can be made from it which, in turn, can be confirmed or disproved by observation.”

✓ It is limited in scope and must be specific.

✓ It is be consistent with most known facts.

✓ It is amenable to testing within reasonable time.

5.5.5.3. This being a hypothesis testing research the aim was to the hypotheses of casual relationships between variables.

5.5.6. Sampling design

5.5.6.1. The steps adopted in this research are:

✓ **Identifying the type of universe.** The universe in this case is finite i.e., the selected factories and within selected factories the industrial safety aspects.

✓ Selecting the sampling unit. Major industrial units.

✓ Preparing the source list.

✓ Specifying the sampling unit.

✓ Determining the specific parameters of interest.

✓ Analyzing the budgetary constraints.
✓ Selecting the sampling procedure.

5.5.6.2. As the area of interest happens to be a big one, the most convenient way in which the sample can be taken is to divide the area into a number of smaller non-overlapping areas and then to randomly select a number of these smaller areas, with the ultimate sample consisting of all units in these small areas or clusters. Within the framework of cluster sampling, multi-stage sampling has been used. For this the first stage was to select primary sampling unit such as major industrial units of two or more industrialized states. Thereafter certain specific firms from these states/districts were identified to be taken for the studies. This would represent a two stage sampling design with the ultimate sampling units being clusters of states/districts. There are two advantages of this sampling design: -

✓ It is easier to administer than most single stage designs mainly because of the fact that sampling frame under multi-stage sampling is developed in partial units.
✓ A large number of units can be sampled for a given cost under multistage sampling because of sequential clustering, whereas this is not possible in most of the sample designs.

5.5.7. Measurement and scaling techniques

5.5.7.1. Interval scale has been used for measurement. It is a simple system wherein intervals are adjusted in terms of some rule that has been established as a basis for making the units equal. The units are equal only as far as one accepts the assumptions on which the rule is based. Interval scales can have an arbitrary zero, but it is not possible to determine for them what may be called an absolute zero or the unique origin. The primary limitation of the interval scale is the lack of a true zero; it does not have the capacity to measure the complete absence of a trait or characteristic.
5.5.7.2. Interval scale provides more powerful measurement than ordinal scales for interval scale also incorporates the concept of equality of interval. As such more powerful statistical measures can be used with interval scales. Mean is the appropriate measure of central tendency, while standard deviation is the most widely used measure of dispersion. Product moment correlation techniques are appropriate and generally used tests for statistical significance.

5.5.7.3. Measurement should be precise and unambiguous in an ideal research study. This objective however is often not met with in entirety. The sources of errors found in the measurement were:

- Reluctance to express due to any reason may lead to an interview of ‘guesses’. At times it was seen that transient factors like fatigue, boredom, anxiety etc. may limit the ability of respondent to respond accurately and fully.
- Situational factors like condition, personal rapport may also come in the way of measurement.
- The interviewer can distort responses by rewording or reordering questions.
- Error may arise because different measurement technique.

5.5.7.4. Sound measurement must meet the tests of validity, reliability, and practicality. The technique of developing measurement tools involves a four-stage process consisting of the following:

- Concept development;
- Specification of concept dimensions;
- Selection of indicators;
- Formation of index.

5.6. Methods of data collection

5.6.1. After deciding on the sort of data to be used for the study, methods of collecting data were decided. In this research we obtained primary data through
observation or through direct communication with respondents in one form or another or through personal interviews. There are several methods of collecting primary data. The important ones used are:

- Observation method;
- Interview method;
- Through questionnaires;
- Through schedules;
- Depth interviews,

5.6.3. The questionnaires were sent by post and also through respondents. The aspects included are as given in the subsequent pages.

5.7. Processing and analysis of data

5.7.1. The data, after collection, has to be processed and analyzed in accordance with the outline laid down for the purpose at the time of developing the research plan. This is essential for a scientific study and for ensuring that we have all relevant data for making contemplated comparisons and analysis. Technically speaking, processing implies editing; coding, classification and tabulation of collected data so that they are amenable to analysis. The term analysis refers to the computation of certain measures along with searching for patterns that exist among data-groups. Thus, in the process of analysis, relationships or differences supporting or conflicting with original or new hypotheses should be subjected to statistical tests of significance to determine with what validity data can be said to indicate any conclusions.

