Inter-Organisational Collaboration and Software Development:

A Study of Software Units In Hyderabad

A Thesis Submitted to the
University of Hyderabad for the award of the degree of

Doctor of Philosophy in
Sociology

By

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Declaration

I hereby declare that **the** research carried in this thesis entitled, **"Inter-Organisational Collaboration and Software Development: A Study of Software Units in Hyderabad"** is an original work carried out by me for the award of degree of Doctor of Philosophy from the University of Hyderabad.

I declare to the best of my knowledge that no part of this thesis was earlier submitted for the award of research degree of any other University.

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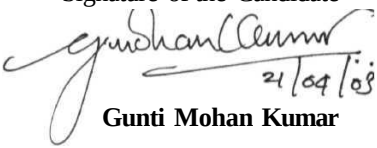

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This is to certify that the research embodied in the present thesis entitled **"Inter-Organisational Collaboration and Software Development: A Study of Software Units in Hyderabad"** was carried out by **Gunti Mohan Kumar** under my guidance for the full period prescribed under Ph.D. ordinances of the University.

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Acronyms

CB	Collaboration Basis
CD	Collaboration Duration
CP	Collaboration Projects
CSI	Collaboration Strength Index
Hysea	Hyderabad Software Exporters Association
IT	Information Technology
Nasscom	National Association of Software and Service Companies
NLD	Number of Learning Days
NLP	Number of Learning Programs
NP	Number of People employed
NTP	Number of Technical People
OLI	Organisational Learning Index
PEF	Project Effort Factor
PTF	Project Time Factor
QFD	Quality Function Deployment
SAE	Software Development Actual Effort,
SAF	Software Development Actual Functional Points.
SAT	Software Development Actual Time,
SDI	Software Development Index
SEE[1]	Software Development Estimated Effort,
SEF	Software Development Estimated Functional Points
SET	Software Development Estimated Time,
STPH	Software Technology Park, Hyderabad
STPI	Software Technology Park of India

Chapter 1: Introduction

1. Introduction

Advances in information and communication technology ushered in radical changes in social structure and culture, in terms of social relations at both the work place and outside the work place and also in the means of communication. The information and communication technology has led to collapse of space -time barriers. In one sense, today's technological revolution is not new. In the past century, impressive advances in transportation, communications and medicine have changed the life style as well as the work culture of the people. What is different now is the convergence and interaction of many strands of technological change-with social consequences far more profound, far more difficult to foresee (Hallberg and Bond, 1999).

We are in the information age, the latest phase in the evolution of human civilisation and markers of a civilisation are the tools and techniques of the time. The earlier evidence of using tools for improved living conditions was found during the Stone Age. The agricultural revolution was the next epoch in the progress of human civilisation, with its more sophisticated tools and practices that increased food production and other facilities through improved technology. The mass production and distribution was the characteristic of the Industrial Revolution. The advent of computers has marked a new era in the civilization with the information technology (IT) revolution, which is speeding forward with full steam. The revolution changes the value system and the paradigm which we have been accustomed to (Philip, 2001). Now we are dealing with commodities that are intangible and invisible. In this new age, information is the most valuable commodity. Everything else depends on the accessibility one has to the wealth of information. The technology used at a

particular time would determine the kind of goods produced and transacted at that time. In the age of information, the primary "good" for transaction is information. The primary means of exchanging information is communication (Philip, 2001).

1.1 Sociology of Technology:

Many sociologists have focused on the interaction between technology and society. Functionalists viewed technology not only as an instrument in developing the economic status but also causing functional interdependence leading to social cohesion. They have viewed motivation and recognition of individual as a part of technological production as the hall-mark of technology. In the emergence of technology, values and beliefs of people become determining factors, creating particular elements of technology.

Technology has been viewed differently by different social scientists. For Davis (1981), technology meant 'application of knowledge to physical phenomena' and it is relevant to study this with reference to culture because the culture of man started with tools and devices. Merton (1949) observes that the socio-economic factors determine the scientific research, creating needs where needs are not found and thus causing conflict between 'morality of science' and 'morality of ordinary behaviour . Davis suggests that technology would minimise the conflict and thus facilitate science in reaching its goal of scientific truth. Technology for Parsons (1951) meant 'mobilisation of resources to achieve a particular goal' and it is determined by the 'conditions of success' and 'cost'. The cost would not only mean in economic sense, but also the cost of sacrificing other technologies. Taking cue from Pareto, Parsons (1949) observes that the relations between means and ends can be called a

technological element because only then it becomes a logical action. Then efficiency of technology would mean, the effectiveness of a technology process relative to cost (Parsons, 1951).

1.2 Technology and Knowledge:

While on the psychological plane technology results in motivation of individual towards the best opted out technologies and balancing costs, on the sociological plane, technology results in collective organisation of resources for which appropriate 'role allocation' and 'institutional means' to achieve the goals would matter. Therefore, technology is functional in the sense that it not only elevates the status of an individual and society by making a lot of facilities feasible but also calls for a group activity thus facilitating 'collective conscience'. If we were to analyse technology development in Durkheimian sense, we can assertively say that it is improving group cohesion and the collective conscience by making collaborations imperative. The technological change, as viewed in terms of a social system, would be definitely managed by the society because of its dynamic nature (Parsons, 1951).

Thus for functionalists technology includes not only the material tools but also the non-material and ethical aspects. Technology, which is a means, causes conflict only when it becomes an end in itself. In order to keep pace with the technological developments, if irrelevant technologies are adopted and unmanageable consequences crop up, the same technology would cause chaos which becomes irreplaceable. From the sociology of knowledge point of view technology and knowledge are considered as one and the same. Therefore, as technology develops, knowledge also develops. This growth in scientific and

technological knowledge facilitates and also gets facilitated by organisational learning. Thus we can say that organisational learning and technology development are parallel processes.

Knowledge is information abstracted from reality and is conceptualised and expressed in a system of shared symbols. Merton (1968) differentiates between knowledge and information. Knowledge is systematically connected body of facts and beliefs which otherwise individually constitute information. The basic assumption of sociology of knowledge is that knowledge is socially and culturally conditioned.

Karl Manheim(1936) gave a separate disciplinary status to sociology of knowledge as a response to German idealism. He conformed to Marxian conception of control of knowledge by extra-cognitive factors, but refused to accept that class is the only social category that conditioned knowledge. The groups needn't be only of economic nature but also be occupational groups and status categories that can condition knowledge.

According to him, all knowledge, except scientific knowledge, is socially and culturally conditioned. Scientific knowledge for Manheim is universal, invariant, objective and atemporal. Manheim subscribes to positivist - rationalist philosophy of science. Manheim seems to have identified two dominant models of thought, viz., aspirations and intentions which form the main content of knowledge and are controlled by the social order (Eisenstadt,1987). He was in consonance with Durkheim's group affiliations and collective conscience. Merton(1957) in his critique of Manheim observes that Manheim identified certain spheres of knowledge but could not really establish the connection between thought and society, as he believed that identification of groups and their ideological affiliations have to be empirically investigated. This is fallacious, as Merton says, because, if the relationship

between a particular sphere of knowledge and society is not established, it becomes difficult to devise a research problem for empirical investigation.

Manheim also gave three points to avoid fallacies in sociology of knowledge. In his view, a theory has to be contextually relevant, appropriate and adaptable to social conditions.

"A theory is wrong if in a given practical situation it uses concepts and categories, which, if taken seriously, would prevent man from adjusting himself at that historical stage." (as quoted in Merton,1968,p557).

According to rationalist epistemology, scientific knowledge is rational, universal, atemporal and objective. Sociological explanation is needed only to account for irrational beliefs in science. However, the recent developments in sociology of knowledge attempt to show that all knowledge is socially caused (Bloor, 1976). Thus, the sociology of science has widened its gamut of operations from mere analysis of the social and moral aspects of science to the content and the process of social production of scientific knowledge and innovations, thus opening up not only the social organizational aspects but also the construction of the content of science to sociological scrutiny.

1.3 Definition of technology

Technology as a body of systematic knowledge, associated practices, values and meanings is embodied in a variety of economic organisations and social institutions. Technology has two dimensions: design and control. Design incorporates functional aspects and control dimension deals with social organisation needed to implement technology and who will be included to access it and who will be excluded from accessing it.

Technology includes artifacts, knowledge underlying the construction of the artifacts and social organization required to implement technology. We have seen that knowledge is built into technology. Then technological change would also mean knowledge change, change in information levels, perceptions and concepts. It would also mean change in practices, cultural as well as technical. Technological change according to Parayil (1991) is, "the outcome of activities that humans engage in and through their collective or individual organizational structures, to optimise their resources subject to constraints imposed by their own limitations in tandem with that of the environment."

According to Saviotti (1986), any technological change is supposed to be having two characteristics: technological and service characteristics which are complementary to each other. The interface between the internal environment of the technological system and the external environment is represented by the service characteristics which provides the link between the technology and the external environment.

In the foregoing paragraphs we have seen the social origins of knowledge. Conventional thesis of technological determinism argues that technology shapes society and brings about social change but it is external to the social world and is seldom influenced by the society (See Mackenzie et al,1998). By contrast, the social shaping of technology approach corrects the fallacies in this notion by arguing that technology and society are mutually dependent entities. There seemed to be two broad approaches,- micro and macro- to social shaping of technology (See Mackay & Gillespie,1992). Three different schools of thought may be identified in the micro approach;

(1) the social constructionist approach which suggests that technological systems emerge out of choices between social groups and technology is socially constructed. (2) the 'systems' approach which focuses on technologists as 'system builders' and postulates that heterogeneous people, disciplines and organizations form a part of 'seam less web' (Hughes,1992) and

(3) the actor- network theory which gives a comprehensive approach to understand the development of technology focusing on the relations between actors of technical and non-technical world.

The social constructionist approach as given by Bloor (Bijker et al, 1987), highlights that, knowledge and knowledge claims are socially constructed. That is, explanations for acceptance and rejection of knowledge claims are sought in the social domain. This approach has given way to empirical research to understand the processes of construction of scientific knowledge in various contexts. This approach has paved way for a new understanding of the relationship between science and technology. Many studies have been carried out to understand the nature of technology and its dependence on science. According to Layton (1977, Pg 210), " Science and technology have become intermixed. Modern technology involves scientists who do technology and technologists who function as scientists. The old view that basic sciences generate all the knowledge which technologists then apply will simply not help in understanding contemporary technology". He also says " the divisions between science and technology are not between the abstract functions of knowing and doing. Rather they are social". (as quoted in Bijker, 1987).

Scientists and technologists are seen to be constructing their respective bodies of knowledge and techniques drawing their resources from each other. Thus Pinch and Bijker (1987) say that there is no sense in considering the relationship between science and technology as unidirectional. According to them, technology studies gain more prominence in the recent literature, which can be studied under three categories viz., innovation studies, history of technology and sociology of technology. The innovation studies are carried out by economists to understand the conditions for success in innovation. The historians of technology study the historical conditions that led to success or failure of innovations. The third and the most important is the sociology of technology which appears to be more promising in giving social explanations not only for success or failure but also looks into the organizational aspects of technology.

Edward Constant (1989) relates technology to the social context. There are two broad traditions identified by him in the treatment of technology, i.e., intellectual and artifactual accounts that have their origins respectively in the two approaches in the history of science and in organisational accounts with business & economic history. The first tradition followers of Layton have seen technology as knowledge. The adherents to the second tradition focused on entrepreneurship and technological change in the context of complex organisations. In the first view scientific progress plays a significant role in technological change, where as in the second view, market demand, entrepreneurial creativity and other economic factors dominate. To put it in a nutshell, technological determination in the organisational context can be debated as to whether

- technology determines/shapes organisation

- or organisations determine/shape technology
- or both are linked to each other in a dynamic interactive matrix that involves external factors as well.

Many historians of technology like Thomas P. Hughes (1983), Alfred Chandler (1977) and Nathan Rosenberg (1982) studied the development of large scale, integrated technological systems and their concomitant organisations. According to Constant (1989), three social loci are identified for technological practice: the technological community, the complex organisation (corporate) and the technological system.

Hughes' notion of technology as a system can be seen in his "Networks of Power" (1983), in which his model consists of three interrelated structures.

- a temporal stage model for the development of technology
- each stage characterized by reverse salients in the advancing technological front. The reverse salients are decomposable into subsidiary critical problems that attract the relevant practitioners.
- each developmental phase, produces a specific culture of technology composed of distinctive values, ideas and institutions.

Technological momentum is created in large scale organisations and institutions by this culture of technology which finally determines the technological trajectory of the organisation. Yet this complex model does not indicate any technological autonomy according to Hughes, who vehemently argues, that, the interaction of various properties of technology with a wide array of geographical, economic, political and historical contingencies determine technological development. Critically reviewing Hughes's model Constant (1989,

P 231) says no technological system is adopted in its entirety. He says "Purchase or use of any modern technology is mediated by the complex organisations that are required to integrate the knowledge and resources necessary to produce and distribute the artefact or service".

This organisationally mediated function of technology has two implications:

- Technological knowledge is never autonomous or independent of the content for it to be expressed as a functional artefact, it needs to be mixed with other forms of knowledge, which means it needs multiple communities of practitioners working together.
- This implies a complex organisation is required for the performance of this technological function.

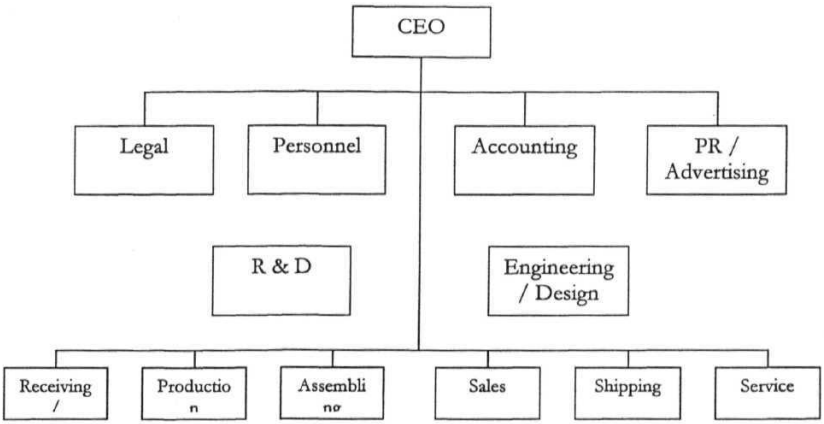
Constant (1989, P 232) says, "If technology as knowledge finds its home in communities of practitioners and their associated professional societies and educational programs, then technology as function has as its locus complex organisation". Organisations with their distinct behavioural characteristics, goals and values need to work together to meet the targets as technological efficiency, quality, reliability, service, style, harmony of operation, expected resale value etc. And all these are the matters of organisational decisions and efficacy rather than straight forward technical solutions to straight forward technical problems. Thus technology is mediated by organizational variables.

While in order to take up complex technological functions, complex organisations are needed, then their internal differentiation and departmentalisation becomes the focus. Structure of a typical manufacturing organization is given by Chandler (as quoted in Constant, 1989,P) which sees the large business organisations not as the result of process of

internal differentiation and specialisation, but as the result of process of successive inclusion. (Fig 1.1).

"Large enterprises internalised separate steps in the sequence of production of distribution that traditionally had been performed by separate business units whose activities were coordinated by market transactions".

Figure 1.1: Structure of a typical manufacturing organization



Source: Constant II, Edward W (1989)

Chandler, (as quoted in Constant, 1989) thus gives the above organizational structure depicting compartmentalisation of modern organisations in which the managerial efficiency plays a major role. Chandler's portrayal of organisational development provides the link between the technological knowledge and organisations in systems perspective.

However, today's business organisations aim more at knowledge acquisition through collaborations. Thus today's technology development takes place through a multitude of interorganisational collaborations.

1.4 ! Organisational Collaboration:

There has been an impressive accumulation of studies focusing on interorganisational collaborations and networks during the last decade. However, the growth in the number of these studies seemingly does not ensure a clear accumulation of knowledge or even conceptual consolidation. Indeed, the variety of research that has been devoted to the analysis of inter-organizational collaborations and networks over recent years is breath-taking (for nature, scope, overview, and reviews of organisational collaboration see Alter and Hage 1993; Auster 1994; Axelsson and Easton 1992; Burt 1992; Contractor and Lorange 1988; Ebers 1997; Ebers and Jarillo 1998; Gulati 1995; Grabher 1993; Grandori and Soda 1995; Hakansson and Snehota 1995; Jarillo 1993; Mizruchi 1994; Mizruchi and Galaskiewicz 1993; Nohria and Eccles 1992; Osborn and Hagedoorn 1997; Powell and Smith-Doerr 1994; Staber et al. 1996; Swedberg 1997; Sydow 1992, 1996 - as quoted in Oliver, 1998).

Strategic collaborations (also referred to as collaborations) have emerged in recent years as a popular strategy in an environment in which fast access to up-to-date technology and emerging markets is more critical than ever (Deeds & Hill, 1996; Mitchell & Singh, 1996; Yoshino & Rangan, 1995). Generally speaking, strategic collaborations are a form of cooperative arrangement between organizations. Even so, there is some ambivalence when it comes to precisely classifying what types of cooperative arrangements can be termed strategic collaborations. Researchers who are in favor of a more inclusive approach maintain

that virtually all kinds of inter-firm arrangements should be called strategic collaborations (Borys & Jemison, 1989; Forrest, 1992; Lei & Slocum, 1991; Murray & Mahon, 1993; Stafford, 1994). In this approach, under the rubric of strategic collaborations, there are various kinds of arrangements: joint ventures, equity investment, licensing, joint R & D arrangement, technology swap, buyer-supplier relationship, and others. On the other hand, some researchers have adopted a more restricted view, and have sought to make a distinction between strategic collaborations and other cooperative arrangements (Devlin & Bleackley, 1988; Yoshino & Rangan, 1995). For them, strategic collaborations refer only to those deals in which the parent firms are tied to each other in a substantive manner, i.e., long-term interdependence, shared control, and continued contributions by the parent firms. Thus, in this narrower conception, it seems that only a few selected kinds of cooperative arrangements would qualify as strategic collaborations, and would include joint ventures, equity investment, joint R & D, and joint marketing. For the present study it is not important to differentiate between narrowly defined strategic collaborations and other types of inter-firm cooperative arrangements. The present study adopts a broader view of strategic collaborations, which includes all the cooperative arrangements that are mentioned above (Joint Venture, Strategic Alliance, Equity Investment, Licensing, Joint R&D, Technology Swap, Buyer-Suppler Relationship, Joint Marketing, Partnership, Tie-Up, etc. Also the concept of Organisation is used in broad sense to indicate various forms — Company, Firm, Agency, etc.)

1.5 Factors Leading to Increased Collaboration according to Bernbom (1999):

- Need for integration of institutional information resources in their various formats.
- Laws, regulations, and litigation in which access to information is required.
- Management trends such as process reengineering that influence the ways information is used.
- Need to support cross-disciplinary work and share information across traditional boundaries.
- Interest in exploiting the potential of technology for managing information.
- Growing awareness that digital information resources are at risk of being lost forever.

1.6 Factors Impeding Collaboration according to Bernbom (1999):

- Lack of financial resources.
- Difficulties with inter-unit communication and organizational issues such as territoriality.
- Lack of support from upper management.
- Fear of change.
- Short-term thinking, with no recognition of the need for information management.
- Unavailability of a sufficient workforce to continue present operations and address new needs.
- Fluidity of technology, which makes it difficult to know when to take action.

- Absence of standards or agreed-upon practices for long-term management of digital information.

1.7 Network Organisation:

What defines a network organization? The behavioral view is that a network is a pattern of social relations over a set of persons, positions, groups, or organizations (Sailer, 1978). This definition is useful because it emphasizes structure and different levels of analysis. A strategic view of networks considers them "long term purposeful arrangements among distinct but related for-profit organizations that allow those firms in them to gain or sustain competitive advantage (Jarillo, 1988)," a perspective which duly recognizes goal-directed processes and economic competition. A third definition incorporates organic adaptation and flexibility, suggesting they are:

"... adapted to unstable conditions, when problems and requirements for action arise which cannot be broken down and distributed among specialists' roles within a hierarchy. ... Jobs lose much of their formal definition ... Interaction runs laterally as much as vertically. Communication between people of different ranks tends to resemble lateral consultation rather than vertical command [and] omniscience can no longer be imputed to the head of the concern." (Lawrence and Lorsch, 1967)

Network organizations are defined by elements of structure, process, and purpose. Structurally, a network organization combines co-specialized, possibly intangible, assets under shared control. Joint ownership is essential but it must also produce an integration of assets, communication, and command in an efficient and flexible manner. Procedurally, a network organization constrains participating agents' actions via their roles and positions

within the organization while allowing agents' influence to emerge or fade with the development or dissolution of ties to others. As decision-making members, agents intervene and extend their influence through association; they alter the resource landscape for themselves, their networks, and their competitors and in the process can change the structure of the network itself. Then, a network as an organi2ation presupposes a unifying purpose and thus the need for a sense of identity useful in bounding and marshalling the resources, agents, and actions necessary for concluding the strategy and goals of purpose. Without a common purpose, agents cannot discern either the efficacy or desirability of association or know whether actions are directed towards cooperative gains. These three design elements — co-specialized assets, joint control, and collective purpose — distinguish network organizations from centralized organizations, inflexible hierarchies, casual associations, haphazard societies, and mass markets.

(Note: In addition to "Network Organization", the concept of an association of distinct business units operating in tandem has also been called "Adhocracy", "Alliance Capitalism", "Agile Enterprise", "Cluster Organization", "Interorganizational Relation", "Joint Venture", "Meta-Corporation", "Modular Corporation", "Moebius-strip organization", "Organic Organization", " Small Firm Network", "Value-Adding Partnership", and "Virtual Corporation".)

1.7.1 Basis for Collaboration:

Broadly there are three bases for collaboration - resource base, technology base and risk base. The resource dimension addresses what an organisation contributes to the collaboration, technology dimension looks into the transfer of technology from haves to

have nots, while the risk dimension portrays what an organisation may fear most. Naturally, organisations would attempt to obtain maximum returns from the resources they commit to the alliances, gaining from the technology transfer and paying close attention to the risks they are exposed to (Ring & Van de Ven, 1992). Thus, these three dimensions capture the critical concerns of prospective collaboration partners.

1.7.2 Resource-based view of Strategic Collaborations:

Popular theories that have been applied to strategic collaborations include transaction cost economics (Williamson, 1985), game theory (Parkhe, 1993), exchange theory (Gulati, 1995), strategic behavior model (Hagedoorn, 1993), dialectical model (Das & Teng, 1996a), and resource-based view of the organisation (Eisenhardt & Schoonhoven, 1996). The resource-based approach examines competition based on the resources possessed by the organisation, rather than on the basis of its products (Wernerfelt, 1984). It has been argued that it is the organisation-specific resources which directly lead to an organisation's competitive advantage (Barney, 1991). Organisation-specific resources include brand names, skilled personnel, machinery, capital, and so on. Tangible resources may include physical assets and financial assets, while intangible resources may include human, managerial expertise, and reputation (Hofer & Schendel, 1978; Grant, 1995).

In the field of strategic collaborations, however, a resource-based view is yet to be fully developed. Though there are some studies examining the effects of resources in strategic collaborations / alliances (Blodgett, 1991; Hennart, 1988; Lyles & Reger, 1993; Parkhe, 1991), they are mostly from other theoretical perspectives (e.g., transaction cost economics and the bargaining model). Therefore, existing studies on strategic collaboration

lack a theoretical focus on the question of resources. In the resource-based view, the concept of "resource" is multidimensional and it can be differentiated into several types of resources (Barney, 1995). Existing studies have not systematically examined the effects of each major type of resource in strategic collaborations. Indeed, the resource-based view informs us that various types of organisation-specific resource would have different kinds of effects on the collaboration making process. If an organisation's core competence is built on its unique resources, then a strategic collaboration as a way of pooling the core competencies of various partners should be critically related to the type of resource contributed by each partner. Hence, the present study identifies three basic types of resources that the partners bring to collaborate and proposes a more comprehensive and integrated resource-based view of strategic collaborations.

In essence, strategic collaborations are about accessing resources that a particular organisation does not already possess, yet which are critical for improving its competitive position. Badaracco (1991), for example, observed that embedded knowledge of the firm, an organisation-specific resource, drives the firms into strategic collaborations. On one hand, a key motive for entering into collaborations is to combine the resources of the partners (Devlin & Bleackley, 1988; Pisano & Teece, 1989). Reciprocal strengths and complementary resources, or "a 'fit' between partners" are identified as a premise for successful alliances (Parkhe, 1991). On the other hand, a particular organisation may attempt to learn the skills or to steal the resources possessed by another firm through forming a collaboration (Hamel, 1991; Kogut, 1988). Thus, one hidden agenda behind entering into a strategic collaboration could be to gain access to organisation-specific resources otherwise unavailable to a

company. Hidden agendas tend to come into play with greater intensity regarding intangible resources than for tangible resources.

Based on an analysis of the various types of resources mentioned in the literature, it can be proposed that those types of organisation-specific resources which are significant in strategic collaborations can be classified into three basic categories: financial, physical, and managerial. Financial resource refers to the availability of capital. Physical resource covers raw materials, production capacity, and distribution channels provided by the firm (Grant, 1995). Finally, the managerial resource can be defined as upper-level people and the skills necessary for effectively running a business organization. Know-how in functional areas such as operations and marketing thereby fall in this category-

Clearly, an organisation's competitive advantage would need to be built on an organic combination of various types of resources it possesses (Chi, 1994). A reliance solely on any single type of resource may well work in the short term, but would be unlikely to generate sustainable competitive advantage in today's environment of intensified competition (Barney, 1991). For example, Reed and DeFillippi (1990) argued that physical assets alone do not help an organisation in building sustainable competitive advantage. It is, therefore, only natural that we see so many firms reaching out to other firms who hold resources complementary to their own. According to Harrison et al. (1991), valuable synergy is often created by combining different (or complementary) rather than similar (or supplementary) resources. The collaboration making process can thus be viewed in part as a process of seeking complementary resources. In this sense, the type of resource that organisations contribute

constitute a key dimension in understanding their orientations and objectives in prospective collaborations.

1.7.3 Risk-based View of Strategic Collaborations:

Risk is a significant factor in strategic management, since strategic decision making is inevitably concerned with assessing odds for successful performance (Baird & Thomas, 1985; March & Shapira, 1987). According to Thompson (1967), the control of uncertainties and risks in one's environment forms the essence of management. Risk sharing or risk controlling have been proposed in other studies (e.g., Kogut, 1988) as important justifications for joining strategic collaborations. For instance, many researchers identified risk control and risk reduction in R & D as a key rationale for R & D-related alliances (Gulati, 1995; Osborn & Baughn, 1990; Teece, 1992). Others have referred to risk reduction in investments as a stimulus for strategic collaborations (Hagedoorn, 1993).

In the process of strategic collaboration, risk considerations are obviously crucial (Brouthers, Brouthers & Wilkinson, 1995; Nueno & Oosterveld, 1988). How much ever crucial as they are, risk considerations are yet to receive adequate attention in the literature (Littler & Leverick, 1995). Traditionally, risk has been defined as either unanticipated variation or negative variation only. Ring and Van de Ven (1994) have suggested that in the alliance structuring process the partners are faced with two sets of risk: those "regarding future states of nature" and those regarding cooperation.

According to Das & Teng (1996b) there are two distinctive and equally important types of risk in a strategic collaboration / alliance viz., relational risk and performance risk. Relational risk is concerned with cooperative relationships, or the probability that the partner

does not comply with the spirit of cooperation. Opportunistic behavior of the partners is a typical source of relational risk. On the other hand, performance risk refers to the probability that intended strategic goals of an alliance may not be achieved, even though cooperation between the partners is satisfactory. According to Miller (1992) the concept "risk" often refers to factors "either external or internal to the organisation that impact on the risk experienced by the organisation," i.e., the sources of risk. In this light, relational risk and performance risk differ in terms of their sources: the first arising from organisation-organisation interaction, and the latter from organisation-environment interaction. Since these two sources represent different realms, they offer two independent types of risk. Whatever damage is caused by sub-optimal cooperation is attributable to relational risk, and whatever losses are caused by firm incompetencies and market uncertainties are ascribable to performance risk.

