CHAPTER-3
Research Methodology

In this chapter the research problem is outlined, the purpose stated objectives are defined, and research hypothesis are given. Further, the research design and the procedures for conducting the study are described. It also defines the procedures for instrument development, pilot testing, sampling, data collection and data analysis procedures.

3.1 Statement of the Problem

Knowledge Management processes of an organization are enclosed in group settings which greatly control these processes (Alavi, Kayworth and Leidner, 2006). Many researchers and professionals (e.g. Lopez et al., 2004; Kulkarni, Ravindran and Freeze, 2007), consider that an Organizational Culture that is supportive and adaptive can facilitate successful achievement of Knowledge Management technologies as well as practices. The earliest references to Knowledge Management date back to the 1980s (Martensson, 2000). As a result of the relatively young body of theory and research in Knowledge Management, the related literature is characterized by a lack of consensus in the definition of knowledge development which is paralleled by the lack of widely accepted theoretical frameworks and inconsistencies in research findings (Fahey and Prusak, 1998; Hendrick’s, 1999). Therefore, in addition to Knowledge Management, this survey focuses on examining literature from related fields that constitutes theoretical foundations for Knowledge Management. These fields include organizational learning, Information system, organization theory and organizational behavior.

There are various researches on organizational efficiency in Knowledge Management, Organizational Culture, and Human Resource Development but only some studies have focused on R&D organizations and roughly any study on R&D
organizational success. In order to attain sustainable economic growth, there is a vital necessity for the R&D profession to evolve an effective Knowledge Management System in R&D.

As Knowledge Management concepts and applications are picking up acceptability in many organizations, this field presents unique opportunities and challenges for the academic world (Garrick et al., 2004; Gustav Clegg, 2005). This has led the academic world to start considering Knowledge Management as a managerial practice and have started to include the related topics in their academic programs. Knowledge Management plays an important role in Research and Development Institutions by enhancing research efficiency and effectiveness and providing value and benefits to research centers (Numprasertchais and Igel, 2005).

Research and Development Organizations today are embarking upon Knowledge Management programs for gaining competitive advantage. The present study aims at investigating the relationship between organizational success at Knowledge Management functioning and the Organizational Culture that supports or inhibit the development. As the organization is accountable for its spending of funds, careful considerations have to be made to avoid failures and unnecessary wastage of funds and resources in Knowledge Management implementation. There is a lack of empirical evidence about what are the specific cultural variables that support Knowledge Management processes and help in the development of knowledge culture (Oliver and Kandadi, 2006). Therefore the purpose of this study is to expand the base of knowledge in the area, and empirically identify the elements of Organizational Culture conducive to Research and Development and Knowledge Management in the Indian R&D Organizations.
The research purpose is to study the Organizational Culture and knowledge management in selected Indian R&D organizations. This study aims to contribute to reducing the gap that exists in determining the role of Organizational Culture in Knowledge Management realization in R&D organizations. In particular, this research aims at investigating the Organizational success at Knowledge Management implementation in the selected Indian R&D Organizations with specific reference to Organizational Culture. Following an extensive literature review, a conceptual model that represents the interaction of Organizational Culture and Knowledge Management success has been developed in the previous chapter.

3.2 Research Objectives

The main objective of this work is to study the relationship between elements of Organization Culture conducive to Research and Development and Knowledge Management success in the Indian R&D Organizations.

As Indian R&D Organizations are trying to leave behind their traditional approach to R&D, they aim for growth through R&D Knowledge Management activities, defining a Future Vision and Strategic Goal for the organization for the development of new products/processes/services, to be achieved through R&D Human Resource Management, Cultural Audit through R&D Information Management Systems and development of new valuable Intellectual Property. This study examines the influence of Organizational Culture facets such as R&D Management Activities, R&D Information Management Systems, R&D Human Resource Management, and Intellectual Property Management on accomplishment of Knowledge Management.
The objectives of the present research are:

1. to study the status of ‘Knowledge Management’ in selected Indian R&D Organizations;

2. To study the elements of the Organizational Culture those influence the Knowledge Management process.

3. To study the relation between Organizational Culture and Knowledge Management in selected Indian R&D Organizations and develop a suitable model depicting this interaction process, and

4. to study the elements of Organizational Culture such as Future Vision and Strategic Approach of an Organization, the Workforce Training and Development, the Cultural Audit process and Intellectual Property Management.

3.3 Conceptual framework

Goh (2005) illustrated the understanding of the management of Knowledge Innovation (KI) and showed the appearance of Knowledge Management as a potent source of competitive advantage. Innovation management should not be examined as distinct from Knowledge Management, but instead must engage in ideas on how to channel Knowledge Management practices for executing Innovation management processes.