5.7.2. Some of the problems in processing the data for analytical purposes are:

- While processing the data we came across some responses that are difficult to handle. One category of such response is ‘Don’t know response’ or DK response. Fortunately in this case the DK response
group was small and it was of little significance, hence it was deduced that the questionnaire was all right and DK response was taken as legitimate DK response. This was possible by good rapport with the respondents.

- While using percentages for data representation it was seen that they hide the base from which data have been computed and the real differences not correctly read.

5.7.3. Analysis of data means computation of certain indices or measures along with searching for patterns of relationship that exist among the data groups. Analysis particularly in this case involves estimating the values of unknown parameters of the population and testing of hypothesis for drawing inferences.

5.7.4. The role of statistics in research is to function as a tool in designing research, analyzing its data and drawing conclusions there from. In this research studies a large volume of data was collected. Inferential statistics are best known as sampling statistics and are concerned with two major types of problems: -

- The estimation of population parameters; and
- The testing of statistical hypothesis.

5.7.5. The important statistical measures that were used to summarize the research data are: -

- Measures of central tendency or statistical averages; amongst the measures of central tendency arithmetic average or mean, median and mode were used.

- Measures of dispersion; from the measures of dispersion, variance and standard deviations are the most often used measures.
✓ Measures of asymmetry (skewness); in respect of the measures of skewness and kurtosis, we mostly use the first measure of skewness based on mean and mode or on mean and median.

5.7.6. Measures of central tendency (or statistical average) tell us the point about which items have a tendency to cluster. Such a measure is considered as the most representative figure for the entire mass of data. Measure of central tendency is also known as statistical average. Mean is also known as arithmetic average, is the most common measure of central tendency and may be defined as the value which we get by dividing the total of values of various given items in a series by the total number of items. We can work it out as under: -

\[
\bar{X} = \frac{\sum X_i}{n} = \frac{X_1 + X_2 + \ldots + X_n}{n}
\]

Mean (or \( \bar{X} \)) = ----- = ------------------------
\[ \frac{n}{n} \]

where
\[
\begin{align*}
X & = \text{the symbol we use for mean.} \\
E & = \text{symbol for summation} \\
n & = \text{total number of items.}
\end{align*}
\]

5.7.7. An average can represent a series only as best as a single figure can, but it cannot reveal the entire story of any phenomenon under study. Specially if it fails to give any idea about the scatter of the values of items of a variable in the series around the true value of average. In order to measure this scatter, statistical devices called measures of dispersion are calculated. In this research we use the standard deviation. Standard deviation is the most widely used measure of dispersion of a series and is commonly denoted by \( \sigma \). Standard deviation is defined as the square root of the average of square of deviations,
when such deviations for the values of individual items in a series are obtained from the arithmetic average. It is worked out as under:

\[
\text{Standard deviation} = \sqrt{\frac{E (X_i - \bar{X})^2}{n}}
\]

5.7.8. When the distribution of items in a series happens to be perfectly symmetrical, we have the following type of curve for distribution:

In this case the curve is showing no skewness, such a curve is technically described as normal distribution. Such a curve is a perfectly bell shaped curve. But if the curve is distorted, we have asymmetrical distribution, which indicates that there is skewness. If the curve is distorted on the right side, we have positive skewness but when the curve is distorted towards the left, we have negative skewness. Skewness is thus a measure of asymmetry and shows the manner in which the items are clustered around the average. In a symmetrical distribution, the items show a perfect balance on either side of the mode, but in a skew distribution the balance is thrown to one side. The amount by which the balance exceeds on one side measures the skewness of the series.
5.7.9. Testing of hypothesis

5.7.9.1. Hypothesis is the principal instrument in research. In social science, where direct knowledge of population parameter(s) is rare, hypothesis testing is the often-used strategy for deciding whether a sample data offers such support for a hypothesis that generalization can be made. Thus, hypothesis testing enables us to make probability statements about the population parameters. The hypothesis may not be proved absolutely, but in practice if it has withstood a critical testing.

5.7.9.2. Ordinarily, when we speak about hypothesis, it simply means a mere assumption or some supposition to be proved or disproved. But for a researcher hypothesis is a formal question that he intends to resolve. Thus a hypothesis may be defined as a proposition or a set of propositions set forth as an explanation for the occurrence of some specified group of phenomenon either asserted merely as a provisional conjecture to guide some investigation or accepted as highly probable in the light of established facts. Quite often a research hypothesis is a predictive statement, capable of being tested by scientific methods, that relates an independent variable to some dependent variable.