Thus, the way we define relational risk and performance risk excludes systematic interactive contamination between them, i.e., the level of one type of risk would not significantly correlate with that of the other. While in certain cases performance risk may contribute to relational risk, in other cases a high level of performance risk may create a sense of crisis and mitigate relational risk. Thus, although there may be situations in which the two types of risk seem to be related or dependent, they are not so in actuality. For example, in R & D alliances, both relational risk and performance risk tend to be high (Osborn & Baughn, 1990). However, just because there happens to be a common factor, such as R & D activities, that contribute to both types of risk, the independence of the two risks is not disproved.

1.7.4 Technology based Strategic Collaboration:

Technology refers to the expertise pertinent to the product, and is a key productive resource of an organisation. It is not easy to copy the technology belonging to other organisations, not only because it is duly safeguarded (technically), but also because it is usually protected by the patent system. The patent system ensures the organisation's exclusive usage of certain types of technology for a specified period of time. Thus, to have access to technological resource owned by other organisations becomes one of the most logical motives for entering into strategic collaborations (Hagedoorn, 1993). At the other end, those who possess technological resource may lack other needed resources, such as capital or distribution channels, to exploit their technological advantage. The point to bear in mind is that a collaboration does not mean a free transfer of technology. Rather, it refers to either a planned access to technology (so that joint objectives can be achieved, such as in joint ventures), or the sale of technology for a limited term (such as in licensing).

When an organisation provides technological resource but does not trust the goodwill of its partner, it will be concerned with protecting its technology. Thus, technology security becomes the firm's motive in the collaboration. Due to the nature of cooperation, it is usually difficult to protect technology and know-how (Osborn & Baughn, 1990). Yoshino and Rangan (1995) have described a collaboration between a U.S. and a Taiwanese firm. After secretly collecting considerable technological information from its U.S. partner in their two-year collaboration, the Taiwanese organisation entered the U.S. market and became a direct competitor. Having learnt a lesson, the U.S. organisation later formed another collaboration with an Asian partner, this time with explicit clauses to safeguard its

technology. For those who provide technology for collaboration, such a scenario is a nightmare. Hamel et al. (1989) have urged organisations in such situations to "develop safeguards against unintended, informal transfer of information."

When an organisation contributes its technology in the collaboration, the scenario is with high performance risk. In this case, the partners trust each other but are concerned about the riskiness of the venture. Therefore, the orientation of the partner with technology is to enhance the utility, or usefulness, of its technology, so that the venture can succeed. The term "utility" carries two meanings. First, it refers to the usefulness of the technology itself. Since technology is what the partner contributes, the first thing it can do to control high performance risk is to improve its technological usefulness. For many emerging technologies, setting high design standards is crucial for the future of the technology (Lei & Slocum, 1991). In industries related to the information superhighway, many American firms reach out to major Japanese firms in order to surround themselves "with an alliance of people who are world-class standard setters" (Armstrong & Holyoke, 1994). In the second sense, technological utility refers to the usefulness of the technology to the organisation, i.e., the economic returns from the technology. Hence, the organisation has to increase the output from the technology by making it accessible to more partners. The organisation can try to either reap increased benefits from the technology, or better control the performance risk through a portfolio of partnerships.

Since the orientation of the organisation is toward improving the "utility" of its technology, the specific objective of the organisation is to license the technology to as many partners as possible. Indeed, empirical studies show that licensing is preferable when the

performance risk is high, since only then can the organisation avoid heavy involvement (Contractor, 1984). Extensive licensing seems to be an option which satisfies both the rationales that have been mentioned. First, licensing to many partners allows the organisation to reach an early standardization of design (Lei & Slocum, 1991). It helps control the pace of industry evolution. The organisation is able to capitalize on its technological innovation fast (Lei & Slocum, 1991), especially when there is still a lot of performance risk. Also, licensing controls high performance risk, because the firm avoids putting all its technological eggs in one alliance basket. Indeed, organisations have realized that licensing and franchising represent a long-run market solution to risk diversification problems (Martin, **1988).**

1.7.5 The Fourth Dimension:

The present three dimensions viz., resource, technology and risk are relevant in the context of old economy organisations. For the purpose of studying the new economy or the digital economy there is a strong need for a fourth dimension, i.e., outsourcing, as the basis for collaboration.

The information technology paradigm has brought about change in the way organisations collaborate and work-together in achieving their ultimate objectives. There has been a major paradigm shift in the information technology collaborations paradigm from single organisation based technology development to that of multi-organisation collaboration since late 1980's. The present digital economy paradigm operates in inter-organisational collaborations and the rapid pace of technology development is ascribed to this phenomenon of multi-organisation collaborations. Collaborations have reached a stage

where IT organisations view collaboration as a key-factor for survival in general and success in specific. The present technology paradigm is largely shaped by high degree of specialisation focusing on core competence. The following Table No 1.1 depicts the difference between the old and new technology paradigms:

Table No 1.1: Difference between the old and new technology paradigms

Technology Factors	**Old Technology Paradigm**	New **Technology Paradigm**
Nature	Fundamental	Application
Development	Incremental	Radical
Scope	Limited & restricted	Unlimited & Wide
Pace	Slow	Fast
Collaboration basis	Resources, Technology & Risk	and Outsourcing

1.8 What is Outsourcing

The concept of "Outsourcing" has been widely used in the recent past and especially in the Information Technology industry. Organisations have started using outsourcing as a collaborative business strategy for competitive advantage. But there are hardly any research studies done in the area of outsourcing in general and in information technology industry in specific. There are some studies done by Leung (1992) Northfield (1992) Kilby (1993), Lacity & Hirschheim (1995), Worthington (1997), Kaganoff (1998), Houghton (2000), etc.

Outsourcing is essentially a 'how' rather than a 'what' term. It describes how IT services are obtained; not what the services are (Houghton, 2000). Outsourcing has been defined as: "A contractual relationship where an external organisation takes responsibility for performing all or part of an agency's Information Technology functions. This can involve a partial or complete transfer of staff and/or resources" (Kilby, 1993).

Outsourcing is also defined as "an arrangement whereby a third party provider assumes responsibility for performing information systems functions at a pre-determined price and according to predetermined performance criteria" (Northfield, 1992). Outsourcing is the strategic use of outside resources to perform activities traditionally handled by internal staff and resources. Outsourcing is a strategy by which an organisation contracts out major functions to specialised and efficient service provider organisations who become valued business collaborators (Kaganoff, 1998).

Organisations have been collaborating in one form or other to level-off peaks and surplus in their workload and thus have formed long-term relationships with firms whose capabilities complement or supplement their own. Organisations have always looked for access to specialised resources to help them with tasks that would otherwise be beyond their individual reach, whether they be buildings, technology, people or any other resource. However the difference between simple "subcontracting" and "outsourcing", is that the latter involves the most efficient restructuring of particular business activities by utilising external partnerships with the required core competencies (Kaganoff, 1998). A closed look at the above definitions brings about three significant features or aspects of outsourcing, namely:

- size and duration of contract;
- transfer of assets or resources; and
- degree of responsibilities.

In its present usage outsourcing implies a greater level of handing over ownership and/or managerial control than has hitherto been the case (Leung, 1992). Thus, there are

differences between outsourcing and other previously used terms such as - contracting out, sub-contracting, leasing out, etc. Also outsourcing is distinguished from the in-house provision of services and in-house provision means that the people who deliver the IT goods or services are normally employees of the organisation.

1.8.1 Reasons for Outsourcing

Organisations have been collaborating for outsourcing and each organisation has its own reasons for outsourcing. There are some studies that focused on the reasons for collaboration in general and with reference to information technology in specific and the reasons include - to reduce and control operating costs (Outsourcing Institute 2000 & 2001; Dave 2001; Worthington 1997; Whitehorse 1995), to improve company focus (Outsourcing Institute 2000 & 2001; Dave 2001; Worthington 1997; Whitehorse 1995), to gain access to world-class capabilities (Outsourcing Institute 2000 & 2001; Dave 2001), to free internal resources for other purposes (Outsourcing Institute 2000 & 2001; Dave 2001), as resources are not available internally (Outsourcing Institute 2000 & 2001), to accelerate reengineering benefits (Outsourcing Institute 2000; Dave 2001), function difficult to manage/out of control (Outsourcing Institute 2000; Dave 2001), to make capital funds available (Outsourcing Institute 2000), to share risks (Outsourcing Institute 2000; Dave 2001), to infuse cash (Outsourcing Institute 2000), to have access to skill (Worthington 1997; Whitehorse 1995), to have access to technology (Worthington 1997; Whitehorse 1995), for flexibility (Worthington 1997; Whitehorse 1995), and for accountability (Whitehorse 1995).

All these reasons can be classified in to the following categories:

Economic Reasons:

Reduce Costs: Organisations can save on operational expenditure by outsourcing and the vendor organisations can save through consolidation of operations, bulk purchases, and stronger bargaining position in the market.

Share Risks: Primarily organisations outsource to share financial risk - to minimize or to give up.

Cash infusion: The cash saving by outsourcing can be infused for other business functions.

Human Resource Reasons:

Free internal resources for other purposes: Organisations outsource their technology development tasks to deploy the internal resources for other works (like maintenance, back-up, trouble shooting, etc).

Resources are not available internally: Also organisations outsource when they don't have adequate resources to cater to the internal tasks.

Management Reasons:

Improve company focus: Outsourcing can allow organisations to focus on their core business functions so that they can improve their business focus.

Function difficult to manage: The organisations mainly outsource when they can not effectively handle certain business functions and when it becomes difficult for them to handle.

Flexibility: Maintaining the level of equipment and human resources required to cover workload peaks can leave an organisation with unproductive resources for a significant proportion of the time. Rather they can outsource the same to have enough flexibility.

Accountability: By outsourcing organisations can make vendors more accountable with focus on service quality, and a consequent quality improvement

Technical Reasons:

Access to Skill: Client organisations can gain access to the skills they require as and when they are required and can call on resources of the supplier for highly specialised skills and/or in unusual situations.

Access to Technology: Many organisations find keeping up with technical developments in computing and communications very difficult. Thus it is for organisations to outsource so that they can have access to state-of-the-art technology from their vendors or suppliers.

1.8.2 Advantages of Outsourcing

The principal benefit of and reason to outsource is that it allows a firm to focus its activities on its core competency (Petrie, 2000; EIU/AA, 1995). The provider firm brings a number of advantages to the performance of its task including access to state-of-the-art technology; economies of scale with regard to hardware, software, and personnel; and aggressive use of low-cost labor pools (Antonucci, Lordi, and Tucker, 1998; Petrie, 2000; EIU/AA, 1995).

The outsourcing firm focuses on broader business issues, or maintains a clearer strategic focus, while operational details are assumed by an outside expert (Petrie, 2000; EIU/AA, 1995). Outsourcing can deliver considerable savings on office space, general overhead, company cars, pensions, insurance and salaries (Petrie, 2000). Since it is their core competency, providers are more likely to remain abreast of technological innovations in their

field. The outsourcing firm then gains easier access to expertise and new technological developments (EIU/AA, 1995).

Providers can be more flexible with regard to workload than an in-house process; this can allow a firm to turn a fixed cost into a variable cost through outsourcing (Petrie, 2000). Providers are more inclined to be flexible because of their customer/supplier orientation, an orientation that may well be absent in an in-house arrangement (EIU/AA, 1995).

In a nutshell, outsourcing is thought to be beneficial because of economies of scale, improved access to new technology, and the flexibility inherent in the outsourcing relationship. By outsourcing, company administrators can structure the outsourcing contract so that a vendor bears the cost of bringing in new equipment and technology. In the same way, the organisation can bring new levels of expertise and business savvy onto its organisation through a vendor. An organisation can, in fact, gain access to higher-level capabilities in a variety of domains without having to hire someone on staff (a particular benefit for smaller organisations). Outsourcing may enable an organisation to gain better control over a function. By awarding a contract, an administrator can more directly link remuneration with quality and completion of a task. It is possible to contract out some of the support functions, enabling administrators to focus attention on more fundamental activities, thereby allowing them to do a better job.

Outsourcing permits organisations to take advantage of economies of scale achieved by vendors (which may be providing services for multiple organisations or in other sectors). And in cases where there is not a constant or consistent need for a service, the organisation does not have to keep staff on hand during periods when the service is not needed.

1.8.3 Disadvantages of Outsourcing

Much of the literature is fundamentally in favor of outsourcing, but several possible problems or concerns are discussed. The concern universally given the most weight is the possible damage to company morale from outsourcing (Petrie, 2000; Antonucci, Lordi, and Tucker, 1998; EIU/AA, 1995). If savings are to be realized, personnel from outsourced functions will be dismissed or transferred to the provider firm, and personnel in potentially outsourced functions will respond adversely. Outsourcing firms fear losses in other areas as well. The nature of outsourcing creates a dependence on the provider firm, with a consequent loss of independence (Petrie,, 2000; Antonucci, Lordi, and Tucker, 1998).

The outsourced department is no longer readily available for use in management training, preventing the creation of easy familiarity with that function (Petrie, 2000; EIU/AA., 1995). A number of concerns relate to the nature of the outsourcing relationship. First, there is a concern that, over time, outsourcing providers will demand ever great premiums (EIU/AA, 1995). Having abandoned the internal function, firms will have no choice but to pay these increased premiums. There is also a concern that the provider will not understand a firm's core business needs sufficiently, or the specific demands of the business environment (Petrie, 2000; EIU/AA, 1995).

In opposition to the asserted flexibility advantage, there is a concern that contracts might actually decrease flexibility, and that provider personnel might be less responsive man internal staff (Antonucci, Lordi, and Tucker, 1998). Finally, there is a concern about lack of long-term vision or loyalty from providers, especially on a short-term contract (Petrie, 2000; Antonucci, Lordi, and Tucker, 1998). Some of the limitations associated with contracting out

relate to the level of expertise and staffing in the organisation, which influence the organisation's ability to manage a contract. Some of the concerns with contracting out are more difficult to write into a contract. Critics of outsourcing are concerned that outside vendors may not understand the culture and mission of a campus, two of the most important characteristics of a campus because of their influence on a student's (or professor's, or staff member's) experience at that institution. All of these phenomena can threaten the sense of community and identity on a campus (Thompson and Morgovsky, 1996).

1.8.4 Collaborative Outsourcing

Sixty-five percent of the organisations that have been interviewed by Accenture (Accenture, 2001) engage in collaborative relationships with outsource business partners to create high-performance support operations that keep pace with industry best practice. As a result, outsourcing benefits have multiplied. Companies now report cost savings that average 50 percent over ten years, as opposed to an average of 20 percent savings reported in the mid 1990s. Furthermore, they gain access to competitive skills, improve service levels, and increase their ability to respond to changing business needs.

Table 1.2 The difference between Conventional and Collaborative Outsourcing:

	Conventional Outsourcing	**Collaborative Outsourcing**
Objective	Hand off support function to specialist provider to cut costs and focus managers on core issues	Upgrade non-core processes to cut expenses and provide flexibility to respond to changing business needs
Partner Role	Run Support Function	Re-engineer and run non-core processes
Approach	Standardized Services Transaction-based, fee for service pricing Narrow scale and scope of services	Flexible, tailored service Output-based, gain share pricing Servicing scaled to meet changing business needs
Typical Benefits		
Inputs	20-50% cost savings Access to best practices Improved career opportunities Improved management focus	50% cost savings Access to competitive skills Improved career opportunities Improved management focus
Outputs	Same, consistent service level Shared financial risk	Higher, consistent service level Improved flexibility, speed Share operating risk

From the above case studies one can identify the advantages of Collaborative outsourcing as follows:

- Step-change improvement in enterprise-level performance
- Reduced time-to-market
- Shared risk
- Increased innovation through access to world-class skills, resources and industry knowledge
- Enhanced core capabilities
- Strengthened competitive positioning

1.9 Organisational Learning

Considerable amount of research has been carried out on the subject of organisational learning. The following are some of the important definitions - "the process by which knowledge about action-outcome relationships and the effects of the environment on these relationships is developed" (Duncan & Weiss, 1978). "The development of insights, knowledge, and associations between past actions, the effectiveness of those actions, and future actions" (Fiol & Lyles, 1985). "The encoding of inferences from history into routines that guide behavior" (Levitt & March, 1988). "The continual expansion of the organization's capacity to create its future" (Senge, 1990b). "The acquisition of knowledge by any of **its** units that it recognizes as potentially useful" (Huber, 1991). "The skill of creating, acquiring, and transferring knowledge, and of modifying its behavior to reflect new knowledge and insights" (Garvin, 1993).

There are different typologies of organizational learning theories that exist in the literature. According to Shrivastava (1983) there are four types of organizational learning perspectives: (i) the process of organizational adaptation, (ii) the process of sharing and changing assumptions, (iii) the development of an action-outcome knowledge base, and (iv) the institutionalization of experience. Argyris & Schon (1978b) identify six categories that are based on organizational definitions: organization as a group, as an agent, as a structure, as a system, as a culture, and as politics.

Organizational learning comprises both behavioral and cognitive processes. Fiol & Lyles (1985) find this distinction persisting within the literature and offer resolution by

exclusively defining lower-level learning, associations formed under repetition of past behaviors, and higher-level learning, the development of new rules and associations regarding new actions. They equate these definitions with Argyris and Schon's (1978a) single-loop learning, the process of error-and-correction when present norms, policies, or objectives are undisturbed, and double-loop learning, the process of error-and-correction involving their modification. Dodgson (1993) equates the two processes with Senge's (1990b) generative learning and adaptive learning, and with Gagne's (1994) verbal knowledge and cognitive strategy dimensions of individual learning, dimensions that Gagné, in turn, equates with Bloom's Taxonomy. Garvin (1993) also acknowledges these two elements, but views them as overlapping, rather than exclusive, processes of organizational learning-

Researchers disagree as to whether either change or effectiveness are requisite to organizational learning (Garvin, 1993). Some state that it need not increase effectiveness, since incorrect learning may occur (Huber, 1991); consider the 'competency traps' such as the QWERTY keyboard offered by Levitt & March (1988) or Argyris' skilled incompetence, the skill of protecting oneself from the threat and pain that come with learning while remaining incompetent and blinded to that incompetence (Kofman & Senge, 1993). Fiol & Lyles (1985), however, note a dozen articles that assume that learning improves performance and Garvin (1993) believes that most scholars agree. Organizational learning need not effect observable organizational change, since it may merely modify existing knowledge (Fiol & Lyles, 1985; Huber, 1991); i.e., organizational learning may be either kinetic or potential in nature. Conversely, organizational change does not infer organizational learning; some change is 'unreflective' (Fiol & Lyles, 1985) and some defensive adaptive behaviors require

no incremental learning (Hedberg, 1981). Others simply state that learning is not fully equitable with change in a more general fashion (Shrivastava, 1983). One might view Simon's programmed and nonprogrammed decisions (Pugh & Hickson, 1993) in similar fashion.

Researchers generally agree that organizational learning that does effect change involves systematic shock anticipated by tension, but differ regarding the constitution of that shock and tension. Sociologist Kurt Lewin states (1951) that organizational change is effected when a 'felt need for change' is first created, when an 'unfreezing' of behaviors is implemented. Chapman, Kennedy, Newell, and Brill (1956) studied radar defense operational teams under simulation and observed that their learning did not occur in smooth increments, but was typically preceded by a degree of stress. Cyert and March (1992) view the organizational adaptation event as the application of external shock to the organization's 'preexisting preferences of state' and its set of internal decision rules. Cangelosi and Dill (1965) view stimulating stress as definitional and note that organizational learning is sporadic rather than continuous. Shrivastava (1983) finds several studies that show that organizational adaptation occurs in an incremental progression of small adjustments moderated by intra-organizational conflicts and bureaucratic procedures. Fiol and Lyles (1985) state that there is considerable evidence to suggest that "some type of crisis is necessary to effect change under higher-level learning;" organizational myths or past success can predispose resistance and "require shocks, jolts, or crisis for ... adaptation to take place." They also state that the process of learning involves the creation and manipulation of [the] tension between constancy and change." Levitt and March (1988), though recognizing that

organizations often change through a sequence of small, frequent changes, claim that in order "to be effective, the design of learning organizations must recognize ... the extent to which the comprehension of history may involve ... abrupt rather than incremental changes." March, Sproull, and Tamuz (1991) note that critical incidents in an organization's history assume a special role in organizational learning when "history is not generous with experience."

1.10 Theories of Organisational Learning:

The importance of information assets to network organizations (Drucker, 1998; Jarvenpaa, 1994 & Powell, 1990) raises important questions about managing information resources. Theories of organizational learning provide a framework by breaking information management into acquisition, distribution, interpretation and memory (Huber,1991). The first two describe the processes of obtaining and sharing information respectively. Sharing is important not only for completeness of access but also for generating new information. Interpretation is the process by which shared information acquires meaning and becomes translated into shared maps, frames, or schema. Organizational memory describes the storage of information for ready access and future use.

More learning may then be said to occur when information is shared more broadly, when more numerous and varied interpretations are developed, when different organizational members comprehend each other's interpretations - even if their **own** interpretations differ, and when latent information is recognized as potentially useful and stored. More learning does not necessarily imply a larger organizational action set, however, since this can add constraints to behavior as well as new options. In monitoring itself, an

organization can also engage in single-loop learning by successively comparing itself to its governing policies and adjusting for mismatches, or it can engage in double-loop learning by examining and changing its governing values (Argyris, 1978).

The flexibility of network organization in adding and discharging members creates several organizational learning problems. One is the problem of diffusing existing information and interpretation to joining members. Another is the problem of maintaining organizational history and experience in-house when members leave (Jarvenpaa, 1994). In highly unstable environments, members may welcome newly shared information but may have little incentive to relinquish their private sources of value. Yet, in fast-changing and competitive environments, organizations may have few alternatives to finding and sharing with partners. Vicarious learning and mimicry can mean entering an occupied niche while learning through experience can mean waiting longer than the opportunity lasts (Huber, 1991). Rather, organizations can network or increase their store of knowledge by grafting on experts. As the need for and rate of knowledge assimilation increases, grafting becomes an attractive means of organizational learning (Drucker, 1998 & Huber,1991). It can be both "faster than acquisition through experience and more complete than acquisition through imitation" (Drucker, 1998). There is fairly strong evidence, for example, that biotechnology firms learn by networking (Powell, 1993). Sociological theories on organizational learning thus offer a possible explanation for the emergence of network organization.

1.11 Learning Through Networks:

The main argument of Powell and others (1996) is that, when knowledge is broadly distributed and brings a competitive advantage, the locus of innovation is found in a

network of interorganisational relationship. In industries in which know-how is critical, companies must have expertise at both in-house research and cooperative research with such external partners as university departments, research centres and skilled competitors. A firm with a greater capacity to learn is adept at both internal and external R&D, thus enabling it to contribute more to a collaboration as well as learn more extensively from such participation. Internal capability and external collaboration are not substitutes for one another, but complementary. Internal capability is indispensable in evaluating research done outside, while external collaboration provides access to information and resources that cannot be generated internally. A network serves as a locus of innovation because it provides timely access to knowledge and resources that are otherwise unavailable, while also testing internal expertise and learning capabilities.

Powell's (1996) concept of networks of learning highlights two key observations: (1) Interorganisational collaborations are not simply a means to compensate for the lack of internal skills, (2) nor should they be viewed as a series of discrete transactions. A firm's values and ability as a collaborator are related to its internal assets, but at the same time, collaboration further develops and strengthens those internal competencies. The development of cooperative routines goes beyond simply learning how to maintain a large number of ties. Firms must learn how to transfer knowledge across alliances and locate themselves in those network positions that enable them to keep pace with the most promising scientific or technological developments.

Knowledge facilitates the use of knowledge. What can be learned is crucially affected by what is already known. Knowledge also requires other knowledge. When the sources of

expertise are disparate, collaborative R&D opens an organisation's eyes to the need for accessing ideas and information from a variety of sources, to exploit the research findings in a commercial context.

1.12 Collaboration and Organisational Learning:

The present day science is growing at fast pace hand in glove with technology development. The actors in the technological field in order to survive have to acquire knowledge and thus are being compelled to learn continuously. Modern organisations only learn through participating in the knowledge pool i.e., collaboration. When there is a regime of rapid technological development, research breakthroughs arc so broadly distributed that no single firm has all the internal capabilities necessary for successes (Powell, 1996). This is the trend in most of the industrialised countries and most of them have proved to be a success.

Powell and his associates (1996), after a survey of organisational literature, have come out with two postulates, rather two different views about collaboration and learning:

(1) The choice to pool resources with another organisation depends on calculations involving risk versus return. Firms turn to collaborate to acquire resources and skills they cannot produce internally, as long as the ha2ards of cooperation can be withstood **to a** tolerable level.

(2) What is learned is profoundly linked to the conditions under which it is learned. Knowledge creation occurs in the context of a community, one that is fluid and evolving rather than tightly bound or static. In this aspect Powell (1990) says that the canonical formal organisations, with their bureaucratic rigidities, are poor vehicles for learning.

According to him, sources of innovation do not reside exclusively inside firms; instead, they are commonly found in the interstices between firms, universities, research laboratories, suppliers and customers. What Powell says mostly applies to the western nations which reached advanced level of industrialisation. Here the question is whether the same can be said of the technology development in India ? If one analyses the nature of restructuring taking place in the Indian R&D scenario, it can be observed that characteristics of Indian R&D organisations are slowly moving from the first postulate (proposed by Powell and his associates) towards the second. That is to say the Indian R&D organisations are coming out of their rigid bureaucratic structures and are heading towards collaborations. Most of the organisations have realised the fact that external ties are the key to success and for that they should build their internal capabilities before they go for a tie-up. But this is only a tip of the ice berg. Most of the firms are going for external collaborations to acquire resources and skills they cannot produce internally.

As far as organisational learning is concerned the Indian organisations are much behind the western organisations though the country has the largest number of S&T personnel in the world. The Indian organisations are still in the stage of infighting and trying to overcome the internal competition rather than competing in the international markets. The need of the hour for the Indian R&D organisations is knowledge gaining through learning and a vertical shift from 'exploitation' to 'exploration'. March (1991) distinguishes between exploitation and exploration in his discussion on learning. According to him, exploitation is the refinement and extension of existing competences, technologies and paradigms and exploration is experimentation with new alternatives. And he says exploration

is "the only way to finish first" though it may work out cosdy. Organisational learning is both a function of access to knowledge and the capabilities for utilising and building on such knowledge. Powell (1996) argues that organisational arrangements that provide access to knowledge quickly and reliably produce competitive advantage. Research breakthroughs demand a range of intellectual and scientific skills that far exceed the capabilities of any single organisation. To illustrate further they quote two best examples of discoveries in biotechnology: The development of an animal model for Alzheimer's disease appeared in a report (Nature, Feb.9, 1995) co-authored by 34 scientists affiliated with two new biotech companies, one established pharmaceutical firm, a leading research university, a federal research laboratory, and a non-profit research institute. Similarly, a publication identifying a strong candidate for the gene determining susceptibility to breast and ovarian cancer (Science, Oct. 7, 1994) featured 45 coauthors drawn from a biotech firm, a U.S. medical school, a Canadian medical school, an established pharmaceutical company, and a government research laboratory. Here the significant point is that more than the number of coauthors are the diversity of sources of innovation and the wide range of different organisations involved in these breakthrough innovations.

1.13 Interorganisational Collaboration and Software Development:

There has been a growing change in the kind of collaborations between industries in the recent past. Today, companies in a wide range of industries are executing nearly every step in the production process, from discovery to distribution, through some form of external collaboration (Powell, 1996). An important observation made in this aspect is that

the R&D intensity or level of technological sophistication of industries is positively correlated with the intensity and number of alliances in those sectors.

Technological change can be broadly classified into two forms:
(1) Incrementalism: Advances built on existing technologies and this process goes **on.**
(2) Radicalism: New discoveries or innovations create technological discontinuities or radical breaks from previously dominant methods.

In the first case the existing firms enjoy the benefits whereas in the second case new organisational structures and practices emerge to exploit the new discoveries. Therefore, one of the objectives of the present study is to examine the organisational arrangements that have arisen in response to the technological possibilities generated by the information technology. The purpose is to map the network structure of this emerging industry and explain the purposes served by the extensive connections that typify the field.