The researchers have started approaching Knowledge Management from a cultural viewpoint, based on studies of the relations among people within a social (i.e., their work) environment (Blackler, 2000). Gupta and Govindarajan (2000) describe social environment as a ‘social system’, or Organizational Culture, in which people operate. As per this study the determinants of a social environment are Culture, Information Systems, Organizational Structure, Reward Systems, Processes, People, and
Leadership. There are four dimensions to human resource development and utilization: decision-making involvement, training and development of employees, support for personal initiative, and goal communication (Rauch et al., 2005). Taking cue from this study, I have selected four independent variables for the analyses made in the present study. These are

(i) Future vision and strategic approach of an organization,
(ii) The Workforce training and development,
(iii) The Culture Audit process and
(iv) Intellectual Property Management.

3.3.1 Future Vision and Strategic Approach of an Organization

Four traits of Organizational Culture have been identified in the literature. These are Involvement, Consistency, Adaptability and Mission. The mission is the existence of a shared vision of the function and purpose of the Organization and members (Denison, 1990; Denison and Mishra, 1995; Foy and Denison, 2003; Denison, et al., 2004). Mission has twofold aspects for Organizational functioning: first, it defines purpose and meaning and second, it envisions the direction and goals. It seems that the key to success is not the skilful management of endless knowledge, but the ability to direct activity to those knowledge resources which are crucial for the organization's economic operations (Karaszewski, 2008). Drongelen et al. (1996) reported that in R&D Organizations, the largest part of knowledge is already available in explicit and tangible formats.

The most appropriate approach for defining organizational effectiveness would be the one that defines it in terms of how efficiently an organization achieves its goals (Cameron, 1980; Lusthaus et al., 2002). In this approach goals become the central
component. Thus it is proposed that the goals that are clearly identifiable, consensual, assessable and time-bounded become the critical aspects to focus on while evaluating Organizational effectiveness (Price, 1972).

It becomes advisable to involve organizational members in brainstorming sessions about organizational effectiveness in which the different criteria, the measurement methodology, and allocation of appropriate weights for these criteria measurement methodologies could be considered. In the case of Research & Development organizations, the output measures can be subjective, discrete or scalar and even non-quantitative. Therefore there is a need to establish clear-cut relationships of these output measures with the Organizational goals (Jian and Triandis, 1997).

Many organizations have felt the need for a new strategic approach organizational effectiveness in view of the emergence of the knowledge society where knowledge and the application of knowledge are considered as the most crucial asset (Stehr, 1994; Barnett, 2003; Jansink et al., 2005). The manager in achieving organizational effectiveness of the organization should decide on the Knowledge Management strategy and goal in harmony with the business strategy. He should also be aware of the objectives and business processes of each and every organizational unit (Greiner et al., 2007). The “strategy frame” can help strategists to take a panoramic view in order to identify decisive strategic issues and place them in the proper context of the organization’s capacity in its operational environment (Khalifa, 2008).

Organizational Culture includes the values, beliefs, norms and expectations widely held in an Organization (Huber, 2001). It is affected both by internal factors, such as the vision, mission and values of the company, the technology employed within the company, the Organizational structure and the management style as well as external factors such as the social environment of the Organization (Lemon and Sahota, 2003).
In this milieu, R&D management activities need to embrace a strategic approach to the management of R&D projects in terms of planning, reviews and leadership support for future vision. Keeping this in mind, I have chosen "future vision and strategic approach" as one of my constructs in this study. Future vision and strategic approach in this study is measured in terms of R&D management activities being taken up by R&D Organizations for the realization of Knowledge Management.

3.3.2 Workforce training and development

One certain way to create Organization-specific resources is human resource development. This development and utilization is related to the practices deployed for improving employee skills using training and other forms of knowledge (Lepak and Snell, 1999). The idea of creating, coding, storing and disseminating knowledge is not new in Organizations as over the years, training, employee development programmes, policies, reports and manuals have served the same purpose (Alavi and Leidner, 1999). The Organizational performance and growth are linked to and dependent on successful human resource development.

Human Resource Development is identified in terms of enhancing motivation, performance, involvement, loyalty and commitment of the employees or members of the organization (Sharabi and Harpaz, 2010). Human Resource Management includes practices which make sure that Organization’s human capital contributes to the business outcomes and helps increase productivity by enhancing employee’s skills and motivation (Huselid, 1995). The additional benefit of the training for employee development is that it will help influence employee’s behavior and attitudes such that it is in line with Organizational goals. Employee involvement in decision making helps foster their commitment which in turn impacts performance positively (Arthur, 1994, Huselid et al., 1997; Lepak and Snell, 1999).
The human resource development systems can aid in the creation of sustained competitive advantage by assisting in the development of competencies that are firm-specific and production of complex social relationships. There are embedded in a firm's history and culture, and can generate tacit organizational knowledge (Lado and Wilson, 1994). Human resource development through various types of knowledge and skill augmentations enhances the human capital that is there in the Organization (Lepak and Snell, 1999). Extent of Human Resource Management is being measured in this study in terms of the training being imparted to the employees and their involvement in the organizational processes and know-how.