5.7.9.3. Basic concepts concerning testing of hypothesis

5.7.9.3.1. The null hypothesis and alternate hypothesis are chosen before the sample is drawn. In the choice of null hypothesis, the following considerations are usually kept in view:

✓ Alternative hypothesis is the one, which one wishes to prove and null hypothesis is the one, which one wishes to disprove. Thus a null hypothesis represents the hypothesis we are trying to reject, and alternative hypothesis represents all other possibilities.
✓ If the rejection of a certain hypothesis when it is actually true involves great risk, it is taken as null hypothesis because then the probability of rejecting it when it is true is alpha (the level of significance) which is very small.
✓ Null hypothesis should always be a specific hypothesis i.e., it should not state about or approximately a certain value

5.7.9.3.2. Generally in hypothesis testing we proceed on the basis of null hypothesis keeping the alternate hypothesis in view, because one can assign the probabilities to different possible sample results, but this cannot be done if we proceed with alternate hypothesis. The level of significance is a very important concept in the hypothesis testing. It is always some percentage, which should be chosen with great care, thought and reason. In case we take the significance level at 5 percent, then this implies that Ho will be rejected when the sampling result has less than 0.05 probability of occurring if Ho is true. In other words, the 5 percent level of significance means that researcher is willing to take as much as 5 percent risk of rejecting the null hypothesis when Ho happens to be true. Thus the significance level is the maximum value of the probability of rejecting Ho when it is true and is usually determined in advance before testing the hypothesis.

5.7.9.3.3. In the context of testing hypothesis, there are basically two types of errors we can make. We may reject Ho when Ho is true and we may accept when in fact Ho is not true. These are known as Type I error or alpha error and Type II error or beta error respectively.

5.7.9.3.4. Two-tailed and one-tailed are two terms which are quite important. A two-tailed test rejects the null hypothesis if, say, the sample mean is significantly higher or lower than the hypothesized value of the mean of the population. Such a test is appropriate when the null hypothesis is some specified value and alternate hypothesis is a value not equal to the specified value of null hypothesis.
Thus in a two-tailed test, there are two rejection regions, one on each tail of the curve, as shown in Table 5.7.9.3.4.
Mathematically we can state:

Acceptance region A : \( |Z| < 1.96 \)

Rejection region R: \( |Z| >= 1.96 \)

If the significance level is 5% and the two-tailed test is to be applied, the probability of rejection area will be 0.05, equally split on both tails of the curve as 0.025) and the acceptance region will be 0.95.

5.7.9.3.5. **One tailed-test.** There are situations when only one-tailed test is considered appropriate as in this research. A one-tailed test would be used when we are to test, say, whether the population mean is either lower than or higher than some hypothesized value. For instance, if our \( H_0 : u = u_{Ho} \) and \( H_a : u < u_{Ho} \), then we are interested in what is known as a left-tailed test (wherein there is one rejection region only on the left tail) which is illustrated in Table 5.7.9.3.5.
Mathematically we can state:

Acceptance region A : \( Z > -1.645 \)

Rejection region R : \( Z <= -1.645 \)

The aspect to be remembered is that accepting \( H_0 \) on the basis of sample information does not constitute the proof that \( H_0 \) is true. It only means that there is no statistical evidence to reject it and we behave as if \( H_0 \) is true.

5.7.9.4. **Procedure adopted for hypothesis testing**
5.7.9.4.1. To test hypothesis means to tell on the basis of data collected, whether or not the hypothesis seems to be valid. In hypothesis testing the main question is: whether to accept the null hypothesis or not to accept the null hypothesis? Procedure for hypothesis testing refers to all those steps that we undertake for making a choice between the actions i.e., rejection and acceptance of a null hypothesis.
5.7.9.4.2. The various steps involved in hypothesis testing are:

✓ Making a formal statement. This step consists of making a formal statement of the null hypothesis \( (H_0) \) and also the alternate hypothesis \( (H_a) \). In this research work;

Formal statement.

"Do we have a sound industrial safety policy and are they effectively implemented and how is it related on the ground in the factories and has it been able to reduce accidents by 10% progressively and do these provisions require changes and improvements?"

5.7.9.4.3. The formulation of hypothesis is an important test which must be accomplished with due care in accordance with the object and nature of the problem under consideration. It also indicates whether we should use a one-tailed or a two-tailed test. If \( H_a \) is of a type greater than or the type lesser than, we use a one-tailed test, but when \( H_a \) is of the type ‘whether greater or smaller’ then we must use a two-tailed test. In this case we use a one-tailed test.