1.14 Knowledge Production in Information Technology Industry : A Paradigm Shift

Information Technology industry has experienced a paradigm shift in the recent past. Earlier on, the soft ware companies were more dependent on self-learning and were self-reliant for their technology development. Because of this approach, they had relatively slow growth, limited knowledge and thus restricted technology development. In order to acquire new knowledge and skills to develop frontier technologies and its application the IT companies have begun sourcing out their avenues through collaborations. Today every company has one or the other kind of collaboration with other companies for their

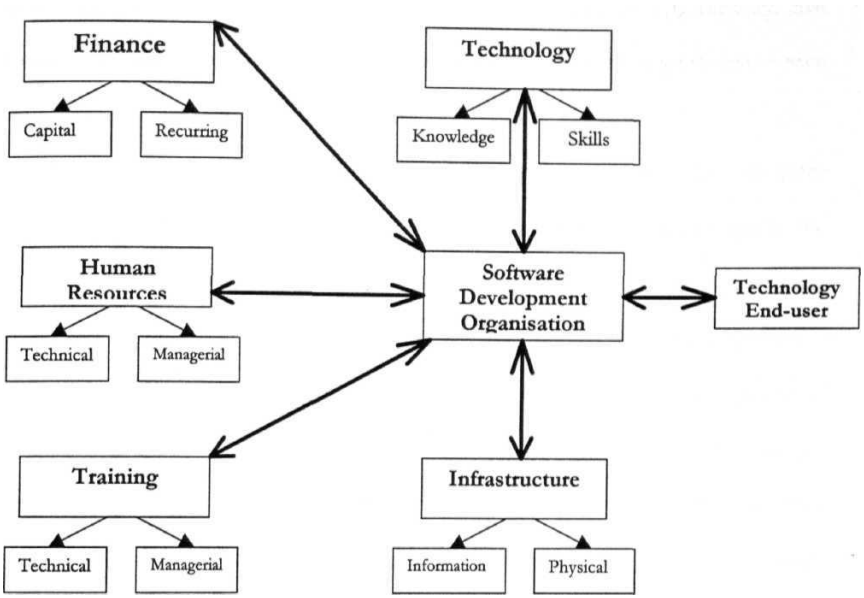
knowledge acquisition. The synergy not only helps them to keep themselves abreast of new developments in technology but also has contributed to their innovative capabilities.

Earlier on in Information Technology industry knowledge has been an individual's intellectual property. Where as in the modern era knowledge is considered as an organisational asset and thus comprehensive organisational learning has become an imperative for organisational success. A more compact definition of organisational learning was given by Fiol and Lyles (1985) as `the development of insights, knowledge, and associations between past actions, the effectiveness of those actions, and future actions'. In the modern world, technology development and organisational learning are found to be interrelated processes and these are improved through collaborations.

1.15 Statement of the Problem

In recent times India has emerged as a leading market player in the field of Information Technology (IT) and especially in the software sector. Much of the success can be ascribed to the collaborations that the Indian companies have with the companies in US & Europe. (see Figure 1.2 for a diagram on collaboration requirements of a software organisation)

Figure 1.2: Collaboration Requirements of a Software Development Organisation

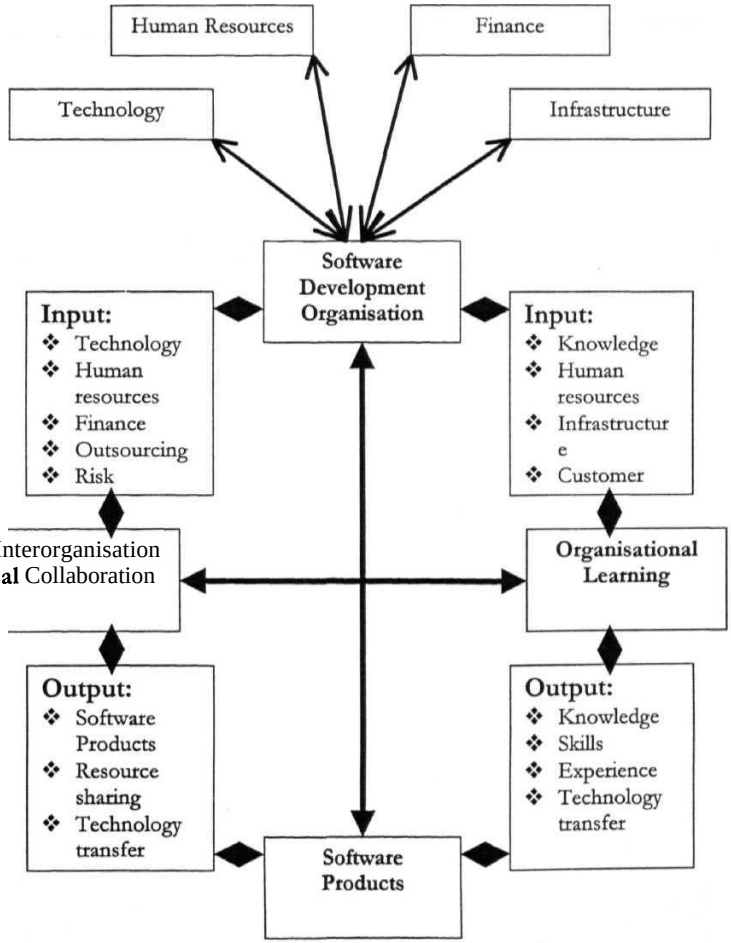


The very fact that the industry is able to survive and develop at a significant rate implies that collaborations are working. Some of the major factors that account for the success of the Indian IT companies are - fast learning curve, availability of qualified manpower and adaptability to the emerging situations. When collaboration is the key issue and possibly the strategic factor for the success of software industry, it is essential that we study the organisational collaboration in detail - the concept, its nature and scope, empirical analysis of basis for collaboration, underlying factors contributing and hindering collaboration and thus build a model for collaboration. Also it is important to look into the relationship among the other key factors involved in collaboration and thus examine the relationship between interorganisational collaboration and organisational learning. (see Figure 1.2 for a "Non-linear model of interorganisational collaboration, organisational

learning and software development") For the purpose of this study it is assumed that interorganisational collaboration and organisational learning are direcdy proportional to each other and a change in one will affect the other and vice-versa.

In an organisational context collaboration can only be a beginning or in some cases collaboration might be a means to achieve the ends. Organisational learning facilitates the process of collaboration, that is, it is a means to achieve the end goals. The end goal in any technology based company is technology development itself. So it is also very important to study technology development - the concept, the nature and scope, the development of different types of technologies and their relationship with other organisational factors like collaboration and organisational learning. Thus it can be hypothesised that interorganisational collaboration and organisational learning are direcdy proportional to each other and in turn software development is positively related to and influenced by interorganisational collaboration and organisational learning-

Figure 1.3: Non-linear Model of Interorganisational Collaboration, Organisational Learning and Software Development



1.16 Hypothesis:

Given the nature of information technology where knowledge is widely distributed, high degree of specialization and collaboration is the order of the day and organizational learning is inevitable - interorganisational collaboration and organizational learning are directly proportional to each other and also software development is positively related and influenced by interorganisational collaboration and organizational learning.

Hypothesis 1: There is a positive correlation between inter-organisational collaboration and organisational learning

Hypothesis 2: A related hypothesis is that software development is positively related and influenced by inter-organisational collaboration and organisational learning

1.17 Objectives:

- To trace the nature of technology development in the software companies in Hyderabad and examine the organisational structures and arrangements that have arisen in response to it.
- To explore the nature, scope & characteristics of different kinds of collaborations in software industry.
- To identify the various methods of organisational learning adopted by the software companies and highlight the various factors that have contributed to collaborative learning.
- To establish the relationship between organisational learning and organisational collaborations and their impact on software development.

1.18 Scheme of Presentation:

The thesis is divided into nine chapters.

Chapter I contains the introduction, the review of literature, statement of the problem, hypothesis and objectives.

Chapter II deals with methodology discussing the sampling plan and plan of analysis

Chapter III gives a brief introduction to Information Technology (IT) and concepts, origin and growth of Information Technology in India, and a concise history of the Software industry in India.

Chapter IV deals with the organisational profile of the sample companies.

Chapter V describes the collaboration patterns of the companies.

Chapter VI deals with the organisational learning patterns.

Chapter VII describes the factors of time, effort and size in software development.

Chapter VIII Testing of Hypothesis with quantitative data analysis

Chapter IX Conclusions

Bibliography

Chapter 2: Methodology

2. Methodology

2.1 Introduction to Research Design:

As mentioned earlier, the present study focuses on the collaboration, learning and technology development aspects of software companies. A survey was carried out among the software companies that were collaborating with other organisations in learning and technology development. The primary data were collected through structured questionnaires and case study techniques. Information and data collected from the companies were statistically analysed. The questionnaire developed was pre-tested through a pilot-survey of few companies in Hyderabad. After the pre-testing of the questionnaire, the corrections were incorporated and the final data were collected using the corrected questionnaire. The data collected was analysed using a statistical package called SPSS.

2.2 Unit of Study:

For the purpose of the present diesis, a software development company is the unit of the study. The software company might have multiple working locations spread across the country, but it was considered as a single unit for the study.

2.3 Base Year

All the data and information collected was for the base financial year 2000-01. That is, the base financial year is from April 2000 to March 2001. Any other information collected for the purpose of comparison was for an year and that is financial year starting from April and ending March of next calendar year. Example: Year 1999-2000 means data pertaining **to** that financial year starting form April 1999 and ending March 2000.

2.4 , Universe of the study:

The universe of the present study consists of all the software development companies in Hyderabad that collaborated with other companies outside the country at the time of the study. Companies that satisfied the following criteria were included in the universe.

- A company registered under the companies act of government of India (as a partnership firm or private limited company or a public limited company) and should have its registered office in Andhra Pradesh.
- A company that had computer software design and development as primary areas of business in general and other primary related areas in specific.
- A company that had at least one collaboration with a company inside or outside the country.

A list of companies that satisfied the above criteria was obtained from the Software Technology Park of India, Hyderabad and all the companies were registered under a 100 % EOU scheme for software companies. The registered companies enjoy certain tax, duty and other benefits if they have a foreign collaboration and export software to other countries. This scheme is implemented under a Government organisation called "Software Technology Parks of India (STPI)" and the scheme is called "STPI 100 % Export Oriented Unit (EOU)". So companies registered under STPI EOU scheme were included in the universe of the present study as per the following conditions:

- Any company that has to qualify under STPI EOU scheme has to be a registered company in India, under the companies act of government of India (as a partnership firm or private limited company or a public limited company).
- The company has to be involved in software development and any other related areas. (Here the universe has to be selected from the list of those STPI EOU registered units that have computer software design and development as primary areas of business in general and other primary related areas in specific)
- The minimum eligibility to get registered under this scheme is that the company should have at least one collaboration with a foreign company and the company should export the software to that country.

Finally the universe for the present study is defined as follows:

All those companies registered under "STPI 100 % EOU scheme" under STPI, Hyderabad and have computer software design and development as primary areas of business and other primary related areas (such as software services, software maintenance, etc) and are live during the financial year 2000-01.

2.5 Sampling:

Stratified random sampling strategy was used. The units were stratified on the size - annual turnover together with the number of people employed.

Table No 2.1: Definition of company size

Company Size	Annual Turnover in Rs. Crores in 2000-01	Number of Employees in 2000-01
Small	Less than 10 million	Less than 24
Medium	11 to 100 million	25 to 99
Big	More than 101 million	More than 100

Note: A company has to satisfy both the conditions of turnover and number of people to be categorised as small, medium & big-

Table No 2.2: Study universe and sample

Company Size (A)	No of STPI companies (software) **(B)**	No of companies approached interview — (as percentage of (B)) (C)	No of companies agreed to participate - (as percentage of (C)) **(D)**	No of companies agreed for in-depth interview - (as percentage of(D)) (E)
Small	184	46 (25 %)	16 (35 %)	5 (31 %)
Medium	98	25 (25 %)	11(44 %)	3(27 %)
Big	42	10 (25 %)	5 (50 %)	2(40 %)
Total	324	81 (25 %)	32 (40 %)	10(31 %)

Note: N = 32

2.6 Pilot Study:

A pilot study was conducted for the purpose of refining the questionnaire and the variables for the study. Based upon the feedback from the pilot study appropriate changes were made in the questionnaire.

2.7 Methods of Data Collection:

Data were collected with the help of a structured questionnaire through personal interviews. In-depth interviews were also conducted with some decision makers in the organizations.

2.8 Sources of Data:

Both primary and secondary sources were tapped for data.

2.8.1 Primary Data:

Software companies involved in collaborations were studied and the primary data was collected with the help of a structured questionnaire.

2.8.2 Secondary Data:

Information regarding the companies was collected from the central agencies like Software Technology Park of India (STPI), National Association of Software & Service Companies (NASSCOM), Council for Promotion of Export in Electronics and Software (CPEES), and other relevant agencies.

2.9 Variables for the study:

2.9.1 Independent Variables:

Age: Age of the organisation is defined as the number of years the company has been in existence and was calculated from the difference in the years between 2001 (the base year for the present study) and the year of establishment of the organisation

People: Number of total employees (both technical and managerial) in the software companies during the financial year 2000-01.

Size: The size of the company is defined based upon the total turn over of the company during the base year 2000-2001. The companies are classified into 3 groups based on their annual turnover viz., Small having less than 15 million Indian Rupees turnover, Medium from 51 to 200 Million Indian Rupees turnover and big more than 200 million Indian Rupees turnover during the base year 2000-2001.

Basis for Collaboration: Basis for collaboration is defined as the platform on which the collaboration relationship is executed or the significant factor that brings two organisations together to form a collaboration relationship.

Collaboration Duration: Collaboration Duration is defined as the period of collaboration relationship between the collaborating companies.

Number of Projects: Total no. of projects executed in 2000-2001 in collaboration with the respective collaborator.

Learning Program — No. of Days: The total number of days that an organisation has spent in learning programs or the number of days the program has been conducted. This is measured in number of person-days.

Learning Program - No. of People: The total number of people who have attended the learning programs or the number of people for whom the learning programs have been conducted. This is measured in number of persons.

Mode of Learning: Mode of learning is the process adopted by the organisation in acquiring the required skills for software development.

Total Number of People: The total number of people employed by the organisation at the time of study.

Project Time Factor: The project time factor is defined as the ratio of time variation between estimated time & actual time, and the estimated time. This essentially indicates the time overrun in the projects and it is expected that it should always be near to 0, on a scale of 0 to 1.

Project Effort Factor: The project effort factor is defined as the ratio of effort variation between estimated effort & actual effort, and the estimated effort. This essentially indicates the effort overrun in the projects and it is expected that it should always be near to 0, on a scale of 0 to **1**

Quality Function Deployment: QFD is the number of functional points or kilo lines of code defined (estimated) verses the delivered (actual). The project QFD is defined as **the** ratio of "the functional points variation between estimated & the actual FPs and the estimated FPs.

2.9.2 Dependent Variables

Collaboration Strength Index (CSI): The collaboration strength index is the combination of three variables and they are - basis for collaboration, collaboration duration and the number of projects executed with the collaborator.

Organisational Learning Index: OLI is an indicator of an organisation's learning and is a combination of number of learning people, number of learning days, and the total number of people.

Software Development Index (SDI): SDI is a combination of software development related variables like development time, development effort and quality function deployment

Note: (In all the above three indices, wherever the variables are quantifiable, their numerical values are taken, like in the case of collaboration duration. Wherever the variables are qualitative, like the basis for collaboration, ranking is given to quantify them.

2.10 Analysis:

Both qualitative and quantitative methods were used for analysing the data. The qualitative methods include - case study analysis. Data on software development processes relevant for the present study were collected through the personal interviews with the key persons (Technocrats, Project managers, system analysts and Corporate Executives) in the organisations. The quantitative analysis was made using the Statistical Package for Social Sciences (SPSS).

2.10.1 Qualitative Analysis:

This was carried out to arrive at the qualitative parameters inherent in collaboration, learning and software development which are not quantifiable and were ranked to derive quantifiable indices.

2.10.2 Quantitative Analysis:

This was carried with the help of some basic statistical tools and techniques like simple frequencies, bivariate and multivariate contingency tables and correlation. Multiple regression was carried out by including the three indices *viz.,* Collaboration Strength Index (CSI), Organisation Learning Index (OLI), Software Development Index (SDI), developed to test the hypothesis.

Chapter 3: Information Technology

3. Information Technology

3.1 Introduction

The rapid advancements in the field of Information Technologies and the resultant growth of the information intensive service sector have radically changed the **world** economy. These changes have given rise to a new society based on knowledge. This has further resulted in the new avenues of development, employment, productivity, efficiency, and enhanced factors of growth.

Information Technology seeks to understand the complex process that involves and requires a number of information-related activities: human information seeking and retrieving behaviours; organization of a collection of texts, and more recendy images, sounds or multimedia, that bear some cognitive content; an intellectual representation of such texts, be it derived by humans directly or indirecdy by a variety of algorithms; intellectual ways and means of searching and retrieval by users; and the systems and techniques to accomplish all of these (Spink, 2000). The complexity of human information seeking and retrieving is derived not only from diese very difficult processes, but from the direct involvement of human agents as generators and users of texts in information systems, bringing in cognitive, affective, social and situational (problem, task) variables.

In other words, Information Technology is not only a technical but also a cognitive, social, and situational process. With the integration of computers and telecommunications, Information Technology is based on facilitating interactive information processes, involving information feedback and human information coordinating behaviour.

The last half of the 1900s has been characterized by the increasing importance of information technology in social and organizational life. Computers, both on the desktop and embedded in automobiles, appliances, cellular phones, and satellite dishes have become part of the fabric of our work and social lives (Sawyer, Steve and Rosenbaum, Howard, 2000). In three decades, the Internet has grown from a network connecting four American universities and research labs to a global communications network. The evolving roles and increasing importance of the World Wide Web (WWW), electronic commerce, digital libraries and computer-mediated distance education are all examples of phenomena that both rely on computing and are becoming commonplace.

Information Technology (IT) is a term that encompasses all forms of technology used to create, store, exchange, and use information in its various forms -business data, voice conversations, still images, motion pictures, multimedia presentations and other forms, including those not yet conceived. It's a convenient term for including both telephony and computer technology in the same word. It is the technology that is driving what has often been called "the information revolution" (Ahuja, 2000).

Policy makers for the G7 (now G8) group of nations recognised, only a few years ago, that:

> "Progress in information technologies and communication is changing the way we live: how we work and do business, how we educate our children, study and do research, train ourselves, and how we are entertained. The information society is not only affecting the way people interact but it is also

requiring the traditional organisational structures to be more flexible, more participatory and more decentralised" (G-7, 1995).

3.2 Features of Information Technology

Given the importance of the software industry in global economic growth, it would be constructive to understand the key elements which are driving this industry. This would help one understand the future prospects of this industry.

Rapid growth: Demand for software and related services comes primarily from two segments viz the business segment and the home segment. Information technology, particularly software has become a vital ingredient of every business/ economy. Information needs have increased dramatically across all segments, which has made software one of the fastest growing industries in the world. The sharp reduction in PC prices has formed a new market segment - the home or the individual segment.

Demand Driven: Information technology, particularly software has become a vital ingredient of every business/ economy. Information needs have increased dramatically across all segments, which has made information technology - both hardware and software - one of the fastest growing industries in the world. The share of IT spending in capital expenditure according to Nasscom reports (Nasscom, 2000) has been increasing rapidly since 1980, the year in which PCs came on the scene. In 1980 IT spending formed 17% of incremental capital expenditure, while in 1997 it formed about 48%. Within total IT spending which includes computers and sophisticated telecom equipment, spending on software and support services is estimated to have grown at a faster pace. As percentage of revenues IT spending comprises about 2-2.2%. On the low-end, retail business which is

highly labor intensive about 1% is spent on IT and at the higher end telecommunications which is critically dependent on IT, about 5-7% is spent.

Home segment: With the advent of Internet and cheaper net centric computers or set top boxes and multimedia capabilities, the home segment is expected to grow further and much faster. The popular software for the home segment are word-processing, spreadsheets, personal finance management and games.

Manpower intensive: Being predominantly a service industry software sector is manpower intensive. This makes issues of availability, cost, turnover and productivity of manpower critical to the functioning of an organization. The limited availability of software professionals with specific skills increases compensation packages, as companies try to attract and retain talent. Manpower turnover is one issue which most software companies have to deal with. Manpower turnover causes disruptions in project implementation and loss of skills inculcated through training and hands-on experience. Though some turnover is inevitable and even healthy (at times), a high level of turnover could be detrimental to a company's business in **a** people-driven industry like software. Productivity of manpower depends on the skill levels and motivation. Companies try to offer excellent work environment with satisfying job responsibilities to keep employee morale high.

Availability: IT being the fastest growing industry in most countries manpower requirements are increasing rapidly. Of the total IT manpower requirement, about 75-80% is estimated to be in software. Many positions remain unfilled for a long time for want of software professionals with specific skills. The situation as described by most companies ranges from somewhat serious to very serious. Ability of universities to meet the growing

demand is limited. An indication of the mismatch in demand-supply is evident from the fact that, almost all computer science graduates get employed within three months of completing their graduation.

Cost: As per the "National Association of Software and Service Companies" reports (Nascom, 2001), salary levels had raised significantly as staffing requirements were peak in 1999 and 2000 due to the Year 2000 (Y2K) problem. After September 11, 2001 the salary increments have stopped increasing rapidly due to recession in the industry.

Turnover: Manpower turnover causes disruptions in project implementation and loss of skills inculcated through training and hands-on experience. Many a time, companies end up recruiting professionals from each other as they compete to attract the same pool of talent. Most software companies try to stem manpower turnover by offering Stock Option Plans. These schemes work in a fashion where longer the duration of employment, more the stock (number of shares) received, providing a disincentive to change jobs frequently.

Productivity: Productivity of manpower depends on the skill levels and motivation. Companies try to offer excellent work environment with satisfying job responsibilities to keep employee morale high. They also offer recreational facilities such as golf course, tennis, swimming pool, gymnasium and other sports facilities. As the number of employees grows, one of the key tasks of top management is to 'manage egos' of senior level professionals. Management also keeps adequate peer pressure through incentive schemes or awards with a view to maintain high level of productivity.

Skill intensive: Software industry is driven by technology and hence tends to be skill intensive. Most functions require thorough technical skills coupled with some business

knowledge required to interact with business counterparts. While at lower levels the blend required is more of technical skills, at higher level it is more of business skills. Imbibing these skills requires considerable effort on the part of the incumbent. Skills are also varied for example - development of systems software requires different skills and understanding of business systems, than do development of applications software. Most CEOs cite lack of skilled professionals as one of the biggest hindrance to growth.

University courses provide some exposure to these technical/ business skills, but companies find in most cases falling short of their requirements. Almost invariably candidates need to undergo further training and hands-on experience before being assigned to live projects. One of the reasons is that changes in university syllabus tends to lag behind compared to the latest technology changes in the market place. Continuous education and skill upgradation is also of prime importance to mitigate the rapid obsolescence of IT skills. This is being addressed by providing technology based instruction (TBI), multimedia training through multiple platforms etc.

Since business skills are also an important aspect, many companies are opting for non-computer professionals and offer them three-six month training, in the initial part of their job. To some extent this tries to solve the availability problem also.

High capital output ratio: Formation of value webs which fosters innovation, allows 'supporters' to set up fairly profitable businesses with little capital. Being manpower and skill intensive critical inputs are more in terms of intangibles, which do not cost much upfront for a closely knit entrepreneurial, run small business. Typically, small assembly shops for

hardware or consultancy and programming services in software require limited capital. This lowers the entry barriers and lets small innovative companies flourish.

Entry into the bigger league or expanding market reach requires high capital investment. Investment requirements are huge as organizations need to invest in infrastructure, research & development, meeting the fixed costs associated with product development, marketing etc. As seen earlier in the higher stages of the value chain, where rewards are high, investment requirements are also high.

However once the infrastructure has been created and the fixed costs incurred to develop a successful product, revenue streams generate huge cash flows, which can be easily used for further expansion. The situation is similar in the case of a company evolving from a small sized outfit to a large organization. During the period of evolution, the company would require very little infusion of capital to sustain growth. Cash profits generated out of successful products and even consultancy or service assignments are large enough to take care of investment requirements. This makes software one of the few industries with a high capital output ratio.

Rapidly changing technology: Most software products have a limited life span. As technological changes sweep the industry, software originally developed for one platform fails to meet user requirements on the changed platform. For instance software written for DOS will not meet requirements of users working on Windows. Modifying the original software to enable it work on the new platform may not be the right solution. In fact this runs the risk of losing market share to a competing product developed specifically for and exploiting the features of the new platform.

Once every 10-15 years the technology changes so radically that software requirements also change dramatically. For instance, software required for mainframes is quite different from software required for PCs. Similarly in the new internet era, software requirements change radically. Even in the case of consultancy and services this holds good, as the organization's technical skills need to be upgraded to suit the changing environment. Companies therefore need to continuously adapt themselves to the changing technology, keep investing in the latest hardware/ software and reorient their strategies in order to remain on top.

Project management: Most software projects encompass various aspects and functions of the business, making them typically large sized projects. This makes it imperative to have proper project management skills and a well-defined approach to software development. The importance of project management assumes more significance when one considers that more and more companies are outsourcing their programming requirements. Software languages have also evolved gradually around this key feature. Fourth generation languages (4GLs) like GUI (Graphical User Interface) based system software has made programming more interactive by providing for easier monitoring of progress. Interconnectivity of desktop systems through e-mail and high speed data communication links also help the project leader in administering the project well. Several 'easy-to-use' project management software are also available off-the-shelf. Nevertheless the job of the project leader has become more important for slippages in deadlines tend to be very costly for software companies.

Infrastructure dependent: Use of IT in business has moved away from simply automating manual tasks to a powerful analysis and communication tool. This requires computers to be

interconnected. To keep networking costs down, existing telecommunication infrastructure is used. Share of voice traffic on telecom lines has reduced dramatically and it is estimated that it currently constitutes only 50% of telecom traffic. Increased outsourcing places further emphasis on communication channels. IT industry therefore is dependent on availability of telecommunication links.

3.3 Structure of Information Technology

IT industry can be segmented into hardware, software and training. Hardware has little synergy with software and very few companies are engaged in both activities. Even where hardware companies provide 'total solutions', software is typically off the shelf - software developed by specialized software companies. Characteristics and market requirements of both the segments are vastly different.

Software and training have a unique, but limited synergy between themselves. Training provides software development activity with the required programmers, while hands on experience gained in software development helps to develop better training inputs. It is therefore quite common to find a single company offering software services/ products and training.

The following is the structure of Information Technology:

1. Software

1.1 Systems Software

1.1.1 Operating System for Client, Workstations, and Server.

1.1.2 System Management and Utilities:

- Storage Management
- Security Management
- Automated Operations

- ❖ Performance Management

1.1.3 Hardware & Network communication / interface programs, interface / communication with other systems programs, etc.

1.1.4 Databases: including Relational Database Management Systems (RDBMS)

1.2 Application Software

1.2.1 Enterprise

1.2.2 SOHO - Small Office & Home Office

1.2.3 Consumer — Entertainment, Education, etc.

1.2.4 Vertical Industry:

- ❖ Banking / Finance
- ❖ CAD/CAM
- ❖ GIS
- ❖ Telecom
- ❖ Manufacturing
- ❖ Services
- ❖ Government / PSUs
- ❖ Energy / Oil.

Note: Services include: Hospitality, Entertainment, Health, Courier & Cargo, Media, Transportation, etc.

1.3 Web & Internet Based

1.3.1 E-commerce

1.3.2 E-Business

- ❖ Enterprise-wide
- ❖ Customer Relationship Management (CRM)
- ❖ Supply Chain Management (SCM)
- ❖ Data Warehousing & Mining pWM)

- ❖ Decision Support Systems (DSS)
- ❖ Enterprise Application Integration (EAI)

1.3.3 Security

1.4 Packaged Software: Cross Industry Applications, Vertical Industry Applications, Development Tools.

1.4.1 Cross Industry Applications: include Accounting, Data Warehousing, Enterprise Resource Planning, Office Suits, Groupware, Messaging, Web Based Applications, etc.