3.3.3 Cultural Audit process

Workforce variety in international organizations reflects a large amount of cultural and ethnic backgrounds. In such situations, shared values may blur cultural disparity. The differences in management practices due to cultural differences from country to country call for aligning the corresponding processes. Significantly, the success or failure of Knowledge Management within organizations depends on culture. This is an issue to tackle for effective knowledge management.

Deshpande and Webster (1989) define Organizational Culture as the set of shared values that help organizational members understand organizational functioning and thus guide their thinking and behavior. The culture is intricate web of standards and values that is produced over time and has an effect on the types and variations of organizational processes and behaviors (Barney, 1986). Organizational Culture as a concept is considered to be a key element in the management of organizational change and renewal (Pettigrew, 1990). Thus, culture is a sort of glue that bonds the social structure of an Organization together. A knowledge-based view of an organization has emerged in the literature over time (Cole 1998; Spender 1996a, 1996
This emerging view is a further buildup and expansion on the resource-based theory that was initially propounded by Penrose (1959) and extended further by other management scholars (Barney 1991; Conner 1991; Wernerfelt 1984). This emerging knowledge-based view maintains that it is the way the tangible resources are combined and applied that result into services and this in turn depends on the firm's know-how. This knowledge is rooted in and is disseminated through multiple entities like organization culture, routines, policies, systems, and documents, as well as employees (Grant 1996; Nelson and Winter 1982; Spender 1996a, 1996b). Knowledge is a fluid mix of framed experiences, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information (Davenport and Prusak, 2000). Information gives rise to knowledge as data delivers information. It is posited that if information is to become knowledge, humans must do virtually all the work (Davenport and Prusak, 2000). Thus, Knowledge Management is a process through which organizations generate and deploy their institutional and collective knowledge by integrating organizational learning, knowledge production, and knowledge distribution (Rastogi, 2000). If the organization culture doesn't support the Knowledge Management initiatives, these initiatives would not take hold in an organization (Holowetzki, 2002), for if knowledge exchange has to happen, significant cultural elements must exist, particularly those that reward the sharing, adaptation and application of the collected corporate knowledge (Hayduk, 1998). Organizations need to develop cultures where their members are encouraged to share knowledge in order to gain a strategic advantage for the organization (Elkjaer, 2004).

Firestone et al. (2005) presented a three-tier framework of business processes and outcomes distinguishing operational business processes, knowledge processes, and
processes for managing knowledge processes. Hofstede, (1991) called culture the "Software of the mind". In the competitive environment the organizations have to change its culture. This modifying of the culture can be said as culture audit process. This process is done through R&D information management, which in the present study is measured in terms of Information and communications technology (ICT) based on Knowledge Management Processes and other operational routines and processes being used in R&D organizations.

3.3.4 Intellectual Property Management

Most organizations nowadays are quite dependent on their human capital. The organization's competitive advantage and their market value are increasingly dependent on their intangible assets, such as their knowledge, core competencies, and organizational capabilities (Lawler, 2005). Economic theory links the accumulation of Research and Development and human capital to the economic growth of a country. It therefore becomes the responsibility of the governments to develop technological infrastructure, including research organizations and an education system, and also develop institutions to protect intellectual property rights which acts as the foundation for the development of innovation capabilities and the pursuit of scientific research (Aghion and Howitt, 1992).

Knowledge is being viewed as the most crucial property of an organization. Managing this knowledge that is complex plays an important role in attaining success for an organization (Petit and Huault, 2008). Social practices, like 'group learning', are at least as important as technological tools. The Knowledge Management has close links to both Organizational learning and complexity theory, and can be described as 'an OL practitioner's methods for helping organizations, not just individuals, learn' (McElroy, 2002).
Bhatt (2002) offers a framework that discovers the differentiation among Individual knowledge and organizational knowledge, and recommend a set of management strategies for knowledge management. Contrasting to manufacturing activities, knowledge activities are complicated to monitor and control, because just a fraction of knowledge is internalized by the organization, the other part is internalized by the individuals. This duality between individual knowledge and organizational knowledge commands different sets of management approach in knowledge management. Ženko and Marn (2006) have tried to understand, using system theory, the complex problems of intellectual property management by analysing some pertinent current issues concerning the standards and possibilities in the areas of computer software protection. Intellectual Property Management involves patents which are legalized monopolies. Monopolists exact higher prices than free market enterprises. This calls for creating equilibrium between the public interests in free access to technological information and the interests of patents in Intellectual Property monopolies. Owing to the lack of system theory employed in this problem solving processes the issues remain unanswered and also vague to many concerned with these processes. I have taken the Intellectual Property Management as one of the main feature and construct for my study. This study will try to measure the extent of Intellectual Property Management is being carried out in Indian R&D organizations.