✓ **Tests of Significance.** Let us assume that:

(i) Null Hypothesis is \( H_0 = P = P_0 \leq 0.10 \). I.e. Claimable: then alternate hypothesis \( H_1 = P > 0.10 \).

(ii) Under the assumption that \( H_0 \) is true, we formulate a test statistic.

\[
Z = \frac{x - \mu}{\sigma}
\]
Which is approximately distributed normally

(c) The SE of \( x \) is calculated as SD / \( \sqrt{n} \).

(d) SE of \( x \) (incidence rate (IR)) and SE of \( x \) (days charged / injury) is calculated for the level of significance is given as 10%.

(e) The critical value of \( Z \) at 10% level of significance is found out and tested.

5.7.9.4.4. A 10% level of significance was adopted for this research. The factors that affect the level of significance are:

- a) The magnitude of the difference between sample means;
- b) The size of the samples;
- c) The variability of the measurement within samples; and
- d) Whether the hypothesis is directional or non-directional.
  - ✓ Deciding the distribution to use
  - ✓ Selecting sample and computing an appropriate value
  - ✓ Calculation of the probability
  - ✓ Comparing the probability
Flow diagram for hypothesis testing

1. State Ho as well as Ha
2. Specify the level of significance
3. Decide the correct sampling distribution
4. Sampling and working out appropriate value from sample data
5. Calculate the probability that sample result would diverge as widely as it has from expectations, if Ho were true
6. Is this probability equal to or smaller than level of significance?
   - No → Reject Ho
   - Yes → Accept Ho

5.7.9.6. As stated above, hypothesis testing determines the validity of the assumption (technically described as null hypothesis) with a view to choose between two conflicting hypotheses about the value of a population parameter. Hypothesis testing helps to decide on the basis of a sample data, whether a hypothesis about the population is likely to be true or false. Statisticians have
developed several tests of hypotheses (also known as tests of significance) for the purpose of testing hypotheses which can be classified as:

✓ Parametric tests or standard tests of hypotheses; and
✓ Non-parametric tests or distribution-free tests of hypotheses.

5.7.9.6.1. Parametric tests usually assume certain properties of parent population from which we draw samples. Assumptions like observations come from a normal population, sample size is large, assumption about the population parameters like mean, variance, etc., must hold good before parametric tests can be used. However in this situation the researcher did not want to make such assumptions. Hence we used statistical methods for testing and z-test was made use of. Z-test is based on the normal probability distribution and is used for judging the significance of several statistical measures. The relevant test statistic (the test statistic is a value obtained from the sample data that corresponds to the parameter under investigation), z, is worked out and compared with its probable value (to be read from the table showing the area under the normal curve) at a special level of significance for judging the significance of the measure concerned. Z-test is generally used for comparing the mean of a sample to some hypothesized mean for the population in case of a large sample, or when population variance is known. Z-test is also used for comparing the sample proportion to a theoretical value of population proportion or judging the difference in proportions of two independent samples when n happens to be large. Besides this the test may be used for judging the significance of median, mode, coefficient or correlation and several other measures.

5.7.9.6.2. In this situation where the population is normal and infinite and sample size is large but variance of population is known, Ha is one-sided, hence z-test is used for testing hypothesis of mean and the test statistic z is worked out
as under:

\[ \bar{X} = \frac{\sum u}{\sqrt{n}} \]

The observed value of \( z \) is tested and seen whether it is in the acceptable region and if yes Ho is accepted, or else rejected as the case may be.

5.8. EXPECTED OUTCOME OF THE PROPOSED RESEARCH WORK

- Review of existing industrial safety management and formulation of a well-defined industrial safety policy.
- It aims at concentrating on important aspects with regards to industrial safety as a tool for better management and productivity. They are as follows:
  - Industrial safety aspects related with turn over and output.
  - Performance criteria.
  - Productivity criteria.
  - Promoting industrial harmony as a result of better industrial safety.
  - Industrial growth and development and industrial safety.
  - Communication and industrial safety.
5.9. Summary

5.9.1. The research topic relates to industrial safety management, which is
dynamic and alive. The study encompasses the safety management at both
macro level as well as micro level. By formulating a working hypothesis
considerable data can be collected. The task of research is to test and establish
such hypothesis. Based on the focus of study hypothesis “The idea of industrial
safety is adequate and is effectively implemented.” was formulated.