1.4.2 Vertical Industry Applications: include Banking, Finance, GIS, CAD/CAM, EDA, etc.

1.4.3 Development Tools: for developing business applications including Case Tools, 3GL, 4GL, GUI, Builder, etc.

1.5 Multi-media Software

1.5.1 Graphics

1.5.2 2D Animation

1.5.3 3D Animation

2. **Hardware**

2.1 Systems: Servers, Workstations, PC Servers, Desktops, Portables.

2.2 Peripherals: Impact Printers, Non-Impact Printers, Monitors, Keyboards, Pointing Devices, HDD/FDD/ CD-ROM Drive

2.3 Networking: LAN Products, WAN Products, VSATs, Structured Cabling.

3. Services

3.1 Software:

- ❖ Software Maintenance
- ❖ Upgrades & Patches
- ❖ Anti-Virus, etc.

3.2 Hardware -

- Maintenance of Own-brand systems
- Third-party Maintenance
- Facilities Maintenance
- Network maintenance

4. Training

4.1 Institute Training

4.2 Computer Based Training (CBTs)

4.3 Corporate Training

4.3.1 In-House Training

4.3.2 Sponsored Training

5. Information Technology Enabled Services

5.1 Customer Care Services (Call Centers)

5.2 Back-office Services

- Data Entry
- Claim Processing
- Technical Transcription
- Accounting
- Legal processing
- Insurance

5.3 Conversions - Databases, GIS, CAD/CAM, HTML, etc

5.4 Medical Transcription

1.4 Information Technology in India

As the world moves from the industrial era to the knowledge era, the factors of production are changing. Industrial society was built around materials and machines as the

key factors, with people being pushed into a dispensable category. In the knowledge society the key factors are people and the human resources are the significant factors of production. The West created wealth through the Industrial Revolution and Middle-East through oil. Where as in India, wealth is being created through knowledge with the help of which it is emerging as a major IT center in the world.

India has great potential to contribute to the development of information technology in general and software in particular. Realising this potential government of India announced a policy in 1986 making "Software Exports, Software Development and Training" as a major thrust area. Also identified were some of the factors impeding the growth of the software industry and formulated the "Software Technology Park" (STP) scheme that facilitate overcoming the impediments and boosting software exports from the country. The scheme had considered aspects like simplifications/rationalisation of procedures, providing single-point-contact services to the industry, providing basic common amenities needed for export operations within a very short gestation period and share infrastructure facilities like computing resources and data communication services in a cost effective manner.

The scheme was designed especially to help Small and Medium Enterprises (SMEs) involved in software exports and it enables them to remain competitive in the global market. The government of India on May 22, 1998 also constituted a "National Task Force on Information Technology and Software Development" to recommend steps to remove bottlenecks in the path of rapid development of information technology and to give a boost to Information Technology and Software Industry. Later the recommendations of the same have been formulated as IT policy and was passed as an act in the year 2001. In India, there

has been a gradual shift towards usage of IT in government, public sector, private sector as well as public services and education. However, usage of computers is yet to reach many homes in the country. Undoubtedly, it was the computerisation of railway passenger reservation system in 1986- that brought computers closer to masses. And, in the last two years - it is the power of internet, E-Commerce as well as the government of India's thrust - which is bringing IT in to the daily life of a common man in India.

Pioneering work done by Indian software companies using the high speed datacom links brought in new paradigm of offshore software development. In fact, Indian software industry has been recognised as representing one of the most successful business models that can help to sustain high growth and competitiveness. Thus, with software as the driving engine, since early 90's, the Indian IT industry has been growing at a phenomenal rate. Also, India's software industry is torch bearer for not only India's IT industry but even Indian economy's global ambitions. It is a way to build competitiveness in technology-driven service economy.

India has many advantages to become an important player in the global IT industry. By marshalling its vast human, industrial and technological resources, especially with expansion of its software sector, India can raise productivity of domestic manufacturing and services. Obviously, this will lead to IT in governance, IT in industry and IT for every citizen of the country. There are even plans of infusing tangible productivity gains amongst various sectors and communities through use of IT.

1.5 **Evolution and Growth** of IT in **India**

The potential of information technology to generate wealth, foreign exchange and employment has already caught the imagination of India's businessmen, citizens, economists, bureaucracy and politicians. There has been a gradual shift towards the usage of IT in the Government, public sector and private sector as also in public services and education. There has been a major paradigm shift in the information technology area in India and the transformation is as follows (Ahuja, 2000):

- From information technology "as a sector" to "as an industry"
- From "providing services to existing users" to "adding value to sustain growth"
- From "government controller of infrastructure & technology" to a "facilitator role"
- From IT "for specialists" to "for masses"
- From "fulfilling external demand" to "creating internal demand"
- From "anti-labour intensive" to "pro-productive & efficient" phenomenon
- From "capital intensive" to "human intensive"
- From "brain drain" to "brain gain"

Information technology has evolved over a period of time since 1970s and its evolution can be studied in five stages as follows:

First Stage: **(Prior to 1970)**

The industry got a start in the early 1960s when software and maintenance cost of software were either equal to or exceeded hardware costs. Till then software was combined

along with the hardware (mainframes) supplied. It was the hardware firms which were producing most of the software. Neither information technology nor software was the focus or priority area for the government. There was no public or private initiative to take up software or hardware development. The main use of computers was only restricted to few critical areas like - defense, advanced scientific research, etc.

Second Stage: (1971 to 1980)

From 1970s there was a boom in the industry globally with the outsourcing of software production to specialised software firms located in India. This was prompted by the standardisation of the software development process, programming languages and hardware. Projects were of the fixed price turn-key type. India entered the software industry at this juncture. Tata Consultancy Services (TCS), the first Indian software company was set up in 1974 to take advantage of the emerging opportunities and the competence of Indian human resources. IBM's departure in 1978 resulted in some of the former employees starting their own software firms in India. Since the domestic market was too small in the late 1970s and early 1980s these firms had to export to remain in business. The Indian Government had a computer policy since the 1970s when the department of electronics (DOE) was first established. The government polices in the 1970s and early 1980s were oriented towards self-reliance and nurturing the domestic software and hardware industries.

India was the first developing country to target software as a thrust area. While export of software was encouraged, the import of software and hardware were allowed with severe restrictions and high import duties. Since import duties were considerably lower for firms engaged in hardware and software training, some domestic companies used this route

to get into the software industry. The Indian government's purchase of software gave priority to Indian firms and the public sector Computer Maintenance Corporation (CMC) was formed in 1976. As the computerisation of Indian industry accelerated from the late 1970s, software development became important. Some large firms developed their own software. This period saw the incorporation of domestic software firms like TCS and NUT.

Third Stage: (1981 to 1990)

The early 1980s led to the era of 'shrink-wrapped' (ready to use) software products. These were mass-produced offering economies of scale. Customer service and technical services became very important activities. The shift was triggered of by scarcity of human resources for custom development software projects. Marketing was an important activity of software companies in this area. Even today, quite a few of the shrink-wrapped products developed in India are marketed by foreign firms under their brands.

Hardware imports were restricted till mid 1980s and the local hardware industry produced mini computers and personal computers. This made Indian software professionals export in non-mainframe operating systems like Unix and MS DOS. This proved to be a great asset for the industry when in late 1980s the world market started moving away from mainframes to personal and mini computers.

Fourth Stage: (1991 to 2000)

The 1990s saw a resurgence of project driven software services. Software systems integration became a big market. Most of the low value activities like data entry, programming and testing were outsourced to India that did the job well and were

inexpensive. This ignited the high growth rates in the Indian software industry. Soon the local industry established itself and multinationals set up their development centres, starting with Texas Instruments in 1986 or subsidiaries like Citicorp Overseas Limited by Citibank in 1985. Body shopping by now was not attractive since the competition had driven margins down.

The software policy that was formulated by the government in 1986 was more supportive in the sense that software and hardware imports were made easier and import duties in these were reduced to facilitate software exports. Texas Instruments in 1986 was set up as the first 100 % export oriented foreign owned subsidiary. The STPI scheme came in 1988. The government provided building, electricity and telecommunications infrastructure in the STPIs. Many successful Indian software firms had their genesis in the STPIs. The National Association of Software and Service Companies (Nasscom) was established in 1988 to liaison with the government in the formulation of policy. The Nasscom was instrumental in making India one of the first countries to grant copyright protection to software. In 1987 the government decided to impose tax on travel expenditure. This tax coupled with US government Visa restrictions and modifications in the wages and tax laws for Indian programmers in 1989 and 1993 led to declining of body shopping.

The post 1991 era saw the economy wide liberalization programme influencing policy in the software industry. Import duties on software and hardware were further reduced. This along with the funding options accelerated the industry's growth. Both the governments at Centre and States were found to have become proactive about the IT and more specifically the software sector. In 1998 the Prime Minister formed a National Taskforce on

Information Technology and Software Development to formulate a long term IT policy for the country.

The ministry of information technology was formed in 1999 to be the nodal institutional mechanism for facilitating all the initiatives in the central government, the stage governments, academia and the private sector. At least 19 state governments have announced the IT policies and have been proactively attracting investments in the IT sector.

Fifth Stage: **(2000 onwards)**

This stage has started consolidating the electronic revolution that swept the world in the previous stage. The new IT policy 2001 has been passed and this has paved way for implementation of e-business and e-governance initiatives in the country.

3.6 Nature & Scope of Services by Indian Software Industry

With the wide array of services which the various software companies in India are offering, it is imperative that one understands the monetary value these different kinds of services offer.

Most software companies in India act as outsourcing partners, executing assignments either onsite at client's premises or offshore at development centers in the country. A few of them who have ventured into products are also into niche segments, which do not generate huge volumes. Many Indian companies have rushed into the highly lucrative applications or generic products segment as the risk of failure is quite low. Based on the risk reward trade-off a value chain can be generated - at the lower end of the value chain the risk of failure is the least and so also are the rewards, at the higher end both risk and rewards are high.

The following is the scope of services that are offered by Indian software companies:

3ody **Shopping**

This refers to the placing of bodies (programmers) at positions in foreign companies. The local company acts like a placement agency. It selects appropriate candidates and sends them abroad and collects a fee from the overseas company for this service. In some cases it also collects a percentage of the candidate's salary from the candidate. Body shopping has low revenue growth potential and risk of failure is also low.

Onsite Contracts

Onsite contracting is similar to body shopping, except that the overseas company pays the contractor and not the programmer. The contractor retains some margin and passes on the rest to the programmer. The margins in this business are relatively high and the limited annuity factor also provides high return. However, the risk is also higher in terms of erosion of margins. As the cost advantage diminishes the risk also increases.

Offshore contracts

In this type of contract the software development work is transferred to a local location. The overseas vendor maintains control on the project through high-speed data communication links. The offshore contractor has to invest considerably in these kinds of assignments. He has to provide for infrastructure in terms of data communication links, office space (typically software development center for a large team of software professionals), hardware and software. Returns are also high as the offshore contractor pays local costs for programmers as well as for maintaining assets. An offshore contractor faces project implementation risk as he has to deliver on the due date and the consequences for not delivering by the due date can be quite stiff.

Productized services

Typically services rendered can be classified into categories where activities are similar. For example, porting code from legacy machines to client-server environment would be similar for most of the clients. In such cases the service provider would gain by productizing his services so that he only needs to 'customize' it to client requirements. This has benefits for the client also, as it reduces project time and associated cost. Productization of services is a step forward from offshore programming. The learning acquired from handling an offshore project is applied to future projects of similar nature by automating several tasks. In the risk reward profile along the value chain, productized services offers the best trade off. Margins in this form of business are higher than in offshore contracts, while the risk is similar. However the potential of revenue generation is not very high as the concept has limited application.

Products

Products are generic software programs, which can be picked off the shelf and put to immediate use. Products leverage on volumes to maximize profits - higher the volumes higher the profits. Developing products involves huge fixed costs in terms of product identification, software development, testing, debugging and marketing. Niche products are products which cater to some specific segments of IT users, like the products for the banking industry. Niche products are built around a company's core competence, either acquired through offshore contracting experience or the experience of the personnel behind the development. This considerably reduces uncertainties, though huge volumes are not generated.

Mass products generate higher volumes. Consequently higher profits can be generated only if the products target the masses and not the elite. Mass product marketing is the last stage in the value chain, where profits generated are the maximum. But so is the risk. Though most of the Indian companies started off as body shoppers only a few small companies are still in this stage. Others have moved up the value chain, to offer a mix of onsite and offshore contracting services. These services offered by Indian companies can be classified as low-end services and high-end services. Data entry jobs, re-engineering of legacy applications, porting of applications from one platform to another etc. constitute low-end offshore services. Many companies have gradually moved from low-end to high-end as they built expertise and goodwill. Very few companies have moved to the products segment. As of now Indian companies offer only niche products.

3.7 The Present Status

The growth of information technology (IT) industry in general and software exports in specific has led to significant changes in the Indian economy and society. According to Nasscom report (Nasscom, 2001) the global ICT industry was estimated at USD2.4 trillion in 1999 and is currently valued at USD 2.4 trillion. This industry is expected to cross the USD 3 trillion mark by 2003. The report says that the expansion indicates a prospective compounded annual growth rate of seven per cent.

Of late, India, Brazil and China have emerged as strong IT markets on the world stage. Most countries have begun understanding the value addition that IT is bringing to economies and are now committed to creating and supporting the policy frameworks,

infrastructure, capital pools, partnerships, skill bases and applications necessary to facilitate the growth of the IT industry.

In India, the growth of the IT industry is predominantly encouraged by the exports of software industry. This has not only led to generation of wealth through foreign exchange in the society but has also been breeding entrepreneurial tendencies among different social and economic classes of the society. Many citizens including civil servants and politicians have started investing in software industry.

There has been an increase in the usage of IT in the government, public sector, private sector as well as public services and education. The year 1999-2000 also witnessed a concerted effort to trickle the benefits of IT to the masses in the country.

Table No 3.1: Indian IT Software and Services Industry (1995-2000)

	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01
Domestic	1670	2410	3510	4950	7200	9500
Growth %	0	44.31	45.64	41.03	45.45	31.94
Exports	2520	3900	6530	10940	17150	28500
Growth %	0	54.76	67.44	67.53	56.76	66.18
Total	4190	6310	10040	15890	24350	38000
Growth %	0	50.60	59.11	58.27	53.24	56.06

Source: Nasscom, 2001

According to Nasscom report (Nasscom, 2001), Indian software industry has grown from **a** mere Rs. 85 crores in 1985 to Rs. 38,000 crores in 2000-01. This industry has been growing at the rate of 50 % over the past 10 years and has recorded 56 % growth in the year 2000-01. This Rs. 38,000 crores industry is divided into two segments - export and domestic sector with 75 % and 25 % contribution respectively. From this it is clear that the software

industry survives on software exports and the domestic segment has comedown from 40 % in the year 1995-96 to 25 % in the year 2000-01. Similarly the export sector has grown from 60 % to 75 % for the same period (Nasscom, 2001).

According to Nasscom report (Nasscom, 2001), the domestic software market recorded a turnover of Rs.7,200 crore in 1999-2000 as against Rs.4,950 crore in 1998-99, a growth of over 45 per cent. Despite a sluggish market, achieving growth at this level is mainly due to increased computerisation of government departments, implementation of e-governance and e-banking, elimination of import duty on software, increased enforcement of anti-piracy laws as well as increased maturity in the end-user organisations.

An important highlight of the year was the focus towards e-governance by state governments in India. As mentioned earlier, 19 of the 26 state governments have already announced their IT policy and many others have formed high-level task forces. The maximum growth in the domestic software market is expected by the state from banking e-governance, defence, Small Office Home Office (SOHO), e-commerce, etc.

According to Nasscom (Nasscom, 2001), the industry exported software and services worth Rs. 30 crore in 1985. In 1999-2000, the total exports amounted to Rs. 17,150 crore.

Table No 3.2: Domestic Software Market Activity Break-up

Support & Maintenance	4.01%
Professional Services	8.30%
Products & Packages	41.00%
Training	4.00%
IT Enabled Services	10.00%
Projects	32.60%

Source: Nasscom, 2001

Table No 3.3: Software Export Industry Activity Break-up

Support & Maintenance	3.50%
Professional Services	40.20%
Products & Packages	8.05%
Training	1.75%
IT Enabled Services	9.75%
Projects	36.75%

Source: Nasscom, 2001

1.8 Information Technology in Andhra Pradesh

Though the information technology (IT) industry in Andhra Pradesh is in its infancy compared to its counterparts in the states of Maharashtra and Karnataka, it has carved a niche for itself in the global market in less than a decade. The state turned its late entry into an advantage by leapfrogging several decades of technological advancements and positioning itself as a premier provider of IT solutions to major software giants across the world. In order to act as a facilitator and an enabler, the state government announced its IT policy in

1996. The policy outlined a clear strategy to be adopted for taking the benefits of IT to the common man and thus initiated several IT related projects which resulted in efficient and quicker delivery of services to its citizens. The Twin Cities Network \services (TWINS) is an example of such initiatives. Under this project, around 30 services from 18 departments are being offered at nine specially established e-Seva centres across the twin cities.

The state promotes not only the software industry but also the hardware. Andhra Pradesh earned the distinction of being the first state in the country to formulate a hardware policy. The electronic hardware policy offers incentives to the new units in Andhra Pradesh. Presently, there are over 1,300 IT companies in Andhra Pradesh, of which around 1,200 are registered with the Software Technology Part of India (STPI), Hyderabad (STPH, 2001).

Table No 3.4: Growth of STP units in Andhra Pradesh

Particulars	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01
Operating Units	31	46	71	106	359	674
	00	48.3	54.3	49.3	238.7	87.8
Approved Units	60	88	112	194	977	1206
	00	46.7	27.3	73.2	403.6	**23.4**

Source: Software Technology Park, Hyderabad (STPH) 2001

Table No 3.5: Software Exports in AP

	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01
Indian Exports	2520	3900	6530	10940	17150	28500
Growth %	0	54.76	67.44	67.53	56.76	66.18
AP	60	134	284	574	1059	1917
As % of India	2.38	3.44	4.35	5.25	6.17	6.73
AP growth	0.00	123.33	111.94	102.11	84.49	81.02

Source: Nasscom, 2001 and Software Technology Park, Hyderabad (STPH) 2001

According to STPI (2001), during the year 2000-01, the export turnover generated by the software companies in the state was around Rs.2000 crores, out of which the STPI registered units accounted for Rs.1,917 crores, recording a growth of 81 percent over Rs.1,059 crores made during the previous year. Towards the end of the year 2000, the IT industry in the US suffered a set-back with many companies implementing cost cutting measures and reducing their IT budgets considerably. The Indian IT industry was heavily dependent on the US market and the slowdown had an adverse effect on the industry in Andhra Pradesh, forcing many small companies to close.

Table No 3.6: Global Reach (2000-2001)

USA & Canada	69.15%
Europe	11.80%
Middle East & Asia	6.39%
Netherlands	5.67%
Japan	4.28%
Australia	1.02%
Others	1.69%

Source: Software Technology Park, Hyderabad (STPH) 2001

The exports made from the state during 2000-2001 were predominantly to the US and Canada, accounting to 69.15 percent of the total exports. Software exports were also made to countries like the UK, the Netherlands, Japan, Europe, Australia, Middle East and other Asian countries etc. Realising the slowdown in the US market, many companies implemented a de-risking strategy of diversifying to various markets. The focus was on

Europe and the Middle East. This is expected to alter the global reach ratios with only around 50 percent exports to the US.

Out of the total exports, e-commerce and web applications contributed to around 29.14 percent closely followed by application software contributing 25.65 percent. Enterprise Resource Planning (ERP) and client server application accounted for 11.15 per cent and system software 8.91 per cent of the exports. Computer-aided design, manufacturing and geographical information systems (GIS) contributed around 4.38 per cent of the exports. Solutions in very Large Scale Integration (VLSI) and embedded software accounted for 2.64 per cent.

Table No 3.7: Area-wise Exports (2000-2001)

E-commerce / Web App	29.14%
Application Software	25.65%
ERP / Client Server	11.15%
System Software	8.91%
IT Enabled Services	8.15%
Consultancy Services	6.51%
CAD / CAM / GIS	4.38%
Communication Software	3.47%
VLSI & Embedded SW	2.64%

Source: Software Technology Park, Hyderabad (STPH) 2001

19 **India's Position in IT Industry**

Indian software sector has several advantages, which enable it to grow at a faster pace.

Location

Though for software companies location is seemingly not a material advantage, India enjoys a location advantage. The advantage it enjoys over other countries, is a 12-hour difference with the world's largest market - the USA. This enables US companies to establish round the clock software factories by subcontracting to Indian companies. The 12-hour difference enables almost continuous working on software projects.

Manpower Availability

As has been aptly put 'What Middle East is to oil, India is to software professionals'. There is a tremendous latent potential of manpower supply in India. India has the second largest pool of technically qualified English speaking manpower (second only to the United States) available at a comparatively lower cost. In the last ten years the growth in manpower availability has been tremendous, considering that India had barely 6,800 professionals in 1985. In the coming years manpower availability is estimated to grow at a much faster pace. (Nasscom, 2001)

Manpower cost

Much of India's strong growth in software in the past is attributable to the low cost of Indian programmers. Indian programmers are paid only about 15-20% of their counterparts in developed nations (Mehta, 1999). Even among competing countries Indian software professionals are paid the least. This provided domestic software companies a cutting edge in pricing software projects. However, the low cost edge has now been considerably eroded with most software professionals getting remuneration on par with

global standards. Nevertheless in terms of cost-quality, India continues to offer significant Value for money'.

Gamut of services

India's advantage was that it could offer a wide range of software services from clerical support/ data processing to sophisticated software systems. The low cost, faster learning curve, technical education and easy availability of manpower at all levels enabled it to offer labor intensive support services, while the technically qualified and skilled personnel enabled it to offer quality solutions involving sophisticated software systems.

Technology advantage

India due to its late entry in to IT industry, had avoided the problem of obsolescence of technologies which the other countries like Japan have been facing. Indian companies started investing in IT significantly, only since mid-eighties, coinciding with the advent of PC in the West. Since then PC segment (including software for PCs) has been the fastest growing segment, enabling India to ride the growth wave.

Project Experience

Indian companies have a rich experience of working with large global software companies. The subcontracting of large Y2K projects has also provided Indian companies with substantial experience in handling and executing large sized projects. Indian companies seem to have high credibility amongst other West European nations and US on the reliability index, which is indicated by the increasing contract sizes.

Skills on Learning curve

Indian companies have over the last decade built expertise on a variety of platforms - from legacy systems to the latest state-of-the-art systems. Indian software professionals have faster learning curve when compared with their counterparts in other countries (Mehta, 2001) Most of the companies have expertise on PC, mainframe, UNIX and midrange platforms with varied operating systems, RDBMS and programming language skills.

Infrastructure facilities

India has more than 500 high-speed datacom links of 32-256 kbps, connecting Indian software companies with their clients abroad. A majority of this infrastructure and communication links are provided by Software Technology Parks of India (STPI). These facilities include floor space, EPABX, fax, Internet, teleconferencing, backup power etc. Local software companies outside the STPI zone are also assisted by STPIs using a network of receivers and microwave/ radio-wave links. Despite this, the current infrastructure fails to meet the growing needs of the Indian software industry.

Leading domestic software exporters have built world class software facilities of their own which include - dedicated telecom links like leased lines, dedicated satellite time and development centers with adequate hardware, own power generation, recreation facilities for staff, etc.

Regulatory framework

The Indian government with its provision of tax and duty benefits to software exporters has facilitated an apparently conducive regulatory framework for IT industry development.

Chapter 4: Organisational Profile

4. Organisational Profile of Software Companies in the Study

4.1 Introduction

Many organisational studies in the recent past have demonstrated the impact of information technology on organisations and vice-versa. The emergence of modern organisation as a result of these impacts is the focus of the present section. The current section discusses the organisation in the systems perspective and describes the structure and function of the technology based organisations. Also the interrelated and interdependent factors like age of the organisations, human resources and the financial turnovers of the organisations are examined.

Benjamin and Levinson (1993) emphasized that for IT-based change in organisations to be effective, technology, business processes, and organization need to be adapted to each other. Comparing the present information revolution with the Industrial Revolution, Malone and Rockart (1993) indicated that the latest changes in IT would lead to the evolution of new technology-intensive organizational structures. They project that the advances in IT would result in dramatic decline in the costs of "coordination" which would lead to new, coordination-intensive business structures. Rockart and Short (1989) suggest that IT would enable the firms to respond to the "new and pressing competitive forces" by providing "effective management of interdependence."

A systems approach to organizations begins with the postulate that organisations are open systems which, of necessity, engage in various modes of exchange with their environment (Katz and Kahn, 1966). The open systems approach to complex organizations emphasizes the consideration of the relationship between a system and its environment as

well as what goes on within the system (Hall, 1977). Baker (1973) notes that organizations undergo change in the course of interaction with and adjusting to their environment and also change that environment. Since environmental dependency inhibits the organization's ability to function autonomously, it must manage such dependency to survive as an independent entity (Kotter, 1979). Organizations typically manage environmental dependency by establishing and maintaining resource exchanges with other organizations (Levine and White, **1961).**

Emery and Trist (1965) argued the need for the concept of "the causal texture of the environment" noting that the environmental contexts in which organizations exist are themselves changing under the impact of technological change - at an ever-increasing rate and towards increasing complexity. The modern software production organisations have been undergoing the process of change with technology and organisations developing and influencing each other. This is a spiral process with shortest possible technology and organisational (in terms of structure & functions) lifecycle.

4.2 Manufacturing and Software Companies

There has been a major paradigm shift taking place in the organisational structure and functions of organisations of manufacturing to software technology based organisations in India: This shift is essentially because of the transformation that has taken place in the information technology industry i.e., from IT as a production center to IT as a productivity tool.

4.3 Organizational Structure of Software Companies under study

As said earlier, the present study was carried out in 32 Software companies in Hyderabad. These companies too have erected organisation structures that suit their technology based organisations . When probed for their reflections on the emerging organisational profiles of software companies, the heads of these companies expressed some vital insights.

For instance, the difference between manufacturing and software companies has been highlighted by a senior vice-president of a big software company who has 32 years of experience (18 years in manufacturing and 14 years in software company):

> "there is considerable difference between manufacturing and software companies. The manufacturing companies have fixed organisational structure and hierarchy, rigid functional units and processes that lasts long and it is not easy to change any of these things. Whereas in software companies the organisational structures keep changing in response to market demands and customer requirements. Even the departments and their functions keep changing. In my previous software company, the management has decided to shift focus from project services to product selling and the functions of the business development department has changed from marketing to sales."

Information technology in general and software technology in particular has caused significant changes in the modern technology-based organisational structure and functions.

4.3 **Structural Changes**

Horizontal Organisational Structures: Software organisations have few levels in their hierarchy and thus have, flat organisational structures. The nature of tasks demand effective communication among the people from top to bottom and thus they cannot afford to have too many layers in the organisational structure. When compared with non-software

organisations, such as typical industrial manufacturing units, the software organisations have different organisational structure and the following table explains this phenomenon.

Table 4.1: Levels in the organisational structure of software and non- software organisations.

Manufacturing Companies	Software Companies
Trainees	Trainee Programmer / Engineer
Junior Executive	Software Engineer / Programmer
Executive	Project Leader
Senior Executive	Project Manager
Asst. Manager	Vice President
Dy. Manager	CEO / Director
Manager	Chairman & Managing Director
Senior Manager	
Asst. General Manager	
Dy. General Manger	
General Manager	
Asst. Vice President	
Vice President	
Director	
Managing Director	
Chairman	

Dynamic Organisational Structures: Some times the software organisations **are** compelled to evolve temporarily and dismantle some organisational structures based upon the situations. The following are some of the reasons for creating temporary organisational structures.

- For the purpose of execution of time bound large-scale projects

- For the purpose of provision of customer services for specific periods of time in an year.
- For specific overseas assignments for temporary duration when employees are deputed on special jobs.
- For filling up the vacancies when people move up the ladder

Special Organisational Units: Software organisations are known for creating special organisational units or groups based upon the situation and market conditions. In the study, there are instances of special organisational units being created such as:

- For trouble shooting the critical applications, a medium software company (included in the study) has created a special division to cater to customer needs.
- An internet software company (included in the study) has created a new organisational division called Help Desk to cater to the personal needs and works of the employees.
- A big software services company (included in the study) has created a special division called Support Services for the purpose of offering infrastructural support services to the main stream organisation.

Increased Span of Control: The less the number of layers in the hierarchy the more will be the span of control. Software organisations are known for their effective span of control.