3.4 Research Hypotheses

The research hypotheses were formulated keeping in mind the specific relationships in the conceptual framework. The main focus of the present study is to examine the predicting role or effects of future vision and strategic approach of an Organization, the Workforce training and development, Intellectual Property Management and the
Culture Audit process (Organizational Culture Attributes) with reference to Knowledge Management success in Indian R&D organizations

In this study the factors considered as independent variables are R&D Management Activities, R&D Human Resource Management, Intellectual Property Management, and R&D Information Management Systems. Their relationship with the perceived effectiveness of Knowledge Management accomplishment, the dependent variable, in the selected Indian R&D Organizations has been studied from the point of the users', particularly Technical heads of the scientific community of Indian R&D Organizations.

**Hypothesis 1:** To maximize the returns on R&D, organizations today are creating vision and strategy and are setting short and long term goals. The future vision and strategic approach of an organization has a positive effect on implementation of knowledge management.

**H₀:** There is no significant influence of the future vision and strategic approach of an organization on implementation of knowledge management.

**H₁:** There is a significant influence of the future vision and strategic approach of an organization on implementation of knowledge management.

**Hypothesis 2:** To leverage and bring-in efficiency to have shorter new product development cycles, the personnel in the R&D Organizations must be trained in skills and competencies of the Organization. The workforce training and development in an Organization has positive effects on implementation of knowledge management.

**H₀:** There is no significant influence of the workforce training and development in an Organization on implementation of knowledge management.
H3: There is a significant influence of the workforce training and development in an Organization on implementation of knowledge management.

**Hypothesis 3:** The Culture Audit process in an organization has positive effect on implementation of knowledge management. In R&D organizations the knowledge sharing and creation is restricted mainly to their internal peer-cluster of the directorates. Communication of knowledge is negligent among the members of other Laboratories and Establishments of an R&D Organization. The few interactions with external experts are principally based on personal association only. In this situation, sound practices in terms of R&D Information Management Systems leads to Culture Audit process which has a positive effect on implementation of knowledge management.

**H0:** There is no significant influence of the Culture Audit process in an organization on implementation of knowledge management.

**H3:** There is a significant influence of the Culture Audit process in an organization on implementation of knowledge management.

**Hypothesis 4:** Intellectual Property corresponds to the talent and thoughts within an organization - the thoughts, the innovation, the creativity and the intelligence that sets the organization apart from others. Intellectual Property can be either the name of company, the packaging of the product, or the know-how of the key people. These need to be protected by taking suitable measures to retain their advantages. Thus Intellectual Property Management is the heart of the success of the organization which helps pool the resources of innovative technologies of the organization and the ways of working. Through Intellectual Property Management multiple benefits can be achieved from the existing business processes. It can identify and build on existing technologies, and help connect schemes which are already in use to share knowledge
and know-how. Therefore, it is our hypothesis that Intellectual Property Management in an organization has positive effect on implementation of knowledge management.

H0: There is no significant influence of Intellectual Property Management in an organization on implementation of knowledge management.

H1: There is a significant influence of Intellectual Property Management in an organization on implementation of knowledge management.

3.5 Scope of the study

The accomplishment of Knowledge Management in Indian R&D organizations would extend benefits in terms of knowledge benefits, intermediate benefits, and organizational benefits.

The knowledge benefits include being able to retrieve the best and latest thinking, faster access to knowledge, better knowledge sharing, skill development, training, knowing who's doing what within the organization and uniformity of job product across the departments of the organizations. The information and knowledge created as the outcomes of using improved and well-organized processes through Knowledge Management is used in the decision making of the R&D organizations. The improvements and efficiencies of these processes are due to the reduced frustration in searching for documents, removal of many non-value-adding steps in the processes or due to the addition to the efficiency of the employees occupied in specific tasks, so that time is saved.

The type of intermediate benefits is such benefits as are gained by leveraging the information, knowledge, and processes. These are: distinct ways of thinking about, designing and conducting evaluation efforts, fresh approaches and new thoughts, faster problem-solving, effective quicker new hires, and minimized duplication of work and doing away with the avoidable re-invention of the processes which have
already been defined by someone else in the organization. These intermediate benefits provide greater competence and effectiveness of the organization. For example, the efficient and logical documentation of activities and tasks in a systems development project enables the teams involved in similar projects subsequently to know the modus operandi of the project and also to avoid the pitfalls experienced by the earlier team and enlisted in the project documentation.

The organizational benefits include improved and rapid innovation and new product development, better user focus and satisfaction, reduced information failure, and enhanced output and superior performance. These benefits will impact the way an organization conducts itself to achieve its objective, for example, to provide quality education, quality products and services, or quality programs to bring about the good of civil society. In a persistently budding and cutthroat competitive environment, organizations must incessantly progress in the area of creating pioneering products and service that would meet the continuously growing needs and requirements of their patrons and clients. For the success of any organization, big or small, investment of goodwill from customers is the only way ahead.

The findings of the present study could help Indian R&D organizations assess as to whether their Knowledge Management plan will be successful and increase the organization’s competitive advantage in relationship to the current Organizational Culture.