5.9.2. After analyzing the data the researcher was in a position to test the
hypothesis. The hypothesis may be tested through various tests, such as:

- z-test;
- Chi square test;
- t - Test;
- F - test etc, depending upon the nature and object of research
  enquiry.

5.9.3. Hypothesis testing will result in either accepting the hypothesis or
rejecting it. In depth analysis and study of literature available on the subject was
essential. Thereafter questionnaire was formulated and use of questionnaire
method for collection of data. Collection of secondary data was made from
journals and publications. Then collation of data and its analysis is carried out.

5.9.4. The research is inductive and deductive. The research can be categorized
also as a case study design. Primary data includes interviews, reports, and
feedback from the questionnaires. The study is about industrial safety
management. The study is being made to analyze the industrial safety in the
current perspective so as to reduce industrial accidents. The study will be carried
out in selected industries, which are major industrial units in India. The data
required is in the form of primary as well as secondary data. The required data
can be found in journals, magazines, previous research work, industrial analysis,
workshops, factory floors, labour tribunals, ESI courts, trade union circulation
etc. Sample design selected is multi stage cluster sampling. The techniques of collection of data will be, In depth analysis and study of literature available on the subject, formulation of questionnaire, Use of questionnaire method for collection of data, Collection of secondary data from journals and publications. This being a hypothesis testing research the aim was to the hypotheses of casual relationships between variables.

5.9.6. The steps adopted in this research are:

- The selected factories and within selected factories the industrial safety aspects.
- Selecting the sampling unit.
- Major industrial units.
- Preparing the sources list.
- Specifying the sampling unit.
- Selecting the sampling procedure. Within the framework of cluster sampling, multi-stage sampling has been used. Measurement and scaling techniques

5.9.7. Interval scale has been used for measurement. Interval scale provides more powerful measurement than ordinal scales for interval scale also incorporates the concept of equality of interval. Measurement should be precise and unambiguous in an ideal research study.

5.9.8. Analysis of data means computation of certain indices or measures along with searching for patterns of relationship that exist among the data groups. Analysis particularly in this case involves estimating the values of unknown parameters of the population and testing of hypothesis for drawing inferences. The important statistical measures that were used to summarise the research data are: -
● Measures of dispersion; from the measures of dispersion, variance and standard deviations are the most often used measures.

● Measure of central tendency is also known as statistical average. In order to measure this scatter; statistical devices called measures of dispersion are calculated.

5.9.9. To test hypothesis means to tell on the basis of data collected, whether or not the hypothesis seems to be valid. In hypothesis testing the main question is whether to accept the null hypothesis or not to accept the null hypothesis? With the assumption that Ho is true, we formulate a test statistic. A 10% level of significance was adopted for this research. Hypothesis testing determines the validity of the assumption (technically described as null hypothesis) with a view to choose between two conflicting hypotheses about the value of a population parameter. Hypothesis testing helps to decide on the basis of a sample data, whether a hypothesis about the population is likely to be true or false.
# RESEARCH METHODS & TECHNIQUES

<table>
<thead>
<tr>
<th>Type</th>
<th>Methods</th>
<th>Techniques</th>
</tr>
</thead>
<tbody>
<tr>
<td>Library research</td>
<td>☐ Analysis of historical records.</td>
<td>☑ Recording of notes.</td>
</tr>
<tr>
<td></td>
<td>☐ Analysis of documents.</td>
<td>☑ Content analysis.</td>
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<tr>
<td></td>
<td></td>
<td>☑ Tape and film listening and analysis.</td>
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<td></td>
<td></td>
<td>☑ Statistical compilations and manipulations.</td>
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<tr>
<td></td>
<td></td>
<td>☑ Reference and abstract guides.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>☑ Content analysis.</td>
</tr>
<tr>
<td>Field research</td>
<td>☑ Non participant observation.</td>
<td>☑ Observational behaviour scales, use of score records etc.</td>
</tr>
<tr>
<td></td>
<td>☑ Participant observation.</td>
<td>☑ Interactional recording, possible use of tape recorders, photographic techniques.</td>
</tr>
<tr>
<td></td>
<td>☑ Mass observation.</td>
<td>☑ Recording mass behaviour, interview using independent observers in public places.</td>
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<td></td>
<td>☑ Mail questionnaire.</td>
<td>☑ Identification of social and economic background of respondents.</td>
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<td></td>
<td>☑ Opinionnaire.</td>
<td>☑ Use of attitude scales, projective techniques, use of sociometric scales.</td>
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<tr>
<td></td>
<td>☑ Personal</td>
<td>☑ Interviews use a detailed schedule.</td>
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<tr>
<td>Interview</td>
<td>with open and closed questions.</td>
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<tr>
<td>- Focused interview.</td>
<td>Interviews focus attention upon a given experience and its effects.</td>
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<tr>
<td>- Group interview.</td>
<td>Small groups of respondents are interviewed simultaneously.</td>
<td></td>
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<tr>
<td>- Telephone survey.</td>
<td>Used as a survey technique for information and discerning opinion, may also be used as a follow up of questionnaire.</td>
<td></td>
</tr>
<tr>
<td>- Case study and life history.</td>
<td>Cross sectional collection of data for interview analysis, longitudinal collection of data of intensive character.</td>
<td></td>
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</tbody>
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**Table 5.3.1: Research methods**
FLOW DIAGRAM: RESEARCH PROCESS

