CHAPTER - III
RESEARCH METHODOLOGY

3.1 Introduction

The human thrust for new areas of knowledge has developed ability for search or research in him. It is a fact that no organization can progress without doing latest research activities. Research is not ready made existing bag of tools and techniques. It is not fishing expedition or an encyclopedic gathering of assorted facts. It is a through investigation of some particular situation or problem. It provides a structure for decision making and improvement. Research is a process by which organization attempts to supply the information required for making management decisions. The research would formulate new theories, discovery of new techniques and an improvement in old concepts. In the present problem exploratory research is used which help to diagnose a situation and thinking of alternatives to discover new ideas and concepts. Research methodology is way and or techniques by which research is carried out. The common research methodology techniques are review of literature, interviews, surveys, case studies etc.

First we discuss the concepts underlying research methodology and then we go on to describe the approach that was taken during the efforts. Assumptions and findings that compelled changes were applied along the way.

Research methodology is an organized way to find root cause of a problem and to solve it. There are various methods, tools and techniques by which knowledge is gained by the researchers. It is a set of rules, activities, procedures by which the scholar remains in a particular discipline. It can be a theoretical analysis of method or models. Research is a careful and scientific inquiry into any subject or area which promises to discover valuable information. John [62] defines research as “Research is systematic activity directed towards the discovery and development of unorganized body of knowledge” Young[134] defines research as “Research may be defined as a scientific undertaking which by means of logical and systematized techniques aim to:
(1) Discover new facts of verify and test old facts

(2) Analyze their sequences, inter-relationship, and causal explanations which are derived with in an appropriate theoretical frame of reference

(3) Develop new scientific tools, concepts and theories which would facilitate reliable and valid study of human behavior.”

To select research methodology depends upon the nature of problem. In this problem mixed research methodology (qualitative and quantitative) is used. Common type of qualitative research methodology is literature survey and experimental and others. In quantitative methodology common type of technique is biographical, case study etc.

Commensurate with the different objectives of the present study various tools and techniques have been employed. Various existing model(s) of software re-engineering and their applications have been studied. As software re-engineering area does not exist from centuries, limited literature is available on this topic. Being new and hot topic much work is to done in this field. In this age of information technology, every routine type job small or big is done with the help of computer programs. This phenomenon is increasing with the increasing technology. In the coming future, from simple to complex, from small to big, all the problems will be solved with software programs. When software existing everywhere, mass level software re-engineering is needed to accommodate the software changes. More and more software engineers would be in demand. Software re-engineering customized tools, techniques, and model(s) are needed to make the re-engineering process fast, less costly and less risky.

3.2 Literature Review Methodology

The literature searching is a very significant step in the research process. The Literature review is fast, inexpensive way for researchers to develop a better understanding of a problem area in which they have limited experience. Review of literature is done to come at the cutting edge of the present development on this topic. It also makes acquainted them with past research results, data sources and the type of data available.
A review of literature on Re-engineering of software systems has been made in order to view the problem against the background of sound theoretical framework. Many researchers have introduced several methodologies to support re-engineering efforts for legacy software systems. Many re-engineering model(s) and techniques have been read and reached to the edge of the knowledge in re-engineering methodology. The state-of-the-art of re-engineering object-oriented software systems is also reviewed. The consolidated methodology for re-engineering efforts will provide comprehensive base for re-engineering. Literature was explored for various re-engineering model(s) existing from time to time. Model(s) were studied for their characteristics, effectiveness and limitations. Their applications in the past software projects and lessons learned. Sources of information in literature review were primary as well as secondary. Primary sources are materials written from the empirical study of the event or situation. Secondary sources are books and articles (print or digital form) in which other researchers report the results of their research based on the primary data or sources. Materials were available in print and/or in electronic media. Lot of efforts was saved in searching materials in digital form. The invention of computer was big help in research but Internet innovation revolutionized the research activities. The people can share the knowledge at common world wide platform with ease.