3.6 Research Design

This section discusses the research design, research population and sample, techniques of data collection, tools used and statistical techniques used for data analysis.
The first phase of this study is exploratory in nature and has helped in developing appropriate research framework with the help of the studies and theories accessed from literature survey on R&D sector, and Organizational Culture with focus on Knowledge Management accomplishment. After laying down the theoretical framework, the next phase of the study is to identify the relationships empirically. To meet this objective, an empirical study of various R&D organizations in India was undertaken. The present study proposes to understand the relationship between the Knowledge Management and the dimensions of Organizational Culture in these R&D organizations and further investigate its impact on these R&D organizations. The Knowledge Management was studied as the outcome variable, which is influenced by the dimensions of Organizational Culture.

3.7 Questionnaire Design

The study required research to obtain data consisting of information on different types of elements of Organizational Culture and dimensions of Knowledge Management conducive to R&D. The overall methodology for the design of the research is to be from multiple sources of research literature and data collection efforts which were identified based on the review of the current literature on Organizational Culture and Knowledge Management, with focus on Indian R&D Organizations.

As KMS is an all encompassing term that includes hardware, software, communication, man and materials required to implement, we have specifically selected Indian R&D Organizations to study Knowledge Management applications in them and how such applications lead to R&D solutions and collaborations among Indian R&D organizations to strengthen the technological foundations and assets of India.
Some of the questions formulated for this study are compilation from previous studies on Knowledge Management adoption and some others are appropriate modifications or are specifically formulated for this study. A research instrument in the form of a structured questionnaire incorporating the relevant variables used in this study has been developed. The measures used for testing the constructs have been developed by the researcher as well as adopted from previous studies by Zheng (2005), Leona Ba (2004), Lawson (2003) and Goodale (2001)

Part I of the questionnaire consists of questions on the profile of the respondent covering the name of the Organization, designation, qualification, length of service, age, gender etc.

Part II covered questions using a six-point Q sort scale having a category “Don’t Know” in addition to a five-point Likert scale and is as follows: Strongly agree (SA), Agree (A); neither agree nor disagree (NAD); Disagree (D); and strongly disagree (SD) and Don’t Know. This category “Don’t Know” was added since some respondents might be expected to be unsure about how to answer. The survey questionnaire reflects the research questions on the aspects of Knowledge management being followed in the Organization, role of Organizational Culture in terms of future vision and strategic approach, Training and Development of the workforce, Intellectual Property Management, and cultural audit of organizations.

R&D management activities section in the questionnaire reflects the organization’s strategic approach to its R&D projects management in terms of planning and reviews and signifies the future vision and strategic approach of the organization, in the questionnaire. The R&D Human Resource Management section indicates the Training and Development of the workforce in the R&D organization. Intellectual Property Management section indicates the Intellectual Property Management practices in the R&D Organization and the section on R&D Information Management System symbolizes the cultural audit process. The Organizational Culture and Knowledge Management are derived variables from the analysis of the responses.

The seven sections i.e. Knowledge Accumulation, Knowledge Creation, Knowledge Utilization, Knowledge Sharing, of the Knowledge Internalization, Knowledge Protection, Knowledge IT Approach have been used to find out about the existing level of Knowledge management in the organization of the respondent. The Knowledge Management value is derived from the calculation of the mean value of the instruments considered under these particular variable categories in the questionnaire.

3.8 Pilot Testing of the Instrument

A Pilot testing was carried out to validate the items and the whole scale of the instrument. This was necessitated because some of the measurement items were modified or developed specifically for this research leading to formulation of some new questions.

A preliminary questionnaire was developed by amalgamating relevant items from the pool of previous studies and distributed to ten scientists and three professors (one eminent retired professor from Delhi University and two professors from Lingaya’s Institute of Management and Technology) to gain their feedback on the content,
layout, wording and ease of comprehension of measurement items. Their feedback for improvements in clarity, readability, content enhancement and layout were incorporated in the second stage of the instrument development.

Interviews were conducted of concerned persons in a set of thirteen Delhi based labs using the revised questionnaire. Verbal feedback was received and changes made accordingly. The pilot test results indicated a requirement of simplification of some words to cater to varied level of English language comprehension in India. Accordingly, the words flexibility and responsiveness were explained again with more clarity.

3.9 Sampling Procedures and Questionnaire Administration

The sampling unit or the target population for this study was the Indian R&D organizations which were surveyed at their corporate office, technical office and laboratory. The key informants were constituted of Corporate and Technical Directors at the Head Quarters of R&D organizations, Lab Directors, middle level Scientists and Technical Officers at Lab level. These were identified through the R&D database of India. ANOVA was used to determine if differences in mean values between three respondent groups are by chance or if they are indeed significantly different.

The purposive sampling approach was followed for data collection. A combination of web based and mail surveys were employed. Questionnaires were sent to all government R&D organizations. A special permission was taken to circulate the questionnaire within the Labs of R&D organizations. A total of 1200 Questionnaires were distributed. The private sector R&D organizations were contacted through web based survey.

The circulation of the questionnaire for the mail survey and the electronic web based survey was done through email, giving the instrument as attachment and also through
a link of the instrument created in the Google docs. Questionnaire mailing procedure included pre-survey notification of initial mailing, a post survey reminder, a physical contact and reminder.