DETERMINE THE PROBLEM

REVIEW PREVIOUS RESEARCH FINDINGS

REVIEW CONCEPTS AND THEORIES

FORMULATE HYPOTHESIS

RESEARCH DESIGN

COLLECT DATA

ANALYSE DATA

INTERPRET RESULTS

REPORT

Table 5.4.1: Research process
General

1. General information of the company. Please provide the following information.

- Historical background.
- Group to which the company belongs to.
- Established in year.
- Modernisation carried out in year.
- Foreign technical assistance in year.
- Joint ventures.
- Products;
- Customers, with in India and export to which all-foreign countries.
- Yearly turn over and profits.
2. Organization.

✓ Outline organization of the company.

✓ Detailed organization of the personal department.

✓ Organization for industrial safety in the company.

3. Provide details of workforce: -

✓ Managerial strength including top & middle management and executives.

✓ Supervisory staff.

✓ Workers.

✓ Highly skilled.

✓ Skilled.

✓ Semi skilled.

✓ Unskilled.

✓ Casual labour.
Industrial safety in the company

4. Safety measures in the company including those in context of welfare.

5. Has the company employed a safety officer? If yes, his qualifications.

6. Safety policy in the company.

7. Standing orders/standing procedures pertaining to safety.

8. Statutory provisions for safety.

9. Safety training and campaigns. Is there any training program or education on safety organized for workers, please give details?
10. How is safety being ensured? Give details of:

✓ Material handling equipment used.

✓ Safety precautions in material handling.

✓ Personal protective equipment used.

11. Accident handling.

✓ Format for accident investigation report.

✓ Procedure to handle an accident, reporting, first aid treatment.

✓ Preventive measures adopted.

✓ Accidents in the last five years. Causes.

✓ Accident hazards in the company.

✓ Use of PPE.
12. Safety inspection and safety organization.


**Fire prevention and fire fighting**


15. Training for fire fighting.

**Miscellaneous**


17. Organization of safety committee.

18. Training and motivation for safety.


20. Tabulation of data and accidents.

21. Any other information.
ACCEPTANCE AND REJECTION REGIONS IN CASE OF A TWO-TAILED TEST (5% SIGNIFICANCE LEVEL)

REJECTION
 ACCEPTANCE
 REGION

REGION

REJECTION
 REGION

0.475 OF AREA

0.475 OF AREA

Z = -1.96

uHo = u

Z = 1.96


together equals 0.95 or 95% of area

REJECT Ho IF THE SAMPLE MEAN (\( \bar{X} \)) FALLS IN EITHER OF THE TWO REGIONS

Table 5.7.9.3.4. : Hypothesis testing
ACCEPTANCE AND REJECTION REGIONS

IN CASE OF ONE -TAILED TEST (LEFT- TAIL) WITH 5% SIGNIFICANCE

REJECT REGION

ACCEPTANCE REGION

ACCEPT Ho IF THE SAMPLE MEAN (X) FALLS IN THIS REGION

0.05 of area

0.45 of

0.50 of

Area:

Z = -1.645

uHo = u

REJECT Ho IF THE SAMPLE MEAN (X) FALLS IN THIS REGION

Table 5.7.9.3.5. : Hypothesis testing