Basically two steps are involved in formulating the research problem, viz., understanding the problem systematically, and reshape the same into significant terms from an analytical point of view.

The most excellent way of understanding the problem is to discuss it with contemporaries or with those having some knowledge in the related matter. In an academic institution the researcher can take the assistance from a guide who is usually an experienced man and has several research problems in his mind. In private business units or in governmental organizations, the problem is usually allocate by the administrative agencies with whom the researcher can discuss the problem originally that how it is came about and what reflections are involved in its possible clarification.

EXAMPLES WITH SOME PROBLEMS:

"The main objective of this work is to contribute to the development of elements of a formal theory for manufacturing systems in order to allow the establishment of a formal methodology for the design and analysis of manufacturing systems"

"The main research questions which have guided this research work are:

Q1: Which are the main characteristics of a collaborative network and of a collaborative networked environment?

Q2: Which are the most relevant conceptual frameworks, architectures, reference models, independent and industry-specific initiatives, ICT platforms and their underlying technologies, targeting interoperability in a collaborative networked environment?

Q3: How can seamless interoperability be achieved?

Q4: Which are the main differences and similarities between existing conceptual frameworks?

Q5: How can conceptual frameworks be compared, and which are the criteria to support such an analysis and evaluation?

Q6: Do the conceptual frameworks and the technological solutions compete or complement each other?

Q7: Which is the path to be followed to allow heterogeneous and geographically distributed organizations to naturally inter-operate?

1. **Broad literature survey**

After the identification of research problem, the researcher must at study all available literature to get himself familiar with the selected problem. He may review two types of literature first is the conceptual literature which is related to the concepts and theories, and second is the empirical

literature which consisting of previous studies similar to the proposed research problem. The researcher should undertake vast literature survey concerned with the problem. For this purpose, the abstracting and indexing journals and published or unpublished bibliographies are the first place where researcher can get the information or knowledge. Academic journals, conference proceedings, government reports, books etc., must be hit depending on the nature of the problem. After this the researcher revise the problem into analytical or operational terms i.e., to put the problem in as specific terms as possible. This assignment of formulating, or defining, a research problem is an important step in the entire research process. Once the problem is formulated, a synopsis of it should be written down.

2. **Hypotheses formulation**

After the literature survey, researcher should make a hypothesis or working hypothesis. Working hypothesis is a guess made to test the logical or empirical outcome of a research. A hypothesis assists to explain the research problem and objective into a comprehensive explanation or prediction of the expected results of the study. Hypothesis is derived from the research problem, literature review and conceptual framework. Since Hypothesis is to be tested therefore it should be very specific and limited to the piece of research. It sharpens the researcher's thinking and focus on the important facts of the problem. Hypothesis formulation could be done by using the following approaches:

a. Discussions with colleagues and experts about the research problem, its source, cause and the objectives in search of a solution;
b. Assessment of data and records,
c. Evaluation of similar previous studies in the area similar problems; and
d. Personal investigation which involves original field survey

Thus, any hypotheses take place as a result of a-prior thinking about the subject, assessment of the available data and material including related previous studies. Formulation of working hypotheses is a basic step of any research process.

Hypothesis example

"Shop floor control/supervision reengineering agility can be achieved if manufacturing systems are abstracted as compositions of modularized manufacturing components that can be reused whenever necessary, and whose interactions are specified using configuration rather than reprogramming."

3. Preparation of research design

A good research design will be prepared if a research problem should be stated clearly. In other words, the purpose of research design is refers as general procedure that you choose to combine the various components of the study in a consistent and logical way. It comprises the outline for the collection, measurement, and analysis of data. A flexible research design which offers the opportunity for allowing the different aspects of a problem is considered suitable if the purpose of the research study is to be clear. There are several research designs, such as, Descriptive (e.g., case-study, naturalistic observation, survey), Correlational (e.g., case-control study, observational study), Semi-experimental (e.g., field experiment, quasi-experiment), Experimental (experiment with random assignment), Review (literature review, systematic review) and Meta-analytic (meta-analysis) out of which the researcher should select one for his task.