A total of 272 responses were received, 200 of them were through the mail survey and 72 of these were through the online web survey. These were received after an intensive follow-up with the help of DRDO scientists wherever they were present.

Existing sources of secondary information related to R&D Organizations were accessed to supplement the primary data. Primary data used in this study are from National Research Corporation (NRDC), Consulting Organizations, World Wide Web, in-house research and studies conducted by various Organizations.

3.10 Reliability and Validity of the Instrument

To draw authenticate conclusions from the research, measures of all the variables are supposed to have validity and reliability (Cronbach, 1971; Nunnally, 1978).

Reliability is defined as the proportion of the variability in the responses to the survey that is the result of differences in the respondents and it concerns it with how consistently similar measures produce similar results. The answers to a reliable survey will differ because respondents have different opinions, not because the survey is confusing or it has multiple interpretations.

Cronbach's alpha is a measure of reliability. More specifically it is a lower bound for the true reliability of the survey. The computation of Cronbach's alpha is based on the number of items on the survey and the ratio of the average inter-item covariance to the average item variance. Under the assumption that the item variances are all equal, this ratio simplifies to the average inter-item correlation, and the result is known as the Standardized item alpha (or Spearman-Brown stepped up reliability coefficient).
To examine reliability and internal consistency, Cronbach's alpha tests were conducted using the 12 survey subscales formed to conduct the study i.e. Knowledge Accumulation, Knowledge Creation, Knowledge Utilization, Knowledge Sharing, Knowledge Internalization, Knowledge Protection, Knowledge IT Approach, Competitive Advantage, R&D Management Activities, R&D Human Resource Management, Intellectual Property Management, R&D Information Management System and two derived variables of Knowledge Management and Organizational Culture. The Cronbach's alpha score for the above stated 14 scales is given in Table III.1 below:

<table>
<thead>
<tr>
<th>No.</th>
<th>Scale</th>
<th>Cronbach's Alpha</th>
<th>No. of Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Knowledge Accumulation</td>
<td>0.876</td>
<td>11</td>
</tr>
<tr>
<td>2</td>
<td>Knowledge Creation</td>
<td>0.870</td>
<td>11</td>
</tr>
<tr>
<td>3</td>
<td>Knowledge Utilization</td>
<td>0.886</td>
<td>14</td>
</tr>
<tr>
<td>4</td>
<td>Knowledge Sharing</td>
<td>0.916</td>
<td>14</td>
</tr>
<tr>
<td>5</td>
<td>Knowledge Internalization</td>
<td>0.904</td>
<td>14</td>
</tr>
<tr>
<td>6</td>
<td>Knowledge Protection</td>
<td>0.878</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>Knowledge IT Approach</td>
<td>0.887</td>
<td>9</td>
</tr>
<tr>
<td>8</td>
<td>Competitive Advantage</td>
<td>0.848</td>
<td>6</td>
</tr>
<tr>
<td>9</td>
<td>R&amp;D Management Activities</td>
<td>0.961</td>
<td>33</td>
</tr>
<tr>
<td>10</td>
<td>R&amp;D Human Resource Management</td>
<td>0.875</td>
<td>9</td>
</tr>
<tr>
<td>11</td>
<td>Intellectual Property Management</td>
<td>0.935</td>
<td>8</td>
</tr>
<tr>
<td>12</td>
<td>R&amp;D Information Management System</td>
<td>0.954</td>
<td>23</td>
</tr>
<tr>
<td>13</td>
<td>Knowledge Management</td>
<td>0.926</td>
<td>7</td>
</tr>
<tr>
<td>14</td>
<td>Organizational Culture</td>
<td>0.909</td>
<td>5</td>
</tr>
</tbody>
</table>

Table III.1: Reliability Statistics

George and Mallery (2003) suggested the following rules of the thumb for evaluating alpha coefficients, "> .9 excellent, > .8 good, > .7 acceptable, > .6 questionable, > .5 poor, < .5 unacceptable." Generally if the value of Cronbach's alpha is more than 0.7 then it is considered that the scale used to measure some variable is reliable and the outcome of this analysis will be reliable and valid. In my analysis, all the scales are having a cronbach alpha score of more than 0.848, which will be considered as good and reliable scales and further analysis done on these scales will be treated as reliable
The Validity of a measurement instrument concerns how well it measures what it is supposed to measure (Rosenthal and Rosnow, 1984). Validity is established by correlating the scores with a similar instrument. There are four types of validity, such as Content Validity, Concurrent Validity, Predictive Validity and Face Validity.

In the present study, the content validity of the measurement instrument was measured by requesting experts to scrutinize the questionnaire and provide feedback for revision. The panel consisted of ten scientists and three professors and they suggested removal of ambiguous statements as well as questions. In the pilot test, each item was inspected for its clarity and relevance to the research.