Redefining of the Organisational Boundaries: Software organisations have redefined the organisational boundaries and in most of the cases, they extend beyond the geographical boundaries. The multinational corporations engaged in design & development of huge

software projects are the examples of boundary less organisations. Essentially a software project has got many phases in the life cycle and thus passes through many divisions in an organisation spread across the globe. For example, a division of an organisation located in Unites States of America may generate the analysis and send it to India where it is actually converted into software by the software divisions in the Indian sub-continent, which might be spread across the country. But for the customer all these divisions spread across the world coalesce to have one identity as boundary less organisation. Also the nature of collaborations that the software companies enter into demand special organisational boundaries, combining both the collaborating organisations located at different places.

Virtual Organisations: Some software organisations have virtual organisations which are those with no physical structures, no people sitting at one place, and no office. There are some software organisations existing on world wide web with no physical office and people maintain from their lap-top computers.

The concept of virtual office has become more popular with software companies and it is further explained by a director –marketing of a medium software company in the study:

> "as a growing company we can not have our business development offices in all major cities in India and thus we have virtual offices with only people (business development managers) working for us. What they have is a lap-top computer and a mobile phone. From corporate office we keep in touch with them (BDMs) through e-mails and phones for day-to-day business transactions. . . . ."

4.4 Functional Changes

The functions of the companies also change based on technologies.

High Division of Labour: Software organisations have got very high division of labour with every person catering to a specialised kind of job which requires high degree of skill and expertise. Software development demands high degree of specialisation and thus requirement for higher level of co-ordination.

Revised Functions: In response to the changes in organisational structures there has been change in functions in terms of additional job responsibilities, job redesign, job enrichment, change in the positions, cross-functional responsibilities, core competency, job content, etc.

Changing pattern of the communication: Software organisations demand fast and effective communication system and more over the modern technology has facilitated this process by way of electronic mail. E-mail has changed the way people communicate within and outside organisations.

Changes **at Organisational** Level: The following broad changes can be observed in a software organisation when compared with an industrial manufacturing organisation:

- Personnel management changed to Human Resource management
- Continuous training needs to keep in pace with the changing technology
- Changes in the employment patterns like consulting on project specific employees, contractual employees etc.
- Changing work culture (job security, working hours, time consciousness, quality consciousness, etc)
- Change in line & staff functions

- Decentralization of authority,
- Change in the decision making process and time
- Increased productivity, performance, and efficiency
- Dehumanization of work and the work culture

These changes are not only because of impact of technology but also due to some other influential factors at global level. This has been expressed by an entrepreneur (director) who owns a software company (included in the study) that deals with legacy-systems maintenance in European countries:

> "there are some major changes happening across the globe that is influencing Indian software companies viz., free movement of capital making capital easily accessible; technology being no longer the preserve of a few companies; unrestricted flow of information making information available to all; globalization creating an all-important quality standard and the world economy increasingly becoming service-oriented"

Note: The respondents were asked to give ranking or priority to the responses to questions they have given in the interview. Though the respondents were asked to give five ranks / priorities, most of them could give maximum of three and thus top three ranks / priorities were taken into consideration for the purpose of analysis.

4.5 Nature of Business Activities:

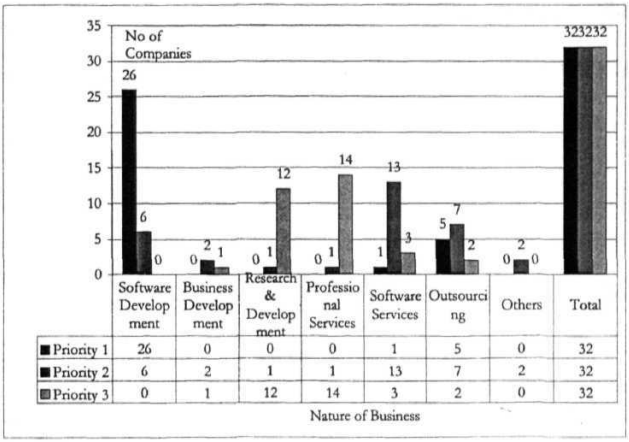
Most of the American and European companies collaborate with Indian software companies primarily because of the strength of software development that the Indian companies possess. Another significant factor that attracts foreign collaborating companies is that in terms of the nature of business, the

Indian software companies are flexible enough to cater to their changing needs. This was emphasized by a knowledgeable person (who worked in USA for 5 years) of an offshore development company:

> "I was told by many of my customers in the United Sates of America that they prefer Indian software companies when compared with other country companies primarily because of flexibility that they have in terms of changing the business nature & activities in response to their needs or their market needs."

The sample companies were asked to mention their priorities in terms of nature of business. Maximum number of companies (81.3%) have software development as their first priority, followed by outsourcing (15.6%) and only one company (3.2 %) with software services as their first priority. In the second priority 40.6% companies have mentioned software services, 28.13% as outsourcing, 18.75% as software development, 6.25% as business development followed by one each (3.2%) in research & development and professional services. Where as in third priority maximum number of companies (43.8%) are involved in software services followed by professional services (37.5%), outsourcing (15.6%) and there is only one company (3.2%) in business development. (see Chart 4.1)

Chart 4.1: Nature of business activities of the software companies



4.6 Software Development Areas of the Companies in the Study

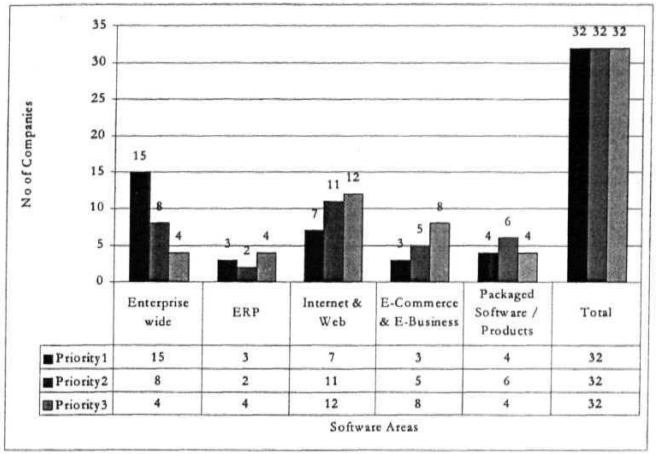
Every software company has core competencies in terms of specific software development area and they take up projects only in those areas. These core competencies go along with the brand name of the company and the customers evaluate the software companies based upon the factors like - number of similar projects executed and number of people who have similar project experience. This core competency has two facets and was explained by a business development manager (BDM) of an ERP company in the study.

> "our customers look for experience in the areas where they want us to develop the software. Past projects executed and the people who have worked in that area matters for our customers. Our concerns are - the reusable components available with us and the people who have worked in similar projects"

Software Areas are the technical segments in which the companies are offering technical services like: Enterprise-wide Solutions, Enterprise Resource Planning (ERP), Internet & Web based Solutions, E-commerce & E-business Solutions and Packaged Software Products. (This technical segmentation is followed by default by industry association like Nasscom & STPI as an industrial standard) (Nasscom, 2002).

The companies were asked to prioritise their technical service areas according to the above technical segments. Forty-seven percent of the companies have mentioned enterprise wide solutions as their first priority followed by 21.9% offering internet & web solutions, whereas the same internet & web solutions is expressed as second and third priorities by 34.4% and 37.5% of the companies respectively. Enterprise wide solutions were reported as second and third priorities by 25% and 12.5% of the companies respectively. Similarly, packaged software products was mentioned as first priority by 12.5% of the companies and as second and third priority by 18.8% and 12.5% of the companies. E-commerce and E-business solutions were the first priority in the case of 9.37% of the companies. (see Chart 4.2)

Chart 4.2: Software development areas of the companies



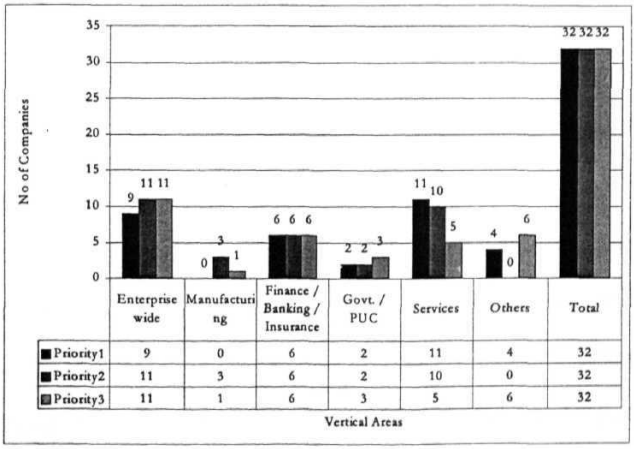
4.7 Vertical Market Segments

Vertical Areas are industry specific segments to which the software companies offer services. These areas are the nature of business of their customers. Like software development areas (known as horizontal segments), the industry specific segments also go with the company brand name. Nasscom (2000) has adopted common vertical market segments like - enterprise wide solutions; manufacturing; finance, banking & insurance; government & public sector under takings; service sector including - hospitality, entertainment, health, courier & cargo, media, transportation etc and other miscellaneous & minor segments. Every software company has its own vertical segments which it caters to and there are some factors that brand a company with a particular industry segment and some of them include - the function al and technical experience of the company; the number of projects executed in that segment; the number of functional consultants with

relevant industry experience; documented experience of the company about the relevant government policies, legal & regulatory procedures, industry specific practices & standards.

The companies were asked to prioritise their target vertical market areas. **The** majority of companies in the study reported that they cater to services market segment which includes hospitality, entertainment, health, courier & cargo, media, transportation etc. Among the 32 companies 11 (34.4%) have expressed series as their first priority, 10 (31.3%) as second priority and 5 (15.6%) as their third priority. General enterprise market is expressed as the first priority by 9 (28.13%) companies and by 11 (34.4%) companies each as second and third priorities. Interestingly an equal number of companies 6 (18.8%) have expressed finance, banking and insurance market segment as their first, second and third priority. Very few companies have targeted other priority areas like govt., public sectors and manufacturing. (see Chart 4.3)

Chart 4.3: Vertical market segments targeted by the software companies



	Enterprise wide	Manufacturing	Finance / Banking / Insurance	Govt. / PUC	Services	Others	Total
Priority1	9	0	6	2	11	4	32
Priority2	11	3	6	2	10	0	32
Priority3	11	1	6	3	5	6	32

4.8 Customer Destination

Most of the Indian software companies export software to other countries and they establish collaborations in those countries. Customer destination of software companies in Andhra Pradesh (total study area) during 2000-2001 were predominantly to the US and Canada, accounting for 69 percent of the total exports and the remaining 31 % software exports were made to countries like the UK, the Netherlands, Japan, Europe, Australia, Asian Countries, Middle East, etc (STPH, 2001). These figures almost match with that of Indian exports to US and Europe followed by other countries. When asked "why most of the Indian companies have their customers in USA, a senior vice-president of a software services company (that has maximum customers in USA) explained the reasons:

> "the obvious reason being the foreign exchange value that we get from USA which is in multiple of 45. That is for every man-day that earn from an India customer, if spent for a US customer will fetch us 45 times more. There are some other reasons like - US being the biggest software market, customers are more professional with time & quality consciousness, and finally the trade between India & USA in software industry is well established. You know that is a beaten track with proven results."

Almost all companies in the sample export software to different countries across the globe and they have their collaborating companies in those countries to which they export the software. Twenty-six (81.25%) companies in the study have their customers in United States and Canada followed by 4 (12.5%) in Middle-East & Africa and 2 (6.25%) in Europe as their first customer destination. In the second customer destination 23 (71.9%) companies

have European countries, followed by 5 (15.6%) as United States & Canada (15.6%); 2 (6.25%) as Australia and Newzealand and 2 (6.25%) as Middle East & Africa. As the customer destination 22 (68.75%) companies have their customers in Asia Pacific & Japan followed by 5 (15.5%) in Europe and 3 (9.3%) in other countries. (see Chart 4.4 & 4.5)

Chart 4.4: Customer destination of the software companies

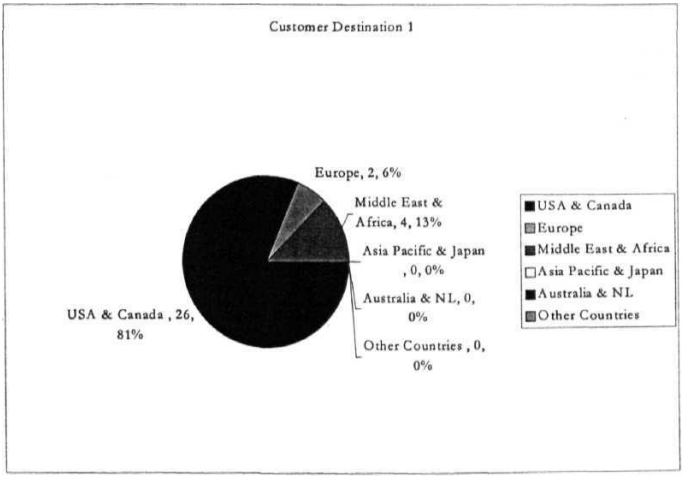
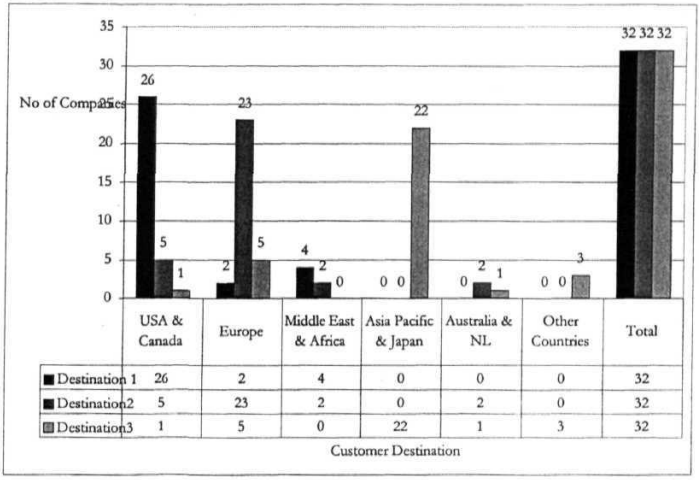


Chart 4.5: Customer destination and their priorities



4.9 Age of the Companies

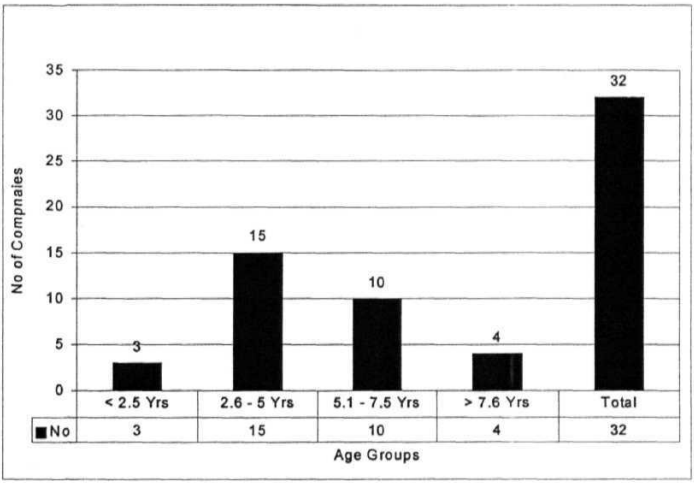
Age of the organisation is defined as the number of years the company has been in existence and was calculated from the difference in the years between 2001 (the base year for the present study) and the year of establishment of the organisation. The minimum age of the organisation in the sample is 1 year, maximum 14 years and the mean age of the sample is 5.4 years. The age of an organisation helps them to get more projects, attract more talented people, accumulate technical knowledge & experience, gain more understanding of vertical market segments and finally gain more stability. The same view was expressed by a promoter / director of a product development company:

> "in the software industry our stakeholders, customers, employees, & investors value companies with long years of existence and track-record."

The age of the organisations has been classified in to four groups for the convenience of the present study. The first group consists of organisations with less than 2.5 years of age, second group from 2.6 to 5 years, third group 5.1 to 7.5 years and the fourth group consists of organisations with more than 7.6 years of age.

There are three (9.3%) companies in the first age group having less than 2.5 years of age; 15 (46.87%) companies in the second age group i.e., 2.6 to 5 years; 10 (31.25%) companies in the third age group i.e., 5.1 to 7.5 years and 4 (12.5%) companies in the fourth age group with more than 7.5 years of existence. (see Chart 4.6)

Chart 4.6: Age distribution of the software companies



4.10 Human Resources:

Human Resources are an important aspect of software organisations and it is the people who make or break the organisations. The present section describes the human

resource profile of the software organisations which includes classification of employee groups in to technical and managerial categories, growth of employees and proportionate strength of technical and managerial employees.

Software industry has high value and regard for people and this can be established from some of the statements made by HR managers of different software companies included in the study:

> "The strategic use of human resources will differentiate better-run firms from the rest"
>
> "Organizations that have world-class ambitions will need to nurture knowledge workers"
>
> "The only thing that distinguishes your company from another is the quality of your people"
>
> "Business today is built, and grows around human resources. So, people are the key resource"
>
> "It is the rising demand from customers that is making people increasingly important"
>
> "All corporate strengths are dependent on- and centred around - human resources"
>
> "Easy access to technology has made your people the differentiating factor in today's environment"
>
> "To reach new frontiers of knowledge, people of high caliber and understanding are essential"

A multi-national corporation with its head-quarters in Hyderabad with more than 7000 employees across the globe has "Our people make the difference" as the punch line along with the corporate brand name. In the recent past many companies have started including human resource profiles in the company annual reports and this trend is significant

in the software industry only. The following details from the annual report of a multi-national software services company demonstrates the value for human resources as reported in the company's annual report.

The employee strength at InfoTech as on March 31, 2000 is 1002 as compared to 951 as on March 31, 1999.

The age profile of Associates as on March 31, 2000 is as follows:

Age Particulars	No. of Associates	% to total
24 and less	547	54.59
Between 25 and 29	378	37.72
Between 30 and 34	53	5.29
Between 35 and 39	10	1.00
40 and above	14	1.40
Total	1002	100.00

The academic background profile of Associates as on March 31, 2000 is as follows:

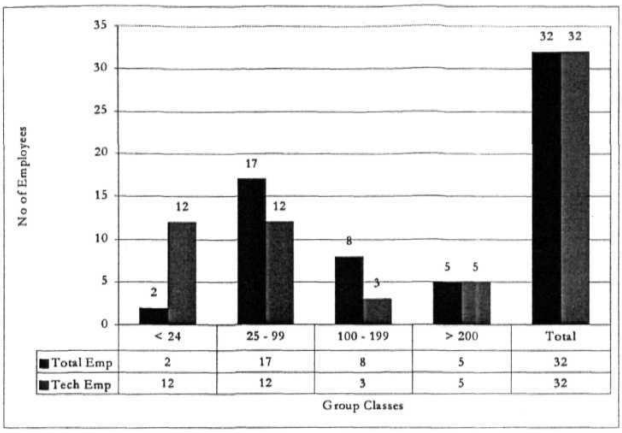
Academic Background	No. of Associates	% to total
Ph.Ds	6	0.60
Engineering / Sciences	924	92.22
Commerce	72	7.18
Total	1002	100.00

Source: Annul Report for the year 1999-2000 of Infotech Enterprises Limited, Hyderabad.

The number of employees employed by an organisation is classified and grouped in to four different categories viz., less than 24 people, 25-99, 100-199 & more than 200 people. Among the companies in the sample, 17 (53.13%) companies employed 25-99 people at the time of study, followed by 8 (25%) companies that employed 100-199 people, 5 (15.6%) companies employed more than 200 people and only two (6.25%) companies had less than 24 people at the time of study. Among the technical employees 12 (37.5%) companies had less than 24 and 12 (37.5%) companies had 25-99 technical people followed

by 3 (15.6%) that had more than 200 technical people and 3 (9.37%) with 100-199 technical people at the time of study. (see Chart 4.7)

Chart 4.7: Employee groups

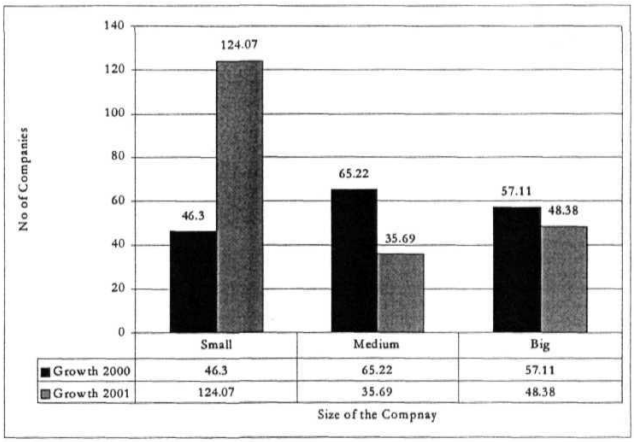


Total number of employees ranged from a minimum number of 20 to a maximum of 9300 employees. Similarly number of technical people ranged from 16 to a maximum of 7616 and the number of managerial people ranged from 4 to a maximum of 1684. The mean number of technical people is 378.88, the mean number of managerial people is 70.35 and the mean total number of people is 449.22. Thus the ratio of technical people to managerial people is 83:17.

Companies regularly recruit people as part of their growth plans. For the period 1999-2000 to 2000-01 the minimum growth among companies in the sample in terms of total employees is 10.61% and the maximum growth is 566.67% whereas in the case of technical people it ranged from minimum 11% to a maximum of 700% and for **the** managerial people it ranged from 9% to 300%. On the whole for the period from 1998-99

to 1999-2000 the average growth in terms of number of employees was 56.21% and for the period 1999-2000 to 2000-2001 the growth was 69.38% for the sample companies included in the study. (see Chart 4.8)

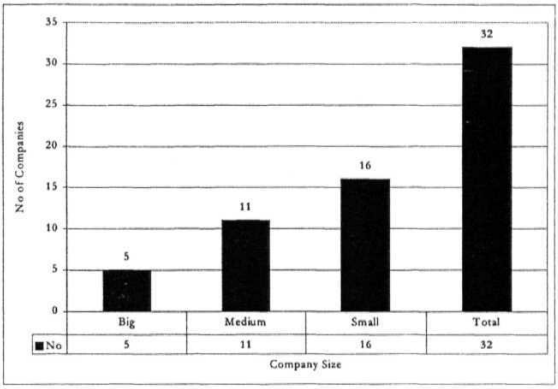
Chart 4.8: Average Growth of People in the Year 2000 and 2001



4.11 Turnover

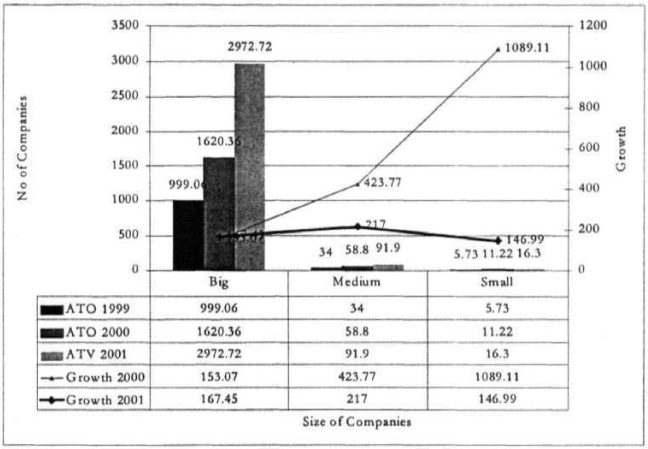
The size of the company is defined based upon the total turn over of the company during the base year 2000-2001. The companies in the sample are classified into 3 groups based on their annual turnover viz., Small companies- that had less than 15 million Indian Rupees turnover, Medium size companies that had from 51 to 200 Million Indian Rupees turnover and Big companies that had more than 200 million Indian Rupees turnover during the base year 2000-2001. Out of the total 32 companies studied, 16 (50%) companies were small, 11 (34.4%) companies were medium and 5 (15.6%) companies were big at the time of the study. (see Chart 4.9)

Chart 4.9 : Size of the companies



The average turnover of small companies grew from Rs.5.73 million to Rs.11.22 million from 1998-1999 to 1999-2000 and to Rs. 16.3 million by 2001. The average growth rate in these periods of the small companies was 489.1% and 146.99% respectively. The average total turnover of the medium companies in the financial year 1998-99 was Rs.34 million and it grew to Rs.58.8 million by 1999-2000 and it reached Rs.91.9 million by 2000-2001. The medium companies had a growth rate of 423.77% from 1998-99 to 1999-2000 and the growth rate fell to 217% by 2000-2001. The average turnover of the big companies was Rs.999.06 million in 1988-89, Rs. 1620.36 million in 1999-2000 and Rs.2972.72 million in 2000-2001. The big companies had a growth rate of 153.07% for the period 1998-1999 to 1999-2000 and 167.45% for the period 1999-2000 to 2000-2001. (see Chart 4.10)

Chart 4.10 : Growth of the companies



Majority of the companies in the sample earned their maximum revenues from software exports which was as high as 100%. The average ratio of Domestic vs Exports turnover was around 21:79 i.e., on an average companies earn 79% of their earnings from software exports and only 21% is from domestic market. The minimum turnover is Rs.3.6 million and maximum is Rs.12467.1 million and the mean turnover is around Rs.504.31 million where as in the exports sector the minimum earnings are Rs.2 million, maximum Rs.11921.04 million and the average Rs.468.45 million. The domestic sector had minimum earnings of Rs.O million, maximum Rs.546 million and the average of Rs.35.87 million.

4.12 Correlation Analysis:

While studying the organisations from the systems perspective it is pertinent to look at the relationships among the variables like age of the organisation, number of people and the turnover of the organisation. At the outset it is evident that there exists a correlation

between age, people and turnover and the following correlation matrix demonstrates the strength of correlation among these variables.

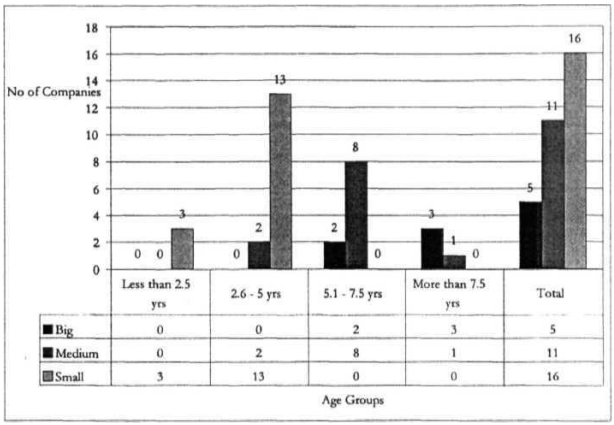
Table 4.2: Correlation Matrix

	Age	People	Turnover
Age	1		
People	0.597641	1	
Turnover	0.53896	0.981546	1

It is clear from the Table No. 4.2 that the people and the turnover of an organisation are positively correlated with each other with strength of 0.982. This indicates that the more the number of people in general and technical in particular the more is the turnover and the corollary is that the turnover of an organisation is direcdy proportional to the number of people it employs. Interestingly there is no strong correlation between the turnover and the age of the organisation (the strength is only 0.539) which indicates the future of the technology based organisations in the IT industry. This point is also proved from the sample organisations where companies with less age had more turnover when compared with companies with more age and less turnover. Similarly age and people are not very much correlated with a strength of 0.598, this again indicates another characteristic feature of software organisations where in people are the assets for the organisation and are not related to the age of the organisation. That means if an organisation is old enough it might have more number of people and conversely organisations with more number of people need not be old. Finally the same argument holds good for the relationship between age and turnover.