4. Determining sample design

Every object that involve in any type of inquiry constitute a 'universe' or 'population'. A complete detail of any object in the 'population' is known as a census inquiry. It can be supposed that in such type of inquiry all the items are covered and not a single element is left and highest accuracy is obtained. But in practical way this may not be true because a single element of bias in such inquiry will get larger the number of observations increases. Moreover, there is no way of scrutiny the element of bias or its level except through a resurvey or use of sample checks. Besides, such type of inquiry comprises a lot of time, money and energy. Apart from this, census inquiry is not possible practically under many conditions. For example, blood sugar testing is done only on sample basis. Hence, quite often we select only a few items from the population for our study purposes. The selection of items in such type of manner is technically called a sample.

The researcher must decide the way of selecting a sample or choose a sample design for his study. In other words, a sample design is an exact sketch determined prior to any type of data collection for obtaining a sample from a given universe. There are two types of sampling: non-probability and probability sampling. Non-probability sampling uses a subjective method of selecting units from a universe, and is generally easy, quick, and economical. Therefore, it is useful to perform preliminary studies, focus groups or follow-up studies. Probability samples are based on simple random sampling, stratified sampling, systematic sampling, cluster/area sampling whereas non-probability samples are those based on straightforward sampling, judgment sampling and quota sampling techniques. There is brief description of some important sample designs as

follows:

i. **Deliberate sampling**

Deliberate sampling is also called as non-probability or purposive sampling. This sampling method consists of purposive selection of particular items of the universe to represent a sample. When samples are selected from a population on the basis of ease of access, it can be called convenience sampling. If a researcher wants to collect the data from students, he may select a fixed number of universities and colleges to conduct the interviews. This is a simple example of convenience sample. Sometimes this type of sampling may give biased results particularly when the universe is not homogeneous. On the other hand, in judgment sampling this is based on the judgment of researcher and used for selecting items from a given population.

For example, a judgment sample of office staff might be taken to secure reactions to a new rule of office. Judgment sampling is used regularly in qualitative research.

ii. Simple random sampling:

This type of sampling is also called as probability sampling or chance sampling where each item in the population has an equal chance of inclusion in the sample and each sample having the probability of being selected in the sampling procedure. For example, names of 20 employees being selected out of 250 employees in a company. In this case, the population is all 250 employees, and the sample is random because each employee has an equal chance of being chosen. There are basically three methods to conduct a random sampling. If we select a sample of 300 items from a population of 2,000 items, then we can write up the names of all the 2,000 items on slips of paper and conduct a lottery. This is called Lottery method. The second method of random sampling is using a random number table and third method is by using the computer in which the computer is used for selecting a sample of prize- winners, a sample of Hajj applicants, and a sample of applicants for residential plots and for various other purposes.

iii. Systematic sampling:

Whenever a researcher choose some specific name or number from the population then this type of sampling is known as systematic sampling. In some example the most practical way of sampling is to select every 10^{th} name in an index, every 15^{th} shop on single side of a street etc. A component of unpredictability is generally commenced into this type of sampling by using random numbers to pick and choose up the item with which to start. This method is helpful when sampling frame is available in the form of a list. In such type of sample design the practice of

selection process begins by picking some random point in the list and then every n^{th} item is selected until the desired number is secured.

iv. Stratified sampling:

In stratified sampling the researcher divides the population into separate groups, called strata or we can say that Stratification is the process of dividing members of the population into homogeneous subgroups before sampling. In this technique, the population is divided into a number of non-overlapping subpopulations or strata and sample elements are selected from each stratum. If the item selected from each stratum is based on simple random sampling technique in complete process of sampling means first stratification and then simple random sampling, this type of sampling is known as stratified random sampling.

v. Quota sampling

In stratified sampling the cost of taking random samples from individual strata is often so expensive that interviewers are simply given quota to be filled from different strata, the actual selection of items for sample being left to the interviewer's judgment. This is called quota sampling. The size of the quota for each stratum is generally proportionate to the size of that stratum in the population. Quota sampling is thus an important form of non-probability sampling. Quota samples generally happen to be judgment samples rather than random samples.

vi. Cluster sampling and area sampling:

Cluster sampling involves grouping the population and then selecting the groups or the clusters rather than individual elements for inclusion in the sample. Suppose some departmental store wishes to sample its credit card holders. It has issued its cards to 15,000 customers. The sample size is to be kept say 450. For cluster sampling this list of 15,000 card holders could be formed into 100 clusters of 150 card holders each. Three clusters might then be selected for the sample randomly. The sample size must often be larger than the simple random sample to ensure the same level of accuracy because is cluster sampling procedural potential for order bias and other sources of error are usually accentuated. The clustering approach can, however, make the sampling procedure relatively easier and increase the efficiency of field work, especially in the case of personal interviews.