Predictive Validity is a statistical approach to validity which is similar to concurrent validity, in that it measures the relationship between examinees' performances on the test and their actual status as masters or non-masters. However, with predictive validity, it is the relationship of test scores to an examinee's future performance as a master or non-master that is estimated. In other words, predictive validity considers the question, "How well does the test predict examinees' future status as masters or non-masters?" For this type of validity, the correlation that is computed is between the examinees' classification as master or non-master based on the test and their later performance, perhaps on the job.

In the present study, Predictive validity is also applied employing interclass Pearson's Product Moment Coefficient of Correlation. The result is given below in Table III.2:

<table>
<thead>
<tr>
<th></th>
<th>Interclass Correlation</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Lower Bound</td>
</tr>
<tr>
<td>Single Measure</td>
<td>0.485</td>
<td>0.423</td>
</tr>
<tr>
<td>Average Measures</td>
<td>0.919</td>
<td>0.898</td>
</tr>
</tbody>
</table>

Table III.2: Interclass Pearson's Product Moment Coefficient of Correlation
Overall, the test results indicate that the instruments used in the study is significant at 95% of the confidence level. This means that the predictive criterion generalises the conclusion up to 95% of accuracy.

3.11 Data Analysis Procedure

The information/data collected using questionnaire was keyed into MS Excel. Further it was exported to SPSS (Statistical Package for Social Sciences) software version 20 for Windows with compatible environment of data coding. The data were subjected to statistical analysis for the purpose of interpretation. Descriptive statistics such as mean, standard deviation and inter correlations were computed to understand the interdependence between the variables. Multiple regression analysis was used to test the hypotheses. Graphical representations of the data such as Tables, charts etc. have been extensively used. The statistical measures used in this study are as follows; descriptive statistics to describe the state of affair of the data and variables, cross-tabulation Pearson Chi-square test statistics to show the interdependency among variables, independent sample t-test statistics to represent the direction and magnitude of impacts of various factors on Knowledge Management and the regression analysis to test the model.

3.11.1 Derived Variables

The variables used in the study are derived from the calculation of the mean value of the instruments considered under the particular variable category in the questionnaire. For Knowledge Accumulation, the mean value of 11 instruments (asked under knowledge accumulation head in the questionnaire) were calculated. Similarly for other variables, Knowledge Creation (11), Knowledge Utilization (14), Knowledge Sharing (14), Knowledge Internalization (14), Knowledge Protection (6), Knowledge IT Approach (9), Competitive Advantage (6), R&D Management Activities (33),
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R&D Human Resource Management (9), Intellectual Property Management (8), R&D Information Management System (23), the mean value of the number of instruments provided in brackets were calculated. In order to derive the value of Knowledge Management Variable, the mean value of 7 instruments (Knowledge Accumulation, Knowledge Creation, Knowledge Utilization, Knowledge Sharing, Knowledge Internalization, Knowledge Protection, and Knowledge IT Approach) was calculated. For calculation of Organization Culture, the mean of 5 instruments (Competitive Advantage, R&D Management Activities, R&D Human Resource Management, Intellectual Property Management, and R&D Information Management System) was calculated. In order to form the categorical variables, the calculated value of these derived variables was divided into two categories, low and high. The values of less than 3 were treated as of a 'low score' on the particular variable while the values of more than 3 were treated as of a 'high score' on the variable. For example, if the value of a particular response for Organizational Culture variable is 2.5, then it will be treated as of 'low score' and further, will be interpreted as indicating that the Organization culture in that particular response category is not good.

3.11.2 Statistical Analysis used and its justification

3.11.2.1 Pearson Chi-square Test

The Pearson chi-square is the most common test for significance of the relationship between categorical variables. This measure is based on the fact that we can compute the expected frequencies in a two-way Table (i.e., frequencies that we would expect if there was no relationship between the variables). The Chi-square test becomes increasingly significant as the numbers deviate further from this expected pattern; that is, the more this pattern of choices for males and females differs.
The value of the Chi-square and its significance level depends on the overall number of observations and the number of cells in the Table. Consistent with the principles discussed in Elementary Concepts, relatively small deviations of the relative frequencies across cells from the expected pattern will prove significant if the number of observations is large. This can be calculated with help of following formula.

$$\chi^2 = \sum_{i=1}^{n} \frac{(O_i - E_i)^2}{E_i} \quad \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots (1)$$

The variables in this formula are not simply symbols, but actual concepts that we've been discussing all along. $O$ stands for the Observed frequency. $E$ stands for the Expected frequency. You subtract the expected count from the observed count to find the difference between the two (also called the "residual"). The only assumption underlying the use of the Chi-square (other than random selection of the sample) is that the expected frequencies are not very small. The reason for this is that, actually, the Chi-square inherently tests the underlying probabilities in each cell; and when the expected cell frequencies fall below 5, those probabilities cannot be estimated with sufficient precision.