First the literature was explored regarding existing re-engineering model(s) as well as their applications and limitations. Literature was reviewed on all the aspects of software re-engineering process. Complete re-engineering process consists of main three stages reverse engineering, Architecture transformation and Forward engineering. Methods, Models, tools and techniques are needed for all the activities in each stage. Benefits, cost of re-engineering and cost of re-engineering comparative to new development of equal domain were reviewed. Literature review made me stand at the critical edge of the knowledge of my research topic. Following were the sources for review of literature

- Books
- Journals
- Conference papers
• Magazines
• Periodicals
• Statements
• Conference and Workshop proceedings
• Internet Surfing
• Reports and databases
• Archives
• Academic thesis
• Newspapers

The sources mentioned above were available in printed form and/or in digital form.

3.3 Re-engineering Methodology

To design model(s), it was pre-requisite to study existing re-engineering methodology. Existing methodology its application was studied from all the sources available. Characteristics and limitations of the model(s) were studied in depth and extensions or improvements were thought. Software engineers, developers, managers, consultants, software professionals, software users and academicians were talked to form the basis of my research. On the basis of these contemplations, new model(s) for different phases of re-engineering process are contributed to the field. Re-engineering model(s) contributed from time to time by software engineers and researchers helped in re-engineering software systems. As technology of software development changes, existing re-engineering model(s) also need change. The existing model(s) were mostly for re-engineering software systems written in procedural oriented languages. With the time gap and change in software development technology, existing re-engineering models were less applicable to the new paradigm of object-oriented software development. The idea was to add new model(s) in the field and/or to re-engineering of existing model(s). As we are talking of re-engineering of software systems, existing model(s) also need re-engineering otherwise existing model(s) will be less useful and discarded with time. Following
are the existing software re-engineering models which have been studied thoroughly with their features and limitations.

- Reflexion Model, 1996
- Horse Shoe Model, 2000
- CORUM Model, 2000
- Byrne Re-engineering Model, 2005
- Rainfall Model, 2007
- Service-Oriented Software Re-engineering Model 2007
- Dual-Spiral Re-engineering Model
- Parallel Iterative Re-engineering Model, 2009

Recently software companies thought of service oriented software for face lift of legacy software systems. In this technique, instead of re-engineering the old legacy software, it is wrapped in additional software to change its behavior. The old legacy software remains intact and at the same time it can adjust new requirements and exploit new technology.

The above mentioned existing re-engineering model(s) and their applications were evaluated methodically. Their effectiveness, limitations and shortfalls were thoroughly reviewed and exposed. There are various stages in complete re-engineering process and many activities in each stage. The existing models do not cover all these activities to complete the re-engineering process. These existing models left the gaps in re-engineering process which is also drawback in the existing models. Models for re-engineering object-oriented software systems have been proposed in this research work. Following research methods were also used to complete the present study.

3.4 Descriptive Research Methodology

Descriptive research is something that is variable, varies to a defined degree, and thus can be measured. Surveys, case studies, causal comparative studies, correlational studies, developmental studies, trend studies are called descriptive research methodology. In the present research work case study method was also
used to estimate the change in parameters of software by re-engineering.

Case study method is a form of qualitative analysis involving very careful and complete observation of some situation, an event or object. It is simple and flexible method of research. Case study involves an in-depth study of status of re-engineering in comparison to new software development in software industry in the specified region. The study of various parameters of reengineered software systems in comparison to the legacy software system can be done. When software is re-engineered, values of various aspects of software change in comparison to legacy software. For example Performance of software increases where as complexity of software decreases in comparison to old legacy software.

Status of re-engineering in the present scenario was also to be estimated. Problems in the way of reengineering were also identified to improve the status of software re-engineering.

Case study is direct solution to problem after studying the real situation. Controls and measures are applied to improve the situation. Following are the components which are important for accuracy in the results of case studies.