Area sampling is quite close to cluster sampling and is often talked about when the total geographical area of interest happens to be big one. Under area sampling we first divide the total area into a number of smaller non-overlapping areas, generally called geographical clusters, then

a number of these smaller areas are randomly selected, and all units in these small areas are included in the sample. Area sampling is especially helpful where we do not have the list of the population concerned. It also makes the field interviewing more efficient since interviewer can do many interviews at each location.

vii. Multi-stage sampling

This is a further development of the idea of cluster sampling. This technique is meant for big inquiries extending to a considerably large geographical area like an entire country. Under multi-stage sampling the first stage may be to select large primary sampling units such as states, then districts, then towns and finally certain families within towns. If the technique of random-sampling is applied at all stages, the sampling procedure is described as multi-stage random sampling.

viii. Sequential sampling

This is somewhat a complex sample design where the ultimate size of the sample is not fixed in advance but is determined according to mathematical decisions on the basis of information yielded as survey progresses. This design is usually adopted under acceptance sampling plan in the context of statistical quality control.

In practice, several of the methods of sampling described above may well be used in the same study in which case it can be called mixed sampling. It may be pointed out here that normally one should resort to random sampling so that bias can be eliminated and sampling error can be estimated. But purposive sampling is considered desirable when the universe happens to be small and a known characteristic of it is to be studied intensively. Also, there are conditions under which sample designs other than random sampling may be considered better for reasons like convenience and low costs. The sample design to be used must be decided by the researcher taking into consideration the nature of the inquiry and other related factors.

5. Collecting the data

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. There are several ways of collecting the appropriate data which differ considerably in context of money costs, time and other resources at the disposal of the researcher.

Primary data can be collected either through experiment or through survey. If the researcher conducts an experiment, he observes some quantitative measurements, or the data, with the help of which he examines the truth contained in his hypothesis. But in the case of a survey, data can be collected by any one or more of the following ways:

(i) By observation: This method implies the collection of information by way of investigators own observation, without interviewing the respondents. The information obtained relates to what is currently happening and is not complicated by either the past behaviour or future intentions or attitudes of respondents. This method is no doubt an expensive method and the information provided by this method is also very limited. As such this method is not suitable in inquiries where large samples are concerned.

(ii) Through personal interview: The investigator follows a rigid procedure and seeks answers to a set of pre-conceived questions through personal interviews. This method of collecting data is usually carried out in a structured way where output depends upon the ability of the interviewer to a large extent.

(iii) Through telephone interviews: This method of collecting information involves contacting the respondents on telephone itself. This is not a very widely used method but it plays an important role in industrial surveys in developed regions, particularly, when the survey has to be accomplished in a very limited time.

(iv) By mailing of questionnaires: The researcher and the respondents do come in contact with each other if this method of survey is adopted. Questionnaires are mailed to the respondents with a request to return after completing the same. It is the most extensively used method in various economic and business surveys. Before applying this method, usually a Pilot Study for testing the questionnaire is conduced which reveals the weaknesses, if any, of the questionnaire? Questionnaire to be used must be prepared very carefully so that it may prove to be effective in collecting the relevant information.

(v) Through schedules: Under this method the enumerators are appointed and given training. They are provided with schedules containing relevant questions. These enumerators go to respondents with these schedules. Data are collected by filling up the schedules by enumerators on the basis of replies given by respondents. Much depends upon the capability of enumerators so far as this method is concerned. Some occasional field checks on the work of the enumerators may ensure sincere work.

The researcher should select one of these methods of collecting the data taking into consideration the nature of investigation, objective and scope of the inquiry, financial resources, available time and the desired degree of accuracy. Though he should pay attention to all these factors but much depends upon the ability and experience of the researcher.