3.11.2.2 t-test for Independent Samples

The t-test is the most commonly used method to evaluate the differences in means between two groups. For example, the t-test can be used to test for a difference in test scores between a group of patients who were given a drug and a control group who received a placebo. Theoretically, the t-test can be used even if the sample sizes are very small (e.g., as small as 10; some researchers claim that even smaller are possible), as long as the variables are normally distributed within each group and the variation of scores in the two groups is not reliably different. As mentioned before, the normality assumption can be evaluated by looking at the distribution of the data or
by performing a normality test. The equality of variances assumption can be verified with the F test, or you can use the more robust Levene's test. If these conditions are not met, then you can evaluate the differences in means between two groups using one of the nonparametric alternatives to the t-test. For calculating t-test statistics, first we need to calculate the standard error (SE); which can be calculated by dividing the standard deviation (SD) with the square root of the sample size n (see equation II).

$$SE = \frac{SD}{\sqrt{n}}$$ ................................................................. (II)

$$t = \frac{(\bar{A} - \mu)}{SE}$$ ................................................................. (III)

For calculation of t-test we can use the formula equation given in equation III. Here $\bar{A}$ is sample mean and $\mu$ is hypothesized population mean.

The p-level reported with a t-test represents the probability of error involved in accepting our research hypothesis about the existence of a difference. Technically speaking, this is the probability of error associated with rejecting the hypothesis of no difference between the two categories of observations (corresponding to the groups) in the population when, in fact, the hypothesis is true. Some researchers suggest that if the difference is in the predicted direction, you can consider only one half (one "tail") of the probability distribution and thus divide the standard p-level reported with a t-test (a "two-tailed" probability) by two. Others, however, suggest that you should always report the standard, two-tailed t-test probability.

I have used t-tests to test for a difference between two independent groups in this study.

I have already conducted Granger causality test on both dependent and predictor variables on the collected data. Based on the result of the Granger causality test, it has
been found that functional relation used in the study happens to be significant. For the sake of avoiding bulkiness, this test has been intentionally skipped in the write up.

3.11.2.3 Analysis of variance (ANOVA).

Surveys are helpful data compilation technique. The statistical survey analysis helps ascertain the facts and insights are developed. While collecting metric data on the surveys, possibly in the shape of responses to a Likert scale, such as amount spent on merchandise, client satisfaction scores, or number of purchases made then it leads to analyzing differences in average score between respondent groups. If we are comparing two groups at a time then it is appropriate to use a t-test to assess the significance of any differences. However, if there are more than two groups it becomes necessary to use another technique. ANOVA, or its non-parametric counterparts, which help to determine if differences in mean values between three or more groups are by chance or if they are indeed significantly different. The null hypothesis is that there is no difference in satisfaction between the three or more groups. ANOVA makes use of the F-test to determine if the variance in response to the questions is large enough to be considered statistically significant. ANOVA indicates whether or not there is a significant difference, it does not provide, however, direction as to which group is higher or lower. Statistical packages, such as SPSS and SAS, allow the survey researcher the option of selecting a post-hoc test which compares groups for individual differences.

3.11.2.4 Regression Analysis

Regression analysis is a statistical tool for the investigation of relationships between variables. Usually, it is used to ascertain the causal effect of one variable upon another. To explore such issues, the data is assembled on the underlying variables of interest and employs regression to estimate the quantitative effect of the causal
variables upon the variable that they influence. The assessment of the "statistical significance" of the estimated relationships, that is, the degree of confidence that the true relationship is close to the estimated relationship is also made. In my study the following regression equation has been used (see equation IV).

\[ KM = \alpha + \beta_1 \ OC + \beta_2 \ IPM + \beta_3 \ RDHRM + \beta_4 \ RDMA + \beta_5 \ RDIMS + e \]

... (IV)

Where,

KM: Knowledge management

OC: Organizational Culture

IPM: Intellectual property management

RDHRM: R&D human resource management

RDMA: R&D management activities

RDIMS: R&D in information management systems and

\( \beta_1, \beta_2, \beta_3, \beta_4, \beta_5 \) are coefficients and \( \alpha \) is intercept.

3.12 Limitations of the Study

This research study has several limitations, some of which are listed here.

- The study focused itself only on R&D conducive elements of Organizational Culture. Other culture types, culture strength, culture congruence, etc. have not been included in the sample.

- The sample consisted of the respondents who were scientists and Technical Officers in R&D organizations, who provided their perspective of the KM Implementation process in their respective R&D Organization and excludes all the others in the hierarchy thus missing their perspective on Knowledge
Management Implementation. Hence the results cannot be generalized for all
the employee segments of the R&D Organizations.

- This study also did not do any impact analysis of different types of
  Organizational Culture.

- This study while measuring the different variables also did not factored in the
differences in respondent's demographic characteristics.

- Only Knowledge Management was the subject of the study and there was no
  comparative analysis with respect to different disciplines of the R&D
  Organizations.

- This study did not identify any elements of Organizational Culture which
  acted as barriers for the KM implementation in R&D Organizations.

- The study might also have suffered from the limited comprehension and
  ability of the researcher with regard to statistical area.