3.4.1 Sample Area

Successful case study is based on the focused sample area. Sampling is concerned with the selection of individuals from within a population to generalize a concept for the whole population. A sample for every research problem is chosen by any of the three methods:

1) Random sampling
2) Purposive sampling
3) Mixed sampling

Here the purposive method is chosen to define the region for the present research. In focused areas data collection will be faster, less costly. Data set being in small size, accuracy and quality of data will be improved.

Sample size is small and medium size software development companies and clients companies in region of Punjab, Chandigarh, and Haryana in the present
study. The population of the study comprised of software engineers, developers, managers, professionals and or users in the respective companies. It is pre-requisite to investigate the status and problems in the software re-engineering in software industry to promote it. Existing and proposed models can also be matched and tried to the real situations. Software engineers, developers, managers, professionals and users from the above said companies were to fill the schedule.

3.4.2 Questionnaire

A case study questionnaire is designed to fill by the respondents in the area under study. It can be open-end, closed end or mixed questionnaire. In this study, closed end questionnaire has been designed on the basis of review of literature and many discussions with software engineers, developers, managers, software consultants and experienced academicians. Questionnaire consists of seven questions, each in the form of a table. Each table further consists of many closed end questions. Questions were to check various parameters of the re-engineered software systems in comparison with legacy software systems. It was simple and clear and could be filled by the people mentioned above. It could be mailed to fill the entries and/or used directly to interview the above mentioned people in their concerned companies. It was pre-tested by visiting software development companies and the client companies and modified accordingly. Afterward the questionnaire was sent through email to software development companies and client companies in the region under study.

The software companies and the client companies (organizations using software) showed interest in studying the questionnaire and filling it. They felt good on this type of research work and provided information. Some companies refused to provide information saying that it was their confidential matters relating to the cost of the reengineered/developed projects. They were not convinced and refused the proposals on the confidentiality grounds as cost of the software installed, purchased/ sold, cost of maintenance and re-engineering etc. were involved.

3.4.3 Data Collection

There are many ways to collect data but in the present study most of the data was collected through e-mail. A separate email account was created to send and
receive for all such type of information. The information about the companies was collected from the Internet sites. Their addresses, telephone numbers and email IDs were available on the Internet. Software engineers, developers, managers and or users in the respective organizations were asked to fill the questionnaires. They could fill the estimated values by their expertise in the columns of the questionnaire. They were to download the attached questionnaire (docx file) and fill the entries in it then after saving the filled entries they were required to send it back.

3.4.4 Data Analysis and Interpretations

All the received emails were printed and sorted out. Data collected was consisting of estimated increased or decreased values of aspects of reengineered software systems in comparison to old legacy software and status of re-engineering in software industry. After sorting the data, reports on seven characteristics of software were to be presented.

There are many factors which hinder re-engineering. Generalization will be done on various reasons according to their magnitude. Data was also collected for this purpose in the focused region. There were 32 statements formulated/collected in negative mode (reasons for low status of re-engineering) about re-engineering of software systems which were to be weighted by likert-type scale ranging from strongly agree to strongly disagree. The scoring was done by assigning a numeric value of 5 to the most favorable (strongly agree) position on the scale, 4 to the next most favorable and so on. In this way, all the responses obtained were converted to quantitative data, which were further subjected to put the statements (reasons) according to the severity.

The basic descriptive statistics were used in this study to generate reports. Graphs were also incorporated to make the interpretations more easy and meaningful. Columns left blank by the respondents in the questionnaires were not considered in evaluating the results. The results were based upon the primary data in the area under study. Simple statistics percentage, mean, standard deviation, CV (Coefficient of Correlation), sorting and summarization of data were done with application software MS-Excel. Reports and graphs for calculated values were also generated with the application of MS-Excel.
Limitations of the study

Every research study has some limitations depending upon the type and nature of the problem and the present study is no exception to it. Many problems in data collection and having useful information relating to the study were encountered. Lack of time and confidentiality of some matters of the organizations were the major problems faced in the study. The non-cooperation of some companies has restricted the coverage of research to some extent.