4.13 Age and Size of the Companies in the Study:

Chart 4.11: Age and Size of the Companies in the Study



The above table helps in strengthening our reasoning on correlation among age, and turnover. There are three small companies (9.3%), and no medium and big companies in the less than 2.5 years age group. In the 2.6 to 5 years age group there were 2 (6.25%) medium and 13 small (40.6%) companies. In the next group of 5.1 to 7.5 years there were 2 (6.25%) big and 8 (25%) medium companies and in the final group of more than 7.5 years age there were 3 (9.37%) big and 1 (3.13%) medium company. From this analysis it is clear that the more the age the bigger the company is and not the converse. (see Chart 4.11)

4.14 Age of the Companies and Human Resources

Table No 4.3: Age and People in the Companies

Age of the Companies	Employee Groups				Total
	<24 People	25-99 People	100-199 People	>200 People	
New (less than 2.5 yrs)	2	1	0	0	**3**
Marginal (2.6-5 yrs)	0	14	1	0	15
Middle Aged (5.1 - 7.5 yrs)	0	2	7	1	10
Old (more tnan 7.5 yrs)	0	**0**	0	4	4
Total	2	17	8	5	32

Table No 4.3 illustrates the relationship between the age of the organisation and the total number of people employed. In the less than 2.5 years age group there were 2 (6.25%) companies with less than 24 employees and one (3.13%) company with 24-99 employee group. In the 2.6-5 years age group there were 14 (43.8%) companies with 24-99 age group and one (3.13%) company with 100-199 employee group. In the 5.1-7.5 years age group mere were 2 companies (6.25%) with 24-99 employee group, 7 (21.9%) companies with 100-199 employee group and one (3.2 %)company with more than 200 employee group. Finally in the more than 7.5 years age group all the 4 (12.5%) companies having more man 200 employee group. From this it is very clear that the age of the company and the number of people are positively correlated.

4.15 Size of Companies and Human Resources

Table No 4.4: Size of the Company and Total Employee Groups

Size of the Company	Total Employee Groups				Total
	<24 people	25-99 people	100 - 199 people	>200 people	
Big	0	0	1	4	5
Medium	0	4	6	1	11
Small	2	13	1	0	16
Total	2	17	8	5	32

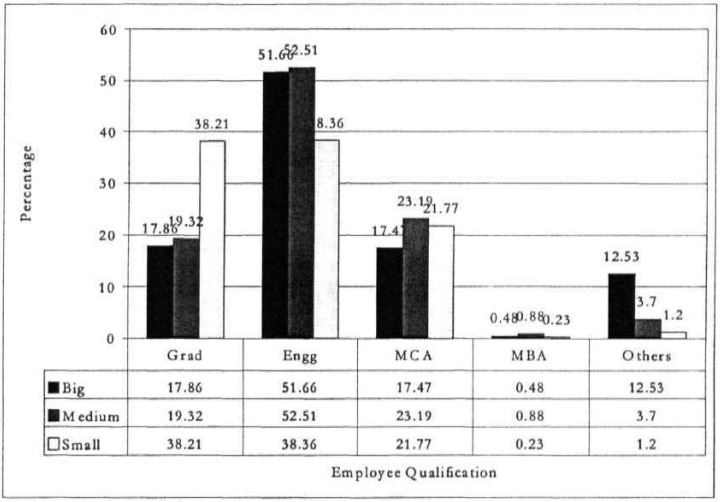
Note: A Small company is one that had turnover of less than 10 million Indian rupees and having less than 24 employees; a Medium company is one that had turnover ranging from 11 to 100 million Indian rupees and having employees between 25 to 99; and a Big company is one that had more than 101 million Indian rupees turnover and having more than 100 employees during the financial year 2000-01.

Table No 4.4 describes the relationship between the size of the company and number of people. In less than 24 employees group there were only 2 small companies (6.25%). In the 25-99 employee group there were 13 small companies (40.6%) and 4 medium companies (12.5%). In the 100-199 employee group there was one small company, 6 medium companies (18.8%) and one big company. In the more than 200 employee gtoup, there was only one medium company and 4 big companies (12.5%). From this it is very clear that bigger the size of the company the more the number of people.

4.16 Size of the Companies and Employee Qualification Profile

There is clear trend in the industry that medium and big companies attract talented and qualified people than the small companies. This trend can also be observed among the sample companies by analysing the following table.

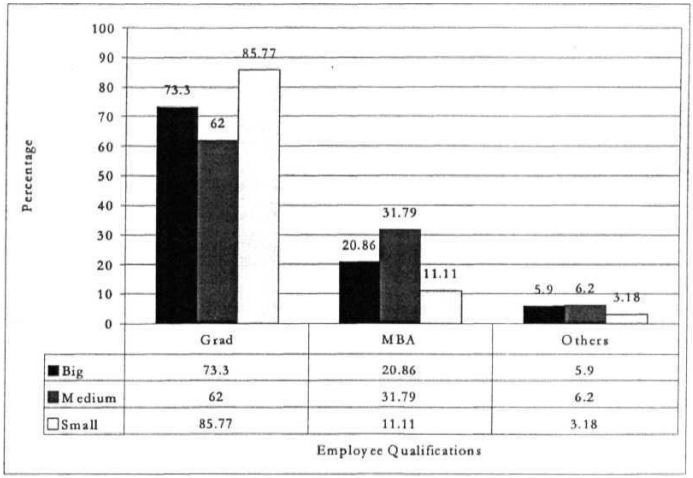
Chart 4.12: Technical Employee Qualifications and Average Number of People



The qualification profile of the technical employees in the organisations ranges from general graduates to engineering graduates and MCAs (Master of Computer Applications). Average (number of people by number of companies) number of general graduates (includes - Bachelor of Science, Bachelor of Commerce & Bachelor of Arts) engineering graduates (all branches of engineering), MCAs (Master of Computer Applications), MBAs (Master of Business Administration), & others (includes - Charted Accountants & Doctorates) were calculated for big, medium & small companies. The average number of general graduates in small companies were 38.21 when compared with 19.32 in medium and 17.86 in big

companies. The average number of engineering graduates were 51.66 & 52.51 in big & medium companies respectively and was more when compared with small companies where the average was 38.36. But there was an exception to the average number of MCA graduates who were employed uniformly in all big - 17.47, medium - 23.19 and small - 21.77 companies. There were very few MBAs employed in these companies and also people with other qualifications. (see Chart 4.12)

Chart 4.13: Managerial Employee Qualifications and Average Number of People



Similarly, the qualification profile of the management employees is very simple with only general graduates (includes - Bachelor of Science, Bachelor of Commerce & Bachelor of Arts) and MBAs (Master of Business Administration). The average number of general graduates in big companies were 73.3 when compared with 62 in medium and 85.77 in small companies. The average number of MBAs employed in the small companies were **11.11** when compared with 31.79 in medium and 20.86 in big companies.

A clear trend emerges in the ratio of technical vs managerial employees employed in the software organisations. On an average big companies employ around 90% of **the** technical people and 10% managerial when compared with medium companies employing 80% technical and 20% managerial, small companies employing 77% technical and 23% managerial. (see Chart 4.13) This explains that big companies are managing with less managerial staff **than** medium and small companies. This is because the small and medium

companies would have to maintain certain minimum number of managerial positions regardless of the strength of technical team.

4.17 Summary of Findings

There is a contrast which can be observed in software organisations from that of manufacturing. Software organisations are distinct in the sense that they have few levels in their hierarchy and thus have flat organisational structures when compared with the industrial manufacturing organisations. The software organisations are compelled to evolve and dismande temporary organisational structures based upon the situations. Software organisations are known for creating special organisational units or groups based upon the situation and market conditions.The organisational boundaries of software companies are redefined and in most cases, they extend beyond the geographical boundaries. Some software organisations can have virtual organisations which are those with no physical structures, no people sitting at one place, and no office. Software organisations have got very high division of labour with every person catering to a specialised kind of job which requires high degree of skill and expertise. In response to the changes in organisational structures mere has been change in functions in terms of additional job responsibilities, job redesign, job enrichment, change in the positions, cross-functional responsibilities, core competency, job content, etc.

With the new organisation structures, software companies in the study are found to have good progress which ultimately helps them in technology development. Majority of the software companies in the study cater to the US market (81.25%) offering enterprise-wide solutions (47.0%) targeted at the services (includes - hospitality, entertainment, health,

courier & cargo, media, transportation etc.) in vertical market (34.4%). The minimum age of the organisation in the sample is 1 year, maximum 14 years and the mean age of the sample is 5.4 years. Also majority (47%) of the companies in the study are in the 2.6 to 5 years age group.

Total number of employees ranged from a minimum number of 20 among the sample organisations and a maximum of 9300 employees. Similarly number of technical people ranged from 16 to a maximum of 7616 and the number of managerial people ranged from 4 to a maximum of 1684. The mean number of technical people is 378.88, the mean number of managerial people is 70.35 and the mean total number of people is 449.22. Thus the ratio of technical people to managerial people is 83:17.

There exists a correlation between age, people and turnover and the correlation analysis demonstrates the strength of correlation among these variables. People and the turnover of an organisation are positively correlated to each other with strength of 0.982. This indicates that the more the number of people in general and technical in specific the more is the turnover and the corollary is that the turnover of an organisation is directly proportional to the number of people it employs. Interestingly there is no strong correlation between the turnover and the age of the organisation (the strength is only 0.539) which indicates the future of the technology based organisations in the IT industry. **This** point is also proved from the sample organisations where companies with less age have more turnover when compared with companies with more age and less turnover. Similarly age and people are not very much correlated with a strength of 0.598, this again indicates another characteristic feature of software organisations where in people are the assets for the

organisation and are not related to the age of the organisation. That means if an organisation is old enough it might have more number of people and conversely organisations with more number of people need not be old. Finally the same argument holds good for the relationship between age and turnover.

Chapter 5: Collaboration Trends

5. Collaboration Trends Among the Software Companies in the Study

5.1 Introduction

The present chapter deals with the collaboration trends among the software companies in the study. The word collaborate comes from the Latin "collaborate", which means "to labor together." According to Webster's Dictionary Collaboration is "to work jointly or together with others, especially in an intellectual endeavor." Collaboration is a broad term which is used by business community, academic community and many others. The present study adopts a more inclusive approach in defining the concept of collaboration. The definition of collaboration has been adopted from the software industry and the study looks into collaboration among software companies from their perspective. In the software industry all kinds of inter organisational arrangements are considered as collaborations and the scope of collaboration includes the following - Joint venture, minority holding, cross holding, licensing of technology, joint R&D programme, joint product development, enhanced supplier relationship (content partnerships), authorized implementation partnerships/solutions partnership, development of standards, joint-production contracts, licensing of brands, reselling & distribution arrangements (e.g., customer access partnerships, off-the-shelf products, etc.), marketing arrangements to access Indian markets, marketing arrangements to access foreign markets, bidding consortium, institutional linkages (e.g., with VC firms, industry consortia etc.). At a macro level collaboration involves goal-oriented interaction between two organisations on the basis **of** complementarity strength. Also the concept of organisation is used in a broader sense to

indicate various forms like agency, firm, private limited company, public limited company etc.;

The present section describes the collaboration patterns among the companies under the following headings: basis for collaboration, nature of collaborating company, country of the collaborator, collaboration areas, duration of the collaboration, number of projects executed during the collaboration period, collaboration participation with investment and people ratios, reasons for collaboration, factors contributing to the strength of collaboration, factors that hamper the outcome of collaborations and advantages & disadvantages of the collaboration.

The significance of the strength of the organisational collaboration is expressed with the help of a composite index called collaboration strength index (CSI). The collaboration strength is a sum combination of three variables viz., collaboration basis, collaboration duration and the number of projects executed with the collaborator during the last financial year (2000-01). CSI is represented in quantitative terms on a scale of zero to one, zero signifying no strength in the collaboration relationship and one as the perfect collaboration relationship. CSI is calculated using the following formula.

CSI = Σ {(CDP) + (CBP) +(NPP)} which means (collaboration duration) + (collaboration basis) + (number of projects executed with the collaborator)

5.2 Basis for Collaboration

Collaboration is a goal-oriented process in which two or more organisations interact on the complementary strengths. Basis for collaboration is defined as the platform on which the collaboration relationship is executed or the significant factor that brings two

organisations together to form a collaboration relationship. Basis for Collaboration is the crux of the relationship. Indian software companies are known for their technology strengths and the huge number of trained software professionals they employ. Many companies in USA & Europe have insufficient human resources and the cost of software development is very high when compared with developing the same software in India. Thus sharing of human resources and technology becomes high priority for the foreign companies and providing outsourcing services and sharing technological innovation becomes priority for Indian companies. Outsourcing services are provided by as many as seventy-five per cent of the companies and this is six times more than the other bases for collaboration like - resource and technology.

Companies were asked to mention the basis on which they have formed a collaborative relationship, outsourcing service was the explicit choice of 25 (78.13%), 24 (75%) and 24 (75%) companies as their first, second and third priorities respectively. This clearly indicates the obvious trend towards outsourcing and majority of the companies in the country have outsourcing relationship with one or more companies out side the country. This trend was ratified by the director of a software company who came back to India from US to start a software company to provide outsourcing companies in USA:

> "According to my experience majority of the Indian software companies survive on providing outsourcing services since last two years and this is the present trend. This trend of providing outsourcing services has replaced the body-shopping trend in the late nineties - from 1995 to 2000. May be after few years this trend might be replaced by some other trend."

The companies in the sample formed collaborations on the basis of resources, technology and risk sharing. There were four companies (12.5%) which reported first and second priorities as resource based collaboration. Similarly, there were two (6.25%) companies which reported technology based collaboration as their first priority, four (12.5%) companies as their second priority and six (18.75%) companies as their third priority. Risk sharing as the basis of collaboration has been reported as the first priority by one company (3.13%) and two (2.25%) as their third priority. This clearly indicates the perception of Indian companies towards risk sharing as the basis for collaboration. Very few companies perceive that risk can be shared through collaboration. When asked why most of the Indian companies lack risk sharing vision, a senior vice-president of an Indian based MNC explained:

> "Indian companies view only financial loss as risk whereas the foreign companies look at risk from a different perspective and they also look at - the opportunity cost & time, brand image, and financial burden"

5.3 Collaboration Patterns

During the survey the companies were asked to give details about their three significant collaboration relationships that they have established till date. These collaborative relationships are represented as first collaboration relationship, second collaboration relationship, and third collaboration relationship respectively through out the section. The collaboration patterns among the companies was studied in detail with reference to a specific collaboration relationship and the factors like nature of the collaborating company, country of the collaborator, collaboration areas, collaboration duration and basis for collaboration

were studied. All the sample companies were asked to provide details for atleast three collaboration relationships and thus for each of the three collaboration profiles the above mentioned factors were looked into.

Table No 5.1: Number of collaborations and the size of the company

Size of the company	Number of Collaborations			
	< 5	**6-10**	**>11**	**Total**
Big	0 (0.0 %)	3 (60.00%)	2 (40%)	5 (100%)
Medium	0 (0.0 %)	10 (90.90%)	1 (9.1%)	11 (100%)
Small	5(31.25%)	9 (56.25%)	2 (12.5)	16 (100%)
Total	5 (15.62%)	22 (68.75)	5 (15.62%)	32 (100%)

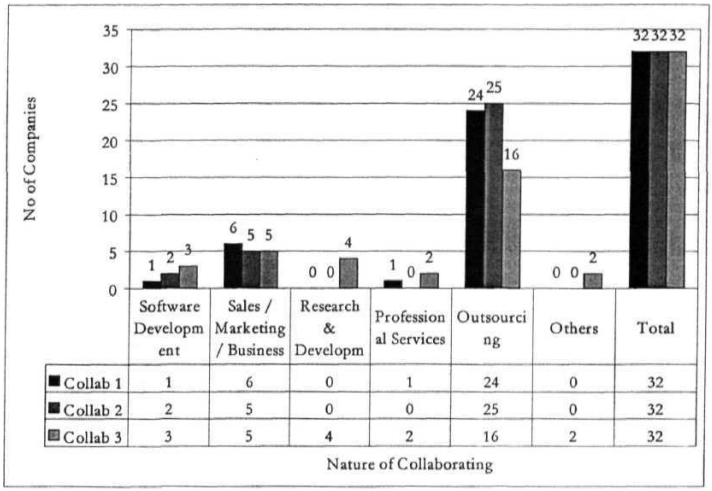
There seems to be a positive relationship between the size of the company and the number of collaborations. Table no 5.1 indicates that many of the big & medium companies have more than six collaborations when compared with small companies with less number of collaborations. From this it can be inferred that the bigger the size of the company more is the number of collaborations and the converse is also true, i.e., the number of collaborations is more for big companies. The average number of collaborations for the sample companies with foreign companies is 6.72 and with Indian companies is 3.13. The big (14.4 foreign & 0.4 domestic) companies tend to have more number of collaborations when compared with medium - (7.54 foreign & 3.27 domestic) and small (3.75 foreign & 3.87 domestic) companies. (see Table 5.1)

5.4 Nature of Collaborating Company

The organisation which is included in the study is designated as collaborating company and the organisation with which the collaborating company is establishing collaborative relationship is designated as collaborator's company. Thus the nature of collaborator's company is reflected by the business activity that the collaborator company is involved in. Companies are classified on the basis of the nature of business activities and they are- software development (Production), sales, marketing and business development, research and development, professional services, outsourcing and others. Majority of the companies in USA and Europe have been involved in outsourcing their software development work to Indian companies and thus they claim outsourcing management as their core competency. This was further established by the sample companies in the study with two-thirds of the companies collaborating with outsourcing companies.

In the first priority collaboration relationship 24 companies (75%) are collaborating with outsourcing companies, followed by six (18.75%) with business development companies, one (3.13%) with software development company and one (3.13%) with professional services company. Even in the second priority collaboration relationship 25 companies (78.13%) are collaborating with outsourcing companies followed by five (15.63%) with business development and two (6.25%) with software development companies. In the third collaboration relationship again 16 companies (50%) are collaborating with outsourcing companies followed by five (15.63%) with business development, four (12.5%) with research & development, three (9.37%) with software development, two (3.13%) with professional services and two (3.13%) with other companies. (see Chart No 5.1)

Chart No 5.1: Nature of collaboration and no of companies

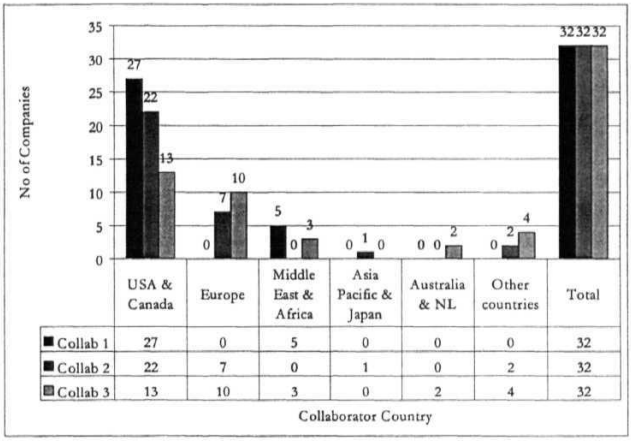


5.5 Country of incorporation of the collaborating company

Country of incorporation of the collaborating company is the country in which the collaborator company is incorporated or located. Indian software companies are known for executing outsourced work and companies across the globe have outsourced projects to Indian software companies. Collaborators of the companies in the sample are distributed across the world and three oldest collaboration relationships (in terms of date of commencement) are considered for the present study. They are as follow. For the first collaboration relationship 27 (84.37%) companies have their collaborator company in USA & Canada followed by five (15.63%) in Middle East & Africa. For the second collaboration relationship again 22 (68.75%) companies have their collaborator in USA & Canada followed by seven (21.88%) in Europe, one (3.13%) in Asia Pacific & Japan and two (6.25%) in other countries. For the third collaboration relationship there are only 13 (40.63%) companies

with collaborators in USA & Canada followed by 10 (31.25%) in Europe, three (9.38%) in Middle East & Africa, two (6.25%) in Australia & New Zealand and four (12.5%) in other countries. (see Chart No 5.2)

Chart No 5.2: Country of collaboration and no of companies



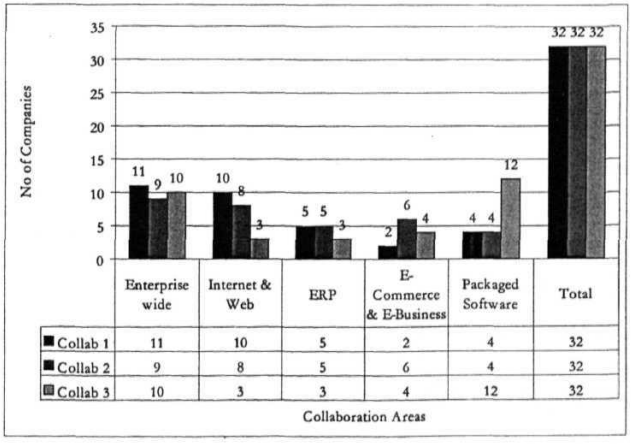
5.6 Areas of collaboration

Collaboration areas refer to the areas in software in which both collaborating and collaborator company have established the relationship. Companies in the sample, were having collaboration in different software areas like enterprise-wide applications, internet and web applications, enterprise resource planning, e-commerce & e-business and packaged software. The sample companies have demonstrated a pattern very close to the national trend (reported by Nasscom, 2000) with majority of the companies providing enterprise-wide solutions and in the study also it was found that one-third of the companies follow the

trend. This is followed by internet and web solutions both at the national level and among sample companies with one-third companies providing the internet and web solutions.

In the first collaboration relationship there were 11 (34.37%) companies collaborating in enterprise wide application, followed by 10 (31.25%) in internet & web applications, five(15.63%) in ERP, four (12.5%) in packaged software and two (6.25%) in e-commerce & e-business. In the second collaboration relationship nine (28.13%) companies were collaborating in enterprise wide applications followed by 18 (56.25%) in internet & web, 6 (18.75%) in e-commerce & e-business, 5 (15.63%) in ERP and 4 (12.5%) in packaged software. In the third collaboration relationship 10 (31.25%) companies were collaborating in enterprise-wide applications followed by 12 (37.5%) in packaged software, four (12.5%) in e-commerce & e-business, three (9.37%) each in ERP & internet & web applications. (see Chart No 5.3)

Chart No 5.3: Collaboration areas and no of companies



5.7 Collaboration Duration

Collaboration duration is defined as the period of collaboration relationship between the collaborating and collaborator company. The strength of collaboration relationship depends upon duration of the collaboration. All the 32 sample companies have an average of 12.54 years of collaboration duration and it is higher for big companies (22.6 years), near to medium companies (14.9 years) and less for small companies (9.46).

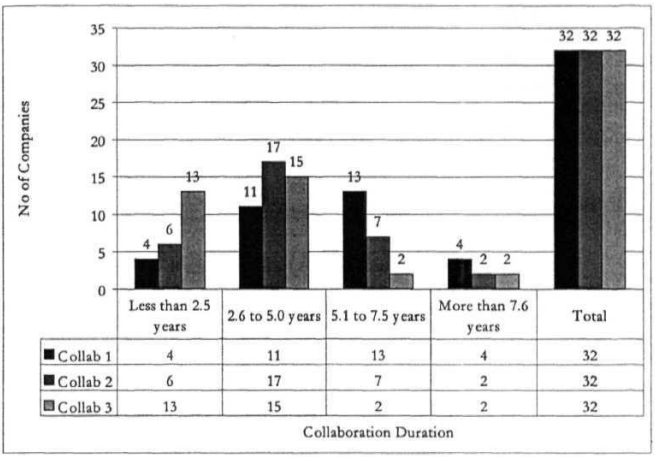
The relationship between collaboration duration and success of software development companies was summarized by a CEO of a medium software company:

> "the more the number of years spent in collaboration the more will be the comfort level between us. With passing of years in collaboration relationship we tend to keep-up our commitments and continuously strive to improve the efficiency in terms of time, effort, size and quality. So, I feel the more the duration of collaboration the more efficient will be software development"

The sample companies were asked to mention the duration of their collaboration with three main collaborators. The duration was classified in to four groups viz., less than 2.5 years, 2.6 to 5 years, 5.1 to 7.5 years and more than 7.6 years. In the first collaboration relationship there were 13 (40.63%) companies in the 5.1 to 7.5 years group followed by 11 (34.37%) companies in 2.6 to 5 years group and four (12.5%) each in less than 2.5 and more than 7.6 years group. In the second collaboration relationship there were 17 (53.13%) companies in 2.6 to 5 years group followed by seven (21.88%) companies in 5.1 to 7.5 years group, six (18.75%) in less than 2.5 years groups and two (6.15%) in more than 7.6 years group. In the third collaboration relationship there were 15 (46.88%) companies in 2.6 to 5

years group followed by 13 (40.63%) companies in less than 2.5 years group and two (6.25%) each in 5.1 to 7.5 years group and more than 7.6 years group. (see Chart No 5.4)

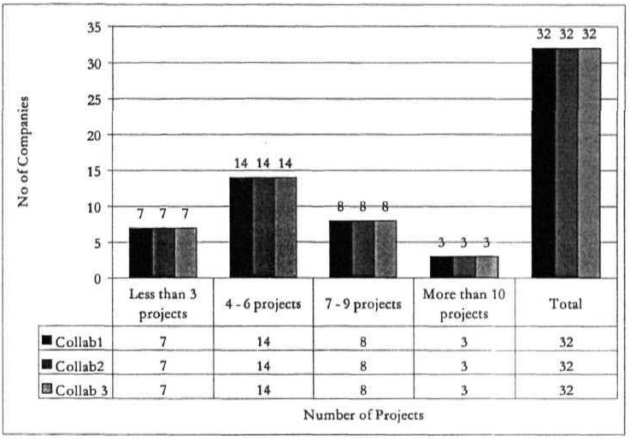
Chart No 5.4: Collaboration duration and no of companies



5.8 Number of Projects

Total number of projects executed during the last year in collaboration with the respective collaborator. The Indian software companies execute a number of projects for their collaborators located in different countries. Each year every software company executes projects for their collaborators. The number of projects are divided into four groups viz., less than 3 projects, 4 to 6 projects, 7 to 9 projects and more than 10 projects executed in the last financial year. In all the collaboration relationships there were 14 (43.75%) companies in 4 to 6 projects group followed by eight (25.0%) in 7 to 9 projects group, seven (21.88%) in less than 3 project group and three (9.37%) in more than 10 projects group. (see Chart No 5.5)

Chart No 5.5: Number of projects and no of companies

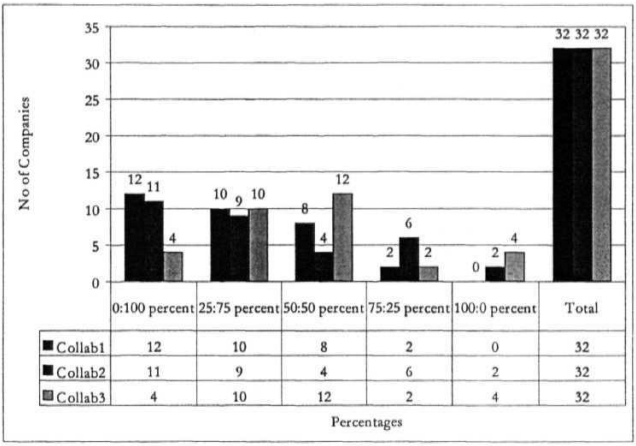


5.9 Collaboration Participation: Investment Ratio

In every collaboration relationship there are two important aspects where both the collaborators contribute certain percentage of financial investment and number of people participating in the project. Financial investment is the amount invested by the collaborating company for various reasons like Capital Investment, Infrastructure Building, Hardware & Software, Travel & Communication expenses, etc. for the execution of the project. The participation ratio is classified and divided into five groups viz., 0:100 percent, 25:75 percent, 50:50 percent, 75:25 percent & 100:0 percent as Indian company vs Foreign collaborator ratio. In the first category (0:100) there were 12 companies followed by 10 in 25:75 percent group, 8 in 50:50 percent group, and two in 75:25 percent group. In the second collaboration relationship there were 11 companies in 0:100 percent group followed by **nine** in 25:75 percent group, 6 in 75:25 percent group, four in 50:50 percent group and two in 100:0 percent group. In the third collaboration relationship there are 12 companies in 50:50

percent group followed by 10 in 25:75 percent group, 4 each in 0:100 & 100:0 percent group and two in 75:15 percent group. (Table 5.6)

Chart No 5.6: Collaboration participation (Investment) and no of companies

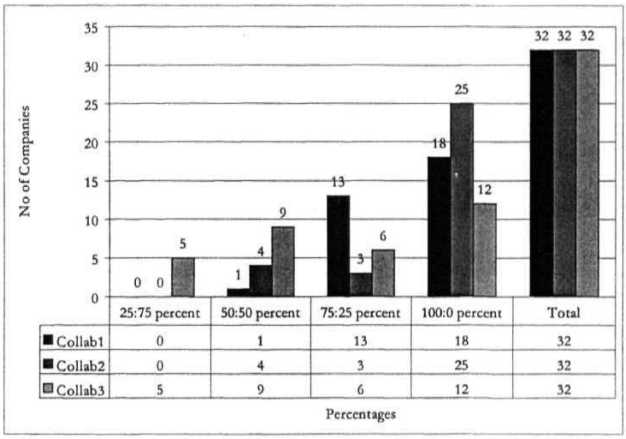


5.10 Collaboration Participation: People Ratio

The second important aspect of collaboration relationship is the number of people participating in the project execution from both the sides. The participation ratio is classified and grouped in the same way as in the case of Financial Investment Ratio Grouping. Interestingly there were no companies in the 0:100 percent group indicating that at any cost people from Indian companies must participate in the project execution. In the first collaboration relationship there were 18 (56.25%) companies in the 100:0 percent group followed by 13 (40.63%) in 75:25 percent group and one (3.13%) in 50:50 percent group. In the second collaboration relationship there were 25 (78.13%) companies in the 100:0 percent group followed by four (12.5%) in 50:50 percent group and three (9.37%) in 75:25 percent group. In the third collaboration relationship there were 12 (37.5%) companies inl00:0

percent group, followed by 9 (28.13%) companies is 50:50 percent group, 6 (18.75%) in 75:25 percent group and 5 (15.63%) in 25:75 percent group. (see Chart No 5.7)

Chart No 5.7: Collaboration participation (People) and no of companies



	25:75 percent	50:50 percent	75:25 percent	100:0 percent	Total
Collab1	0	1	13	18	32
Collab2	0	4	3	25	32
Collab3	5	9	6	12	32

5.11 Product Ownership and Intellectual Property Rights

The ownership pattern of the end products is not clearly established in most of the sample companies. According to the collaboration understanding and project agreements, the ownership rights of the products are clearly established. But in practice most of the Indian companies re-use large number of components / software items in the subsequent projects. Because of this factor most of the companies refused or avoided answering questions related to ownership or intellectual property rights. Nevertheless, the information was gathered through informal interviews and all the respondents had emphasized that the statements made by them should not be related with their names or associate with company's name. The general trend in the industry is that unless specified in the software development agreement, the product ownership is with the collaborator and if the product is

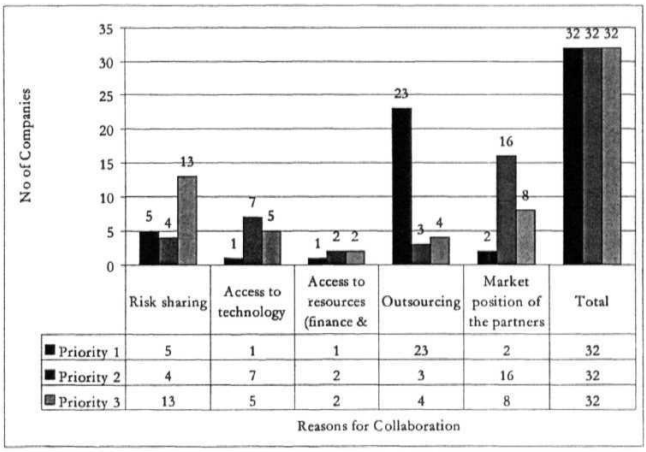
in a specialised area the collaborators were demanding the source code and force the collaborating company not to reuse the code or components. If both the participating companies share the investment, either finance or people, then the product will have joint ownership and the ratio of ownership will be based upon the investment and risk sharing. Most of the sample companies in the study have invested in terms of human resources and got the 25 per cent to 40 per cent ownership in the products that they have developed with the collaborator investing finance for infrastructure, hardware and software.