6. Analysis of data:

After the data have been collected, the researcher turns to the task of analyzing them. The analysis of data requires a number of closely related operations such as establishment of categories, the application of these categories to raw data through coding, tabulation and then drawing statistical inferences. The unwieldy data should necessarily be condensed into a few manageable groups and tables for further analysis. Thus, researcher should classify the raw data into some purposeful and usable categories. Coding operation is usually done at this stage through which the categories of data are transformed into symbols that may be tabulated and counted. Editing is the procedure that improves the quality of the data for coding. With coding the stage is ready for tabulation. Tabulation is a part of the technical procedure wherein the classified data are put in the form of tables. The mechanical devices can be made use of at this juncture. A great deal of data, especially in large inquiries, is tabulated by computers. Computers not only save time but also make it possible to study large number of variables affecting a problem simultaneously.

Analysis work after tabulation is generally based on the computation of various percentages, coefficients, etc., by applying various well defined statistical formulae. In the process of analysis, relationships or differences supporting or conflicting with original or new hypotheses should be subjected to tests of significance to determine with what validity data can be said to indicate any conclusion(s).

For instance, if there are two samples of weekly wages, each sample being drawn from factories in different parts of the same city, giving two different mean values, then our problem may be whether the two mean values are significantly different or the difference is just a matter of chance. Through the use of statistical tests we can establish whether such a difference is a real one or is the result of random fluctuations. If the difference happens to be real, the inference will be that the two samples come from different universes and if the difference is due to chance, the conclusion would be that the two samples belong to the same universe. Similarly, the technique of analysis of variance can help us in analyzing whether three or more varieties of seeds grown

on certain fields yield significantly different results or not. In brief, the researcher can analyze the collected data with the help of various statistical measures.

7. Hypothesis-testing

After analyzing the data as stated above, the researcher is in a position to test the hypotheses, if any, he had formulated earlier. Do the facts support the hypotheses or they happen to be contrary? This is the usual question which should be answered while testing hypotheses.

Various tests, such as Chi square test, t-test, F-test, have been developed by statisticians for the purpose. The hypotheses may be tested through the use of one or more of such tests, depending upon the nature and object of research inquiry. Hypothesis-testing will result in either accepting the hypothesis or in rejecting it. If the researcher had no hypotheses to start with, generalizations established on the basis of data may be stated as hypotheses to be tested by subsequent researches in times to come.

8. Generalizations and interpretation:

If a hypothesis is tested and upheld several times, it may be possible for the researcher to arrive at generalization, i.e., to build a theory. As a matter of fact, the real value of research lies in its ability to arrive at certain generalizations. If the researcher had no hypothesis to start with, he might seek to explain his findings on the basis of some theory. It is known as interpretation. The process of interpretation may quite often trigger off new questions which in turn may lead to further researches.

9. Preparation of the report or the thesis

Finally, the researcher has to prepare the report of what has been done by him. Writing of report must be done with great care keeping in view the following:

1. The layout of the report should be as follows:

(i) The preliminary pages; (ii) the main text, and (iii) the end matter.

In its preliminary pages the report should carry title and date followed by acknowledgements and foreword. Then there should be a table of contents followed by a list of tables and list of graphs and charts, if any, given in the report.

The main text of the report should have the following parts:

(a) Introduction: It should contain a clear statement of the objective of the research and an explanation of the methodology adopted in accomplishing the research. The scope of the study along with various limitations should as well be stated in this part.

(b) Summary of findings: After introduction there would appear a statement of findings and recommendations in non-technical language. If the findings are extensive, they should be summarized.

(c) Main report: The main body of the report should be presented in logical sequence and broken-down into readily identifiable sections.

(d) Conclusion: Towards the end of the main text, researcher should again put down the results of his research clearly and precisely. In fact, it is the final summing up.

At the end of the report, appendices should be enlisted in respect of all technical data. Bibliography, i.e., list of books, journals, reports, etc., consulted, should also be given in the end. Index should also be given specially in a published research report.

2. Report should be written in a concise and objective style in simple language avoiding vague expressions such as 'it seems,' 'there may be', and the like.

3. Charts and illustrations in the main report should be used only if they present the information more clearly and forcibly.

4. Calculated 'confidence limits' must be mentioned and the various constraints experienced in conducting research operations may as well be stated.