5.12 Reasons for Collaboration

The reasons for collaboration are the factors that make the collaborating company to go for a collaboration with the collaborator company. The sample companies were asked to mention the reasons for collaboration. The reasons revealed by the respondents are classified into the following groups viz., risk sharing, access to technology, access to resources (finance & human), outsourcing and the market position of the partners. When asked about their first priority of reasons 23 (71.88%) companies have mentioned outsourcing as the prime reason for collaboration followed by 5 (15.63%) for risk sharing, 2 (6.25%) for market position of the partner, one (3.13%) each for access to technology and access to resources. In the second priority as many as 16 (50%) companies have mentioned the market position of the partners as reason for collaboration followed by seven (21.88%) for access to technology, four (12.5%) for risk sharing, three (9.37%) for outsourcing and two (6.25%) for access to resources. In the third priority 13 (40.63%) companies have mentioned risk sharing as the prime reason for collaboration followed by eight (25%) for the market

position of the partners, five (15.63%) for access to technology, four (12.5%) for outsourcing and two (6.25%) for access to resources. (see Chart No 5.8)

Chart No 5.8: Reasons for collaboration and no of companies



5.13 Factors promoting collaboration

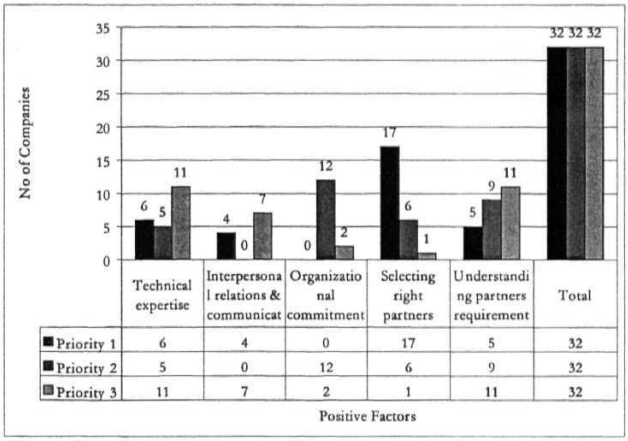
Factors promoting collaboration are those that contribute to the strength of the relationship and if they are present they make the collaboration relationship more stronger and if not present they do not affect the strength of the relationship. The sample companies were asked to mention the positive factors that contribute to the strength of the collaboration relationship. Seventeen (53.13%) companies have mentioned selecting the right partners as the top most positive factor followed by six (18.75%) as technical expertise, five (15.63%) as understanding the partners requirement, and four (12.5%) as interpersonal relations & commitment as their first priority. In the second priority 12 (37.5%) companies

have mentioned organisational commitment as the most important factor followed by nine (28.13%) as understanding the partners requirement, six (18.75%) as selecting the right partner and five (15.63) as technical expertise. In the third priority 11 (34.27%) companies have mentioned technical expertise and 11 (34.27%) have mentioned understanding the partners requirement as top factor, followed by seven (21.88%) as interpersonal relations & communication, two (6.25%) as organisational commitment and one (3.13%) as selecting the right partner. (see Chart No 5.9)

A Business Development Manager of a product development company has commented on ideal conditions promoting collaboration:

> To achieve the true benefits of collaboration, three things must occur: the benefits of collaboration need to be seen as important for the success of the organisation, and for all its members; the process of collaboration must be recognized and rewarded by the organization's personnel evaluation methods; and employees need to be trained in how to collaborate and how to use the tools for collaboration that are available.

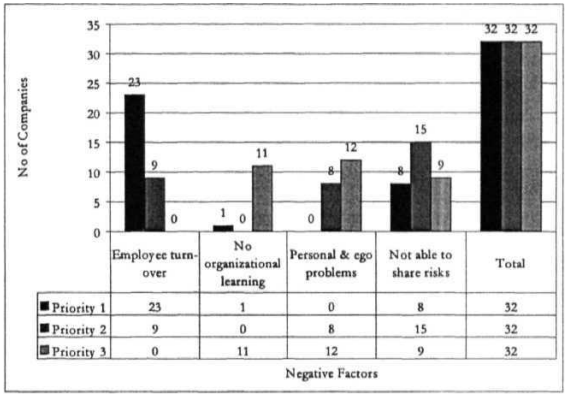
Chart No 5.9: Factors promoting collaboration and no of companies



5.14 Factors hindering collaboration:

Hindering factors are those if present weaken the collaboration relationship and if they are not present do not contribute the strength but nullify the effect on the collaboration relationship. Similarly when asked about the negative factors that hinder the strength of the collaboration, 23 (71.88%) companies have mentioned employee turnover as the prime reason followed by eight (25%) as 'not able to share risks' and one (3.13%) as no organisational learning. In the second priority 15 (46.88%) companies have mentioned 'not able to share risks', nine (28.13%) companies as employee turnover and eight (25%) companies as personal & ego problems, as the negative factors. In the third priority 12 (37.5%) companies have mentioned personal & ego problems, closely followed by 11 (34.37%) companies that have mentioned as no organisational learning and nine (28.13%) companies as 'not able to share risks' as the negative factors that weaken the strength of the collaboration. **(see Chart No 5.10)**

Chart No 5.10: Factors hindering collaboration and no of companies



5.15 Summary of Findings

The significance of the strength of the organisational collaboration is expressed with the help of a composite index called collaboration strength index (CSI). CSI is represented in quantitative terms on a scale of zero to one, zero signifying no strength in the collaboration relationship and one as the perfect collaboration relationship. As envisaged, around eighty per cent of the companies in the study had outsourcing as the basis for collaboration and seventy-five per cent of them have collaborated with American companies. Enterprise wide applications and web & internet applications are the prime areas for collaboration for sixty-five per cent of the companies. The study indicates that seventy-five percent of the companies have been collaborating since 2.6 to 7.5 years. Sixty-nine per cent of the companies have executed 4 to 9 projects with their collaborator during the last financial year i.e., 2000-01. More than two-thirds of the companies in the study have formed collaboration based upon the outsourcing relationship. In terms of investment participation,

one-third of Indian companies in the study have received 100 % investment from their collaborators and in terms of people, more than fifty per cent of the Indian companies have participated in collaboration with 100 % people.

Chapter 6: Organisational Learning

6. Organisational Learning

6.1 Introduction

Learning plays a significant role in the success of a software organisation. As mentioned earlier, technology development in the information technology industry is very fast and knowledge is widely distributed among the key players of the industry. The key input factor for this industry is human resource and key performance factor of human resources directly depends upon the learning potential and the knowledge-base that people possess in an organisation at a given point of time. Learning direcdy influences the performance and productivity of an organisation and thus plays an important role in software development. In the context of interorganisational learning mutual or reciprocal exchange of ideas and knowledge takes place and both the organisations benefit from the learning process. The significance of learning in software organisations can be assessed from the following excerpt from an interview with a chief knowledge officer of a big software service company:

> "To ensure that the entire work force is kept abreast of updates in process and technology, we implement the following procedures - A target of seven man-days of training per employee per year and training programmes ranging from Java to Yoga, aimed at overall development; Facilities to enhance individual skills and growth opportunities of employees; An atmosphere of easy, all-round communication with open-meetings between the chief executive and all levels of employees and Problem solving is treated as a collective responsibility where the rewards are shared among all ranks"

6.2 Collaboration and Learning

Companies pursue collaborations for a variety of reasons : to reach new customers and access new technologies, to pool capital, to share and reduce risk. Today, a new, and equally compelling reason has emerged: A growing number of companies are designing collaborations to do something more—that is, to change their organizations from being static prganisations to learning organisations. Through collaborations, these companies aim to learn new ways of doing business to gain insights into everything from specific market segment needs, to new technologies and innovative production processes. Companies that continue to focus solely on traditional alliance goals are shifting their focus to acquire new skills and knowledge.

While learning has always been an element of collaboration, traditionally it has been more or less a secondary concern. Now more organizations are making learning an explicit collaboration goal, right alongside the well-established economic objectives. Furthermore, this kind of learning is fundamentally different from the exchange of proprietary information typical of the joint ventures of earlier decades. The nature of alliances has fundamentally changed and in the present era there is far less incentive for one party to take advantage of the knowledge capital of the other through temporary alliances, because of an explicit intention to create shared value in the near term and more effective relationships in the future.

In the most recent Accenture Annual Alliance Issues and Trends survey, learning was cited as a critical goal in 41 percent of the alliances maintained by respondents, a fraction expected to exceed 50 percent by 2000. (Palmer,2000)

The deliberate focus on learning appears to be closely related to success with collaborations. The survey identified alliance "winners" that is, executives who report high levels of satisfaction with alliances and whose alliances have resulted in increased value. Results showed that such winners are almost five times more likely than non-winners to include "learning" as an explicit goal for their alliances. More than 80 per cent say that they have evaluated the changing nature of alliance learning and adjusted their practices accordingly, compared to just 37 percent of non-winners. And surveyed alliances that have explicit learning objectives ultimately generate twice the market value, on average, than non-learning-oriented alliances. (Palmer,2000)

6.3 **Reasons for** Learning

Every organisation has its own reason to learn or not to learn. All the software companies in the study have agreed that learning is the key differentiating factor of success and this was stated by a human resource manager of a multi-national company:

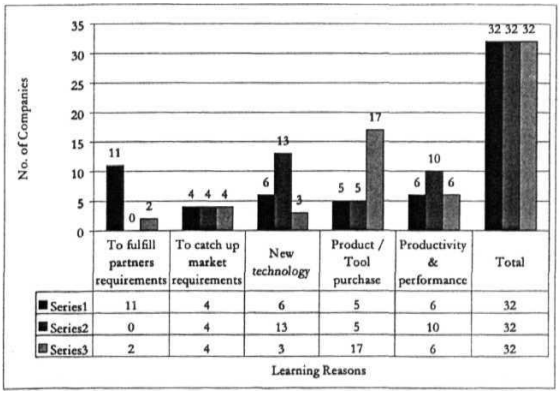
> "Only the learning organi2ations can cater to today's dramatic demands quickly and not only will the global market reward learning, it will severely punish the lack of learning"

When asked about the reasons for the organisational learning as many as 11 (34.37%) companies have mentioned fulfillment of partners requirement as the prime reason followed by six (18.75%) as improvement of productivity & performance, another six (18.75%) as new technology, five (15.63%) as product purchase and four (12.5%) as catching up with market requirements as their first priority. In the second priority 13 (40.63%) companies have mentioned that new technology has driven them to go for organisational learning

followed by 10 (31.25%) as productivity & performance improvement, five (15.63%) as product purchase and four (12.5%) as catching up with market requirements as the reasons for organisational learning. In the third priority 17 (53.13%) companies have mentioned product purchase, six (18.75%) as productivity & performance improvement, four (12.5%) as catching up with market requirements, three (9.37%) as new technology and two (6.25%) as fulfilling partners requirement. (see Chart No 6.1) Finally the real need for learning was explained by a CEO of a software company in the study who returned from London:

> "Organisational learning is essential because, only it can survive tomorrow's knowledge-based economy, only it can manage tomorrow's intense global competition, only it can cope with tomorrow's rapid fire technological changes, only it can handle tomorrow's demanding and fragmented markets and only it can build a people-based work system in a company"

Chart No 6.1: Reasons for Learning



6.4 Nature of Collaboration in Learning

The focus areas of the collaborating company form the primary business concern of the collaborator company. The software companies have entered into collaboration with different companies for the purpose of organisational learning and the focus areas of these collaborators are as follow: Software development, education & training, research & development, product selling, consultancy, individual and others. Majority of the software companies collaborate with training institutes in the same city. This is evident from the statement made by the head of corporate learning center of a major software company:

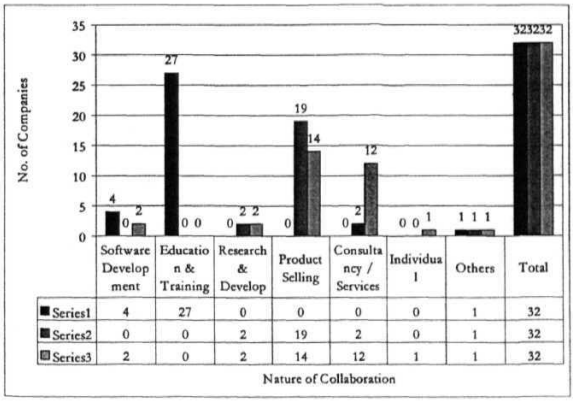
> "We have identified the best software training institutes in the city for each technology area and our company has entered into collaboration with these companies for specific areas. For example, for all Microsoft technologies we have three partners who will cater to our training needs round the year."

In the first priority 27 (84.37%) companies have collaborated with educational & training companies followed by four (12.5%) with software development companies and one (3.13%) with any other company. In the second priority 19 (59.37%) companies have collaborated with product selling companies followed by two (6.25%) with research & development, another two (6.25%) with consulting and one (3.13%) with any other company. In the third priority 14 (43.75%) companies have collaborated with product selling companies closely followed by 12 (37.5%) with consulting companies, two (6.25%) each with software development and research & development, one (3.13%) each with individual and any other company. (see Chart 6.2) Some companies in the study have gone beyond the traditional methods of learning and entered into collaboration with organisations in different fields to explore the new frontiers of technologies. The following statement from

the annual report (2000) of Satyam Computers Services limited, Hyderabad makes this point clear:

> "Bioinformatics is a growing industry, and IT has a significant role to play in its growth. Satyam has focus on building new competencies in this field, through a strategic alliance with Center for Cellular and Molecular Biology, Hyderabad (CCMB) --a world recognized bio-tech R&D organization. CCMB will bring domain expertise to the alliance whereas Satyam will manage the client relationship and the business unit. Satyam is also aligning itself with leading universities in India and abroad to offer continuous training to its associates in this area."

Chart No 6.2: Nature of Collaborative Learning

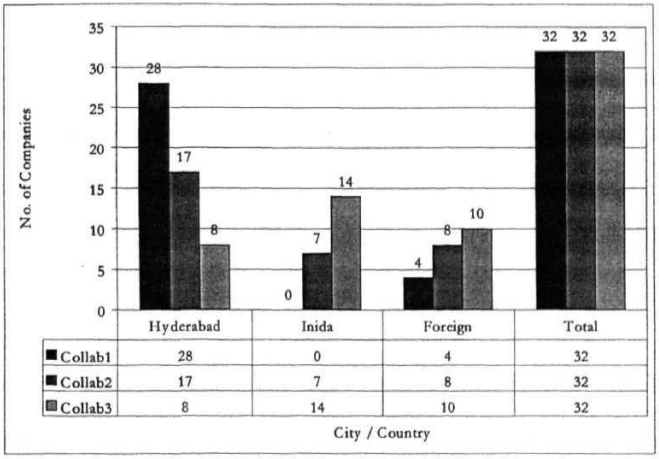


6.5 City/Country of incorporation of collaborating company

City/country of incorporation of collaborating company is the city/country in which the collaborator company is incorporated or located and will indicate the reach of the collaborating company (Indian) in selecting a learning partner. Collaborators of the

companies in the sample are distributed across the world, including Hyderabad and three oldest collaboration relationships for learning (in terms of date of commencement) are considered for the present study. Majority of the collaborating companies for organisational learning were located in Hyderabad. In the first priority as many as 28 (87.5%) companies were Hyderabad-based and four (12.5%) are in other countries. In the second priority 17 (53.13%) were Hyderabad based, eight (25%) were based overseas and seven (21.88%) outside Hyderabad in India. In the third priority there were 14 (43.75%) companies that were located outside Hyderabad within India, 10 (31.25%) foreign based and eight (25%) were Hyderabad based. (see Chart No 6.3)

Chart No 6.3: City/Country of incorporation of collaborating company



6.6 Learning Methods

Learning methods are those which are adopted by the collaborating company in the process of acquiring the knowledge and skill for software development. Some of the most

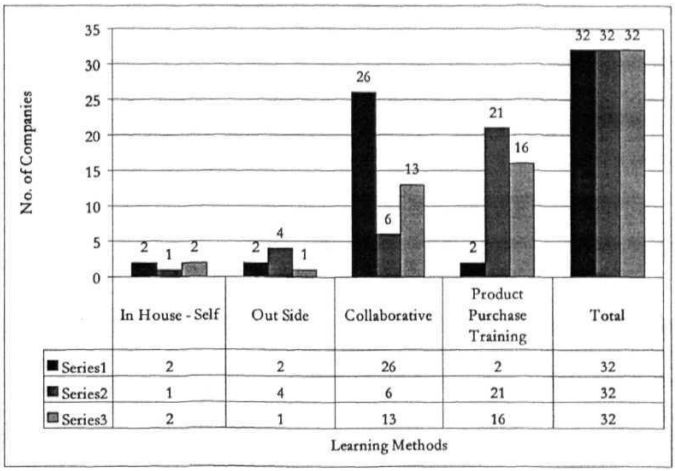
significant methods are in-house-self, outside collaborative and product purchase training. In-house training is training people with the help of expertise of people within the organisation. This method is essentially used to train newly recruited people as trainees and the experienced people in the company are used to train these trainees. Outside training is essentially used to acquire particular skill required to develop a specific software when in-house expertise is not available in that area. Collaborative training is used when the company makes use of the collaborating company's experience in the technical areas for developing software. This is done by interactive learning methods between the collaborator and collaborating companies. Product purchase training is used when a company purchases a particular tool or product from a collaborator company, the collaborator company sends some of its experienced people to train the collaborating company people in that specific technology domain. Each learning method is best suited for a specific nature of technology and this was explained by a corporate trainer in a corporate training institute:

> "In-house training is suited for old and established technologies where many people are available internally; when companies have no infrastructure and trainers, outside training is best suited and collaborative learning is best suited for platform based technologies like Microsoft, Oracle, Java and IBM"

Majority of the companies in the study are adopting collaborative learning methods and in the first priority 26 (81.25%) companies have chosen collaborative learning method followed by two (6.25%) each in-house self, outside and product purchase training. In the second priority 21 (65.63%) companies have adopted product purchase training as their prime learning method followed by six (18.75%) as collaborative, four (12.5%) as outside and one (3.13%) as in-house self. In the third priority 16 (50%) companies have chosen

product purchase training, 13 (40.63%) as collaborative learning, two (6.25%) as in-house self and one (3.13%) as outside learning method. (see Chart No 6.4)

Chart No 6.4: Learning Methods



6.7 Organisation of Learning

Organisation of learning is the process adopted by the companies in acquiring the required skills for software development. The most important modes of learning are formal-in-house, formal-individual-outside, formal-organisational-in-house, informal-individual. Formal-individual-in-house is when an individual is identified and trained for a specific reason in specified technologies and trained in- house with the help of experienced people with in the organisation. Formal-individual-outside is same as the above but the identified individual is sent outside for the purpose of learning when the required competencies are not available with in the organisation. Formal-organisational-in-house is when a group of people are identified and trained for a specific reason in specified technologies and trained in house

with the help of experienced people with in the organisation. Informal-individual is when an individual is given permission to learn himself either inside or outside in specific technologies for specified reason. Majority of the companies have adopted 'formal-in-house' training method and many companies in the sample believe that it is very cost-effective and time saving. This was described by a HR Manager in a medium software company:

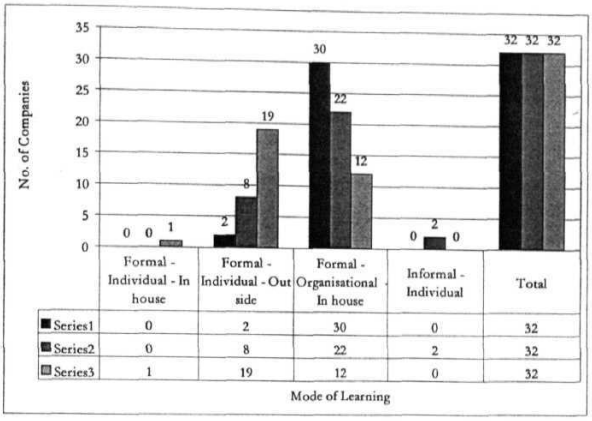
> "When we conduct internal training with existing people (formal-in-house) it is very cost effective for us. We can use the existing infrastructure and with available experts within the company that will result in lot of time saving. The best part of it is we (HR people) can monitor the training programs and keep them under control"

Thirty companies (93.75%) in the study have formal organisational in-house as the prime mode of organisational learning in the first priority followed by two (6.25%) companies as formal individual outside. In the second priority there are 22 (68.75%) companies that have chosen formal organisational in-house mode of learning followed by eight (25%) as formal individual outside and two (6.25%) as informal individual. In the third priority 19 (59.37%) companies have chosen formal individual outside as the prime learning mode followed by 12 (37.5%) as formal organisational in-house learning mode. (see Chart 6.5)

Training Centers
Our Company has training centers at the new facility at Infocity, Madhapur with 7 training halls with state-of-art infrastructure and faculty for Computer Based Training. These will host all the Training
& Development programs for our Associates.

Source: Annual report (2000-01) of Infotech Enterprises limited, Hyderabad.

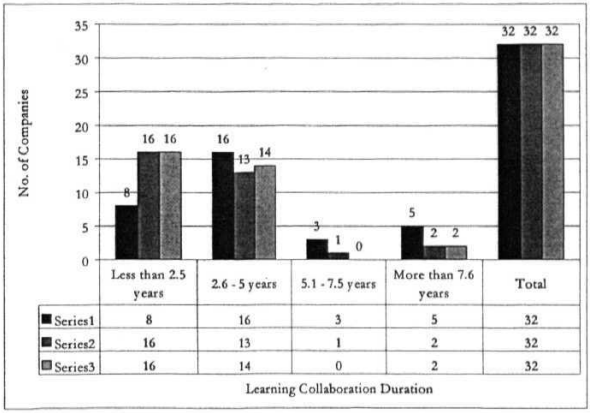
Chart No 6.5: Organisation of Learning



6.8 Duration of Collaboration for Learning

Organisations collaborate for learning and the period of collaboration in number of years is expressed as duration of collaboration for learning. The duration of the collaboration for learning has been classified into four groups viz., less than 2.5 years, 2.6-5 years, 5.1-7.5 years and more than 7.6 years. In the first category there were 16 (50%) companies in the 2.6-5 years group followed by eight (25%) in less than 2.5 years group, five (15.63%) in more than 7.6 years and three (9.37%) in 5.1-7.5 years group. In the second category there were 16 (50%) companies in the less than 2.5 years group followed by 13 (40.63%) in 2.6-5 years group, two (6.25%) in more than 7.6 years and one (3.13%) in 5.1-7.5 years group. In the third category there were 16 (50%) companies in the less than 2.5 years group followed by 14(43.75%) in 2.6-5 years group and two (6.25%) in more than 7.6 years at the time of study. (see Chart No 6.6)

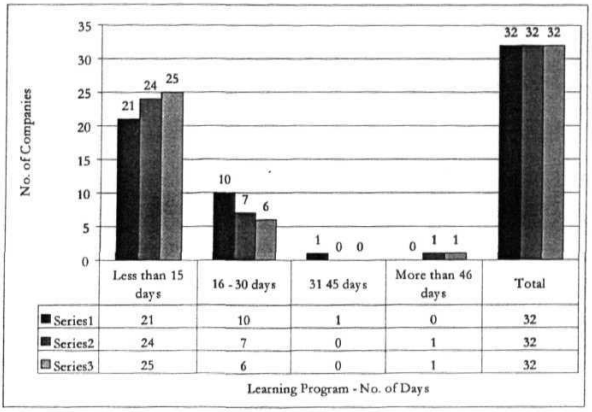
Chart No 6.6: Duration of Collaboration for Learning



6.9 Learning Program - Number of Days

The details of the learning programs of the companies along with duration of the learning program have been gathered and the number of people attended was collected. The duration of the program is classified and divided into four groups vi2., less than 15 days, 16-30 days, 31-45 days and more than 46 days. In the first priority 21 (65.63%) companies have conducted programs for less than 15 days duration followed by 10 (31.25%) companies for 16-30 days duration and one (3.13%) company for 31-45 days duration. In the second priority 24 (75%) companies have conducted programs for less than 15 days duration followed by 7 (21.88%) companies for 16-30 days duration and one (3.13%) company for more than 46 days duration. In the third priority 25 (78.13%) companies have conducted programs for less than 15 days duration followed by 6 (18.75%) companies for 16-30 days duration and one (3.13%) company for more than 46 days duration (see Chart No 6.7)

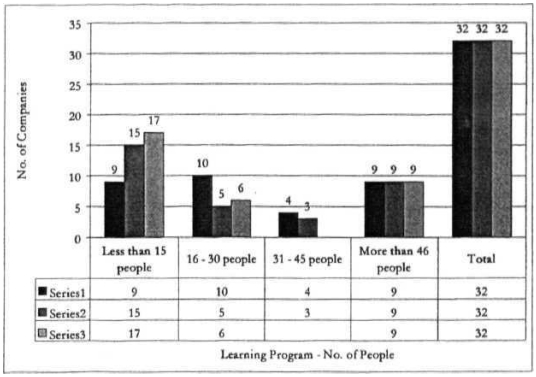
Chart No 6.7: Learning Program - Number of Days



6.10 Learning Program - Number of People

The details of the learning programs of the companies along with number of days the program has been conducted and the number of people attended was collected. Number of people who attended the program is classified into four groups viz., less than 15 people, 16-30 people, 31-45 people and more than 46 people. In the first priority there are 10 (31.25%) companies in the 16-30 people group followed by 9 (28.13%) each in less than 45 and more than 46 people group and 4 (12.5%) in 31-45 people group. In the second priority there are 15 (46.88%) companies in the less than 15 people group followed by 9 (28.13%) companies in more than 46 people group, 5 (15.63%) in 16-30 people group and 3 (9.37%) in 31-45 people group. In the third priority there are 17 (53.13%) companies in the less than 15 people group followed by 9 (28.13%) companies in the more than 46 people group and 6 (18.75%) in 16-30 people group. (see Chart 6.8)

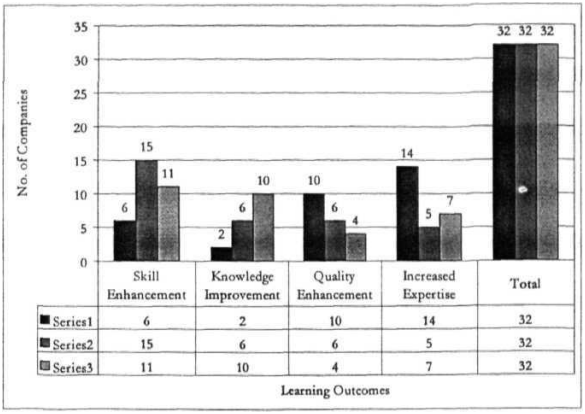
Chart No 6.8: Learning Program - Number of People



6.11 Learning Outcomes

Learning outcomes are the results of the learning programmes conducted by the software companies . The outcomes of the learning programs are as follow: skill enhancement, knowledge improvement, quality enhancement and increased expertise. In the first priority 14 (43.75%) have mentioned increased expertise, 10 (31.25%) companies as quality enhancement, six (18.75%) as skill enhancement and two (6.25%) as knowledge enhancement as learning outcomes. In the second priority 15 (46.88%) companies have mentioned skill enhancement, six (18.75%) each as knowledge improvement and quality enhancement and five (15.63%) as increased expertise as the learning outcomes. In the third priority 11 (34.37%) companies have mentioned skill enhancement, 10 (31.25%) as knowledge improvement, seven (21.88%) as increased expertise and four (12.5%) as quality enhancement. (see Chart 6.9)

Chart No: 6.9 Learning Outcomes



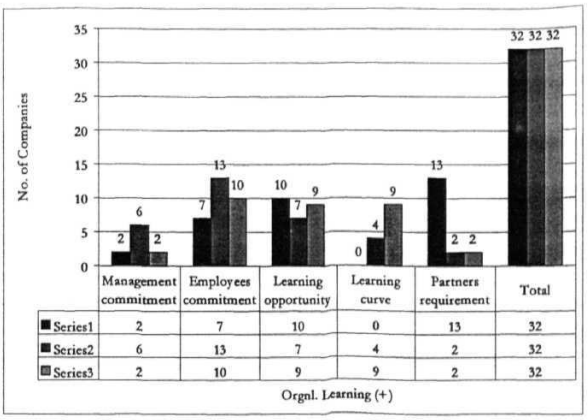
From this, we conclude that learning is seen by majority as an opportunity to improve one's expertise and quality of production of the company. This indicates that quality of production is more dependent on collaboration and collaborative learning and thus positively related to it. Productivity, quality that are indicators of software technology development thus seem to be positively related to organisational learning-

6.12 Positive Factors in Organisational Learning

There are some positive factors which contribute to the organisational learning process and they are as follow: Management commitment, employees commitment, learning opportunity, learning curve and partners requirement. In the first priority 13 (40.63%) companies mentioned partners requirement as the prime positive factor followed by 10 (31.25%) as learning opportunity, seven (21.88%) as employees commitment and two (6.25%) as management commitment. In the second priority 13 (40.63%) companies mentioned employees commitment, seven (21.88%) as learning opportunity, six (18.75%) as

management commitment, four (12.5%) as learning curve and two (6.25%) as partners requirement. In the third priority 10 (31.25%) companies mentioned employees commitment followed by nine (28.13%) each as learning opportunity and learning curve and two (6.25%) each as partners requirement and management commitment. (see Chart No 6.10)

Chart No 6.10: Positive Factors in Organisational Learning



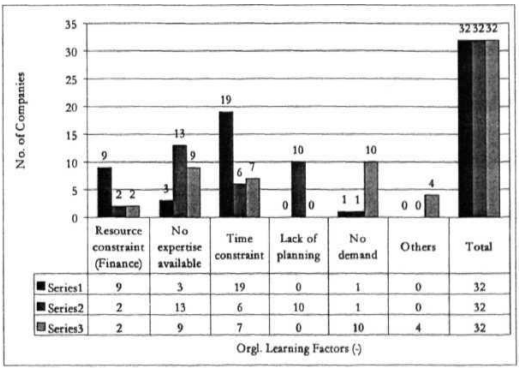
The real challenge of organisational learning was stated by a HR Manager in-charge of corporate training:

> "The challenges of Organisational learning are as follow: make learning one of the fundamental values of the company; commit major resources and adequate time to training; use training to bridge the gap with the external world; integrate training into initiatives for change management; use training as a developmental tool for individuals; link organizational, operational, and individual training needs; install training systems that substitute work experience; ensure that training allows the Soft skills to bloom; use retraining to continuously upgrade employees' skills and create a system to evaluate the effectiveness of training"

6.13 Negative factors in Organisational Learning

Similarly there are some factors that hamper the organisational learning process and they are as follow: Financial resource constraint, un-availability of expertise, time constraint, lack of planning and lack of demand. In the first priority 19 (59.37%) companies mentioned time constraint as the prime reason followed by nine (28.13%) as financial resource constraint, three (9.37%) as un-availability of expertise and one (3.13%) as lack of demand. In the second priority 13 (40.63%) companies mentioned un-availability of expertise, 10 (31.25%) as lack of planning, six (18.75%) as time constraint, two (6.25%) as financial resource constraint and one (3.13%) as lack of demand as the negative factors in the organisational learning. In the third priority 10 (31.25%) companies mentioned lack of demand, nine (28.13%) as un-availability of expertise seven (21.88%) as time constraint, four (12.5%) as other reasons and two (6.25%) as financial resource constraint. None of the companies seems to have financial constraint as the primary constraint. (see Chart No 6.11)

Chart No 6.11: **Negative Factors in Organisational Learning**



Most software companies are faced with some serious issues that seem to constrain the opportunity to learn through collaborations. This was stated by a vice-president of an MNC based in Hyderabad:

> "First, there is usually a limited training budget, which focuses primarily on technical training. Second, rapid change in communication and computing technology means that investments in information technology are expensive but prone to more rapid obsolescence."

6.14 Summary of Findings

Learning plays a significant role in the success of an IT organisation. As mentioned earlier technology development in the IT industry is very fast and knowledge is widely distributed among the key players of the industry. The key input factor for this industry is human resource and key performance factor of human resources directly depends upon the learning potential and the knowledge base that people possess in an organisation at a given point of time. Learning directly influences the performance and productivity of an organisation and thus plays an important role in software development.

Still majority of the Indian software companies learn only when there is compulsion from their collaborating partner and one-third of the companies have confirmed this factor. Only one-fifth of them are interested in learning a new technology and equal number of companies finally take it for productivity & performance improvement. For learning eighty-five per cent of the companies in the study have partnered with an education and training company to fulfil their learning requirements with ninety per cent of them being located in Hyderabad. More than ninety per cent of the companies have adopted Formal-

organisational in-house training method as this method is more productive and cost-effective. Fifty per cent of the companies have been collaborating for learning since 2.6 to 5 years. Around sixty-five per cent of the companies have conducted programs for less than 15 days duration and thirty per cent of them have conducted for 16-30 day duration. One-third of the companies preferred a training program with a strength of 30 people as this is the ideal span of control for formal-in-house training.

A quote from an interview with vice-president -human resources will summarise the essence of organisational learning-

> "Organizational learning is an active philosophy and not merely an organizational system which believes that its only competitive advantage is learning, encourages people to learn to produce the results they desire, nurtures creative and innovative patterns of collective learning and develop fresh organizational capabilities all the time"

Chapter 7: Software Development

7. Software Development in the Companies in the Study

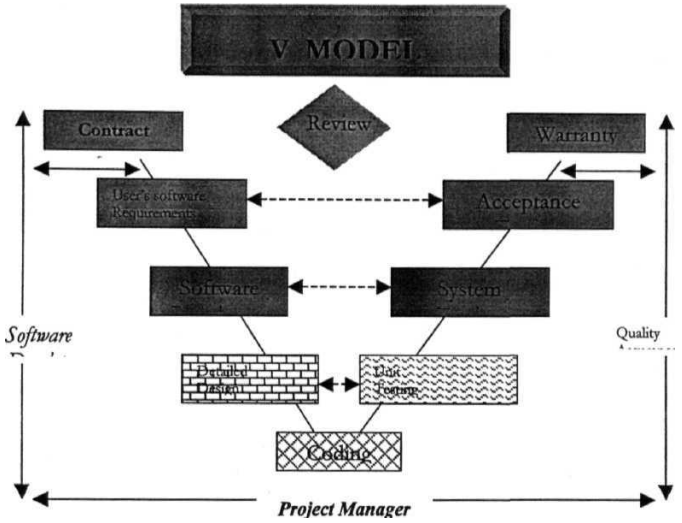
7.1 Introduction

The primary objective of software companies is software development and the inputs for this are people and technology, the process includes learning and development of software and the outcome is software products. There are three significant factors which contribute to the success of 'software development' and they are - time, effort and magnitude of software projects. Time is measured in terms of calendar days, effort in terms of man-days and magnitude in terms of functional points or Kilo Lines of Code (KLOC). For the purpose of the present study, the magnitude was measured in functional points only.

7.2 Software Development Process

The objective of the present section is to define how a full life cycle development project shall be extended. Each development project that is taken up by the Company may go through all the phases of the Software development Life Cycle (SDLC) which is detailed in this section, or may go through only certain phases of SDLC. For instance, a project may encompass only coding and unit testing phases based on the customer's requirements. The phases that will be followed during the course of the project will have to be detailed in the Software Development Plan (SDP) for the project.

Figure 7.1: Software development methodology



Phase 1 - User's Requirements

In this phase, the information about the user's software requirements shall be gathered and documented in the Quality Management System (QMS) standard format. Discussions shall be held to understand the user's software requirements. A decision has to be taken as whether the acceptance testing is done by the customer or by the Company. The software requirements shall be documented in Company's QMS standard format. The documentation shall use the terms familiar to the customer and encompass the entire functionality of the product as foreseen by the customer. Acceptance Test Plan (ATP) and Acceptance Test Cases (ATC) shall be formulated against the baseline version of User Requirement Document (URD), in case the Acceptance Testing is Company's responsibility.

Phase **2-** Software **Requirement Specifications (SRS)**

In this phase, the User's requirements shall be converted to implementation specific statements. The user-interface shall also be detailed here. The screen dumps of input/ output interfaces, menus etc. may be included where necessary. The user's software requirements shall be thoroughly understood to convert to Company specifications. The software requirements specifications shall be documented in Company's QMS standard format. The documentation shall use the implementation specific terms for the ease of understanding for the designers and developers. A traceability matrix shall be established to map the user's requirement may be fulfilled by one or more software requirement specifications. The SRS shall be on par with the base-line URD. System Test Plan (STP) shall be prepared to validate the functionality of the product. Corresponding System test Cases shall be documented with the base-line SRS as the reference

Phase 3 High Level Design

In this phase, the major modules in the software shall be identified, and High Level Design Documents (HLD) shall be prepared for each of the modules. The interdependencies across the modules shall be documented. The high level design and detailed design phases may be combined into one integrated design phase, if required, based on customer requirements. In this case, the Integrated Design Document (IDD) shall be prepared, and the integration testing phase may be waived. This shall be document in SDP. The major modules shall be identified based on the functionality and design documents shall be prepared for each of the modules.

Phase 4 Detailed Design Document (DDD)

In this phase, each module shall be granuli2ed to simple units, and design specifications shall be prepared for each unit. Unit Test Plan (UTP) and Unit Test Cases (UTC) shall be prepared for each of these Units. The granular units of the product shall be identified and design specifications shall be documented. Unit Test Plan and Unit Test Cases shall be formulated. The Detailed Design Documents are prepared in Company's QMS standard format. Unit Test Plan and Unit Test Cases are documented against the base-lined input documents.

Phase 5 Coding and Unit Testing

In this phase, coding shall be done following the Programming standards. The coding shall be carried out at each DDD level, code review shall be done and the code shall be unit tested. The programming standards to be used shall be identified. GUI standards, if applicable, shall be indicated. Programmers, Code Reviewers and Unit Testing team **shall be** aware of the relevant DDDs. Unit Test Plan and Unit Test Cases shall be in **place.**

Phase 6 - Integration Testing

In this phase, the product shall be tested module- wise and the interdependencies among the modules shall be validated. The ITPs and ITRs that are drafted at the High Level Design phase shall be reviewed and approved before this phase begins. The Integration Testing Reports (ITRs) shall be generated.

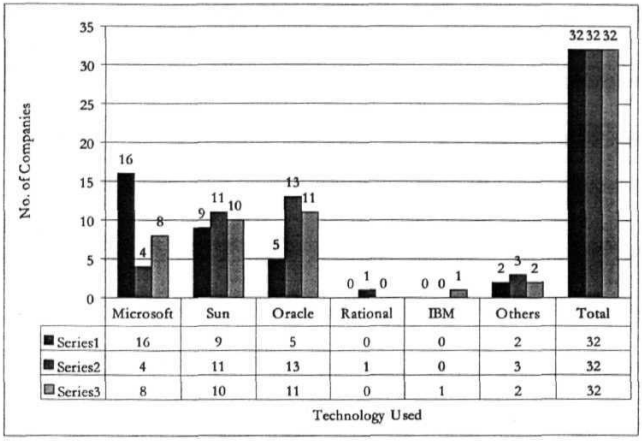
Phase 8 - Acceptance Testing

The final product shall be validated against the user requirements, acceptance criteria and acceptance data.

7.3 Technology Used

Software companies in the study used different combinations of tools & technologies for developing software. Broadly these tools & technologies can be classified as follows — Microsoft, Sun, Oracle, Rational, IBM and others. For example the broad group Microsoft indicates that the operating system is windows based, the application development tool is visual studio, web server is IIS, database is MS SQL Server and tools & technologies packages under the brand name of Microsoft. Similarly other broad technology groups indicate the usage of tools & packages under that brand name. Most commonly these tools & packages are used in combination. Primarily these groupings are representation of broad usage of tools & packages under three priorities. In the first priority 16 (50%) companies were using Microsoft platform followed by nine (28.13%) companies using Sun platform, five (15.63%) companies were using Oracle platform and two (6.25%) companies were using other technologies at the time of the study. In the second priority 13 (40.63%) companies were using Oracle platform, 11 (34.37%) companies were using Sun platform, four (12.5%) were using Microsoft platform, three (9.37%) companies were using other technologies and one (3.13%) company was using Rational platform. In the third priority 11 (34.37%) companies were using Oracle platform followed by 10 (31.25%) companies using Sun platform, eight (25%) companies were using Microsoft platform, two (6.25%) companies were using other technologies and one (3.13%) company was using IBM platform. (see Chart 7.1)

Chart No 7.1: Technology Used for Developing for Software



7.4 Nature of Technology Development

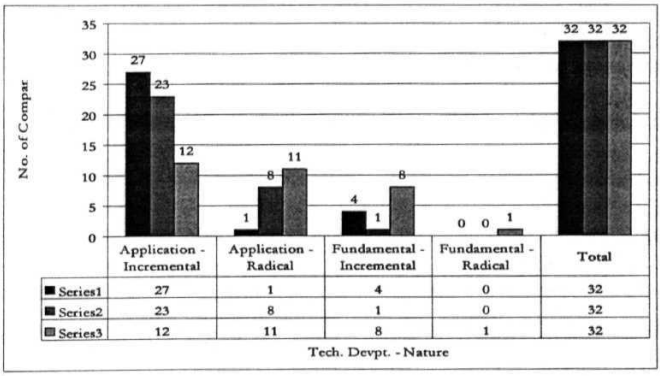
Technology development may be classified on the basis of two criteria — (a) the content of technology and (b) quantity of change. The second relates to gradualist quantitative or a radical qualitative. Gradual - qualitative development takes place in a phased manner over time, whereas radical — quantitative indicates a qualitative shift from one kind of technology to another. If the technology development area is at systems level it is called "fundamental development" and if the nature of technology that has been developed is used for general business applications it is called "application development". If the technologies are developed over a period of time in phased manner with some additions and improvements in every phase of development it is called "incremental development" and if the same is done at a time it is called "radical development". Based upon the above two classifications the nature of technology that has been developed can be divided into four groups as shown in the following table.

Table 7.1: Technology Development Areas

	Application	Fundamental
Incremental	Application Incremental	Fundamental Incremental
Radical	Application Radical	Fundamental Radical

The majority of 27 companies (84.37%) were involved in developing software in the area of application - incremental as the top priority activity, four (12.5%) in the fundamental - incremental area and one (3.13%) in the application - radical area. In the second priority there were 23 (71.88%) companies in the application - incremental area, eight (25%) in the application — radical area and one (3.13%) in the fundamental — incremental group. In the third priority there were 12 (37.5%) companies in the application — incremental area followed by 11 (34.37%) in the application - radical area, eight (25%) in the fundamental - incremental area and one (3.13%) in the fundamental — radical area. (see Chart No 7.2)

Chart No 7.2: Nature of Technology Development

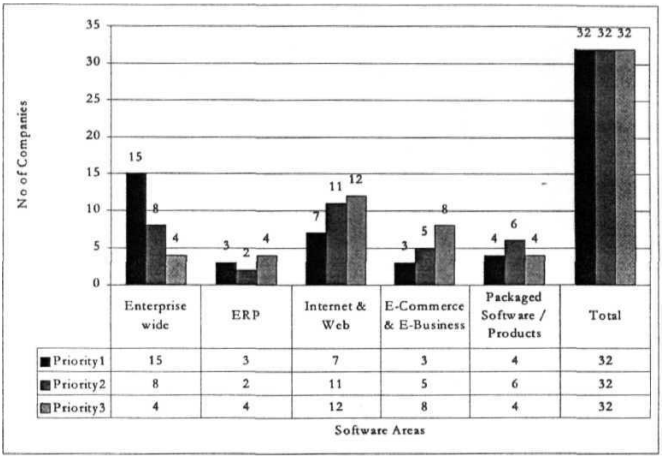


7.5 Software Development Areas of the Companies in the Study

Every software company has core competencies in terms of specific software development area and takes up projects only in those areas. These core competencies go along with the brand name of the company and the customers evaluate the software companies based upon the factors like - number of similar projects executed and number of people with similar project experience. Software Areas are the technical segments in which the companies are offering technical services like: Enterprise-wide Solutions, Enterprise Resource Planning (ERP), Internet & Web base Solutions, E-commerce & E-business Solutions and Packaged Software Products. *(This* technical segmentation is followed by default by industry association like Nasscom & STPI) as industrial standard. (Nasscom, 2002)

The companies were asked to prioritise their technical service areas according to the above technical segments. Forty-seven percent of the companies have mentioned enterprise wide solutions as their first priority followed by 21.9% offering internet & web solutions, whereas the same internet & web solutions is expressed as second and third priorities by 34.4% and 37.5% of the companies respectively. Enterprise wide solutions were reported as second and third priorities by 25% and 12.5% of the companies respectively. Similarly, packaged software products was as first priority for 12.5% of the companies and as second and third priority for 18.8% and 12.5% of the companies. E-commerce and E-business solutions were the first priority in the case of 9.37% of the companies. (see Chart 7.3)

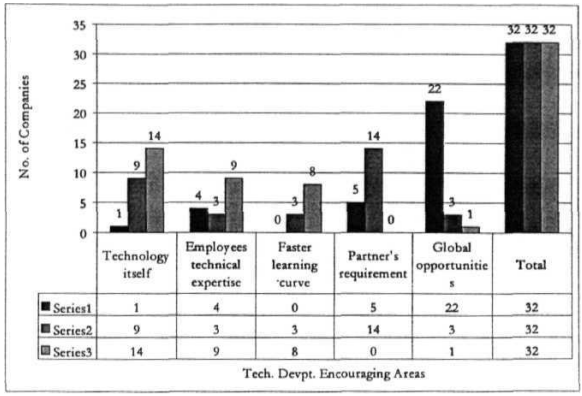
Chart 7.3: Software Development Areas of the Companies



7.6 Encouraging Areas in Software Development

Encouraging are those which contribute to the strength of software development process. When asked about the encouraging areas in technology development 22 (68.75%) companies mentioned global opportunities as the prime reason followed by five (15.63%) as partners requirement, four (12.5%) as employees technical expertise and one (3.13%) as technology itself as their first priority. In the second priority 14 (43.75%) companies mentioned partners requirement, nine (28.13%) as technology itself, three (9.37%) each as employees technical expertise, faster learning curve and global opportunities as the encouraging areas in the technology development. In the third priority 14 (43.75%) companies mentioned technology itself as the prime area followed by nine (28.13%) as employees technical expertise, eight (25%) as faster learning curve and one (3.13%) as global opportunities. (see Chart No 7.4)

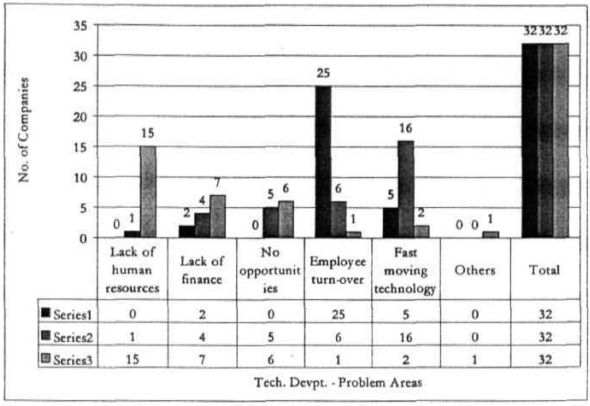
Chart No 7.4: Encouraging Areas in Software Development



7.7 Constraints in Software Development

Constraints are those which hamper the process of software development. When asked about the constraints of software development 25 (78.13%) companies ranked employee turnover as the first constraint, followed by five (15.63%) who ranked constraints in coping with fast moving technology and two (6.25%) ranked lack of finance as their first constraint. In the second rank 16 (50%) companies mentioned fast moving technology, six (18.75%) as employee turnover, five (15.63%) as no opportunities, four (12.5%) as lack of finance and one (3.13%) as lack of human resources as the problem areas in technology development. In the third rank 15 (46.88%) companies mentioned lack of human resources, seven (21.88%) as lack of finance, six (18.75%) as no opportunities, two (6.25%) as fast moving technology and one (3.13%) each as employee turnover and other reasons. (see Chart No 7.5)

Chart No 7.5: Constraints in Software Development



7.8 Software Development Projects - Size

The size of the software project is generally measured in terms of the number of functional points or number of kilo lines of code. For the purpose of the present study the number of functional points is taken as the measure of size of software project. The big companies had an average of 855.4 estimated functional points and 855.4 actual functional points delivered without any gap between the estimated and the actual functional points. However in case of medium size companies the average functional points estimated were 114.73 and they had actually delivered 137 functional points, thus over shooting the estimated functional points by 18.56% as compared to the actual functional points delivered. The small size companies tend to show a huge difference. The difference between the average estimated functional points (81.63) and the average actual functional points delivered (103.94) were 44.66%.

7.9 Technology Development - Effort

Similarly the average estimated effort for the big companies was 636 man-days and the actual average effort was 636.8 with a negligible difference of 0.34 per cent. However, the same for the medium size companies was 84.01 average estimated man-days and 93.82 average actual delivered man-days with a difference of 12.57 per cent. The small companies have a huge difference of 34.71 per cent between the average estimated man-days (27.5) and the average actual delivered man-days (33.34) at the time of study.

7.10 Technology Development — Time

The time or schedule difference between the average estimated time (13.7 months) and the average actual delivered time (13.75 months) for the big companies was 0.53 per cent. For the medium companies the average estimated time was 8.9 months and the average actual delivered time was 10.31 months with a difference of 11.1 per cent. For the small companies the difference between the average estimated time (8.45 months) and the average actual delivered time (10.35 months) was 31.55 percent.

7.11 Summary of Findings

The primary objective of the software companies is software development and the inputs for this are people and technology, the process includes learning and development of software and the outcome is the software product. There are three significant factors which decide the success of software development and they are time, effort and magnitude. Time

is measured in terms of calendar days, effort in terms of man-days and magnitude in terms of functional points

Fifty per cent of the companies in the sample were working in the Microsoft based technologies (that is - the operating system is windows based, the application development tool is visual studio, web server is IIS, database is MS SQL Server) and one-third were using Java as the technology platform. Eighty-five per cent of the companies were involved in "application — incremental" method of software development. Forty-seven percent of the companies have mentioned enterprise wide solutions as their first priority followed by 21.9% offering internet & web solutions.

The big companies had an average of 855.4 estimated functional points and 855.4 actual functional points delivered without any gap between the estimated and the actual functional points. However in case of medium size companies the average functional points estimated were 114.73 and they had actually delivered 137 functional points, thus over shooting the estimated functional points by 18.56% as compared to the actual functional points delivered. The small size companies tend to show a huge difference. The difference between the average estimated functional points (81.63) and the average actual functional points delivered (103.94) were 44.66%.

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have a huge difference of 34.71 per cent between the average estimated man-days (27.5) and the average actual delivered man-days (33.34) at the time of study.

The schedule difference between the average estimated time (13.7 months) and the average actual delivered time (13.75 months) for the big companies was 0.53 per cent. For the medium companies the average estimated time was 8.9 months and the average actual delivered time was 10.31 months with a difference of 11.1 per cent. For the small companies the difference between the average estimated time (8.45 months) and the average actual delivered time (10.35 months) was 31.55 percent.

Chapter 8: Analysis of Interrelations

8. Collaboration, Learning and Software Development - An Analysis of Interrelations

8.1 Introduction

The study sets out with the following hypothesis that "software development is positively related to and influenced by the interorganisational collaboration and organisational learning." There are six significant variables that help in testing the hypothesis and they are - age of the software companies, size of the software companies, people employed by the software companies, software development index, collaboration strength index and organisational learning index. The present section tests the hypothesis with the help of Chi-square test, correlation and regression.

8.2 Indices for Testing Hypothesis

Information technology enterprises in general and software organisations in particular tend to have different characteristic features when compared with other business organisations like industrial manufacturing. Software organisations are characterised by a high degree of specialisation, shorter technology life cycles, widely distributed knowledge among key players in the industry, continuous learning process and collaborations based upon risk-sharing, resource-sharing, technology-sharing and outsourcing. In the above mentioned frame-work it is proposed to test the present hypothesis that "there is a positive correlation between organisational collaboration, organisational learning and software development". Dependent variable in the hypothesis is the software development and the independent variables are interorganisational collaboration and organisational learning.

Relations between dependent and independent variables is shown in the following expression: CSI a OLI a SDI

Where, SDI is software development index, OLI is organisational learning index and CSI is collaboration strength index.

8.2.1 Software Development Index (SDI)

SDI is a combination of software development related variables like project time factor, project effort factor and quality function deployment.

Project Time Factor: (PTF)

The project time factor is defined as the ratio of time variation between estimated time and actual time, and the estimated time. This essentially indicates the time overrun in the projects and it is expected that it should always be near to 0, on a scale of 0 to 1.

$$PTf = \frac{[\text{Actual time} - \text{Estimated Time}]}{\text{Estimated Time}}$$

Project Effort Factor (PEF)

The project effort factor is defined as the ratio of effort variation between estimated effort & actual effort, and the estimated effort. This essentially indicates the effort overrun in the projects and it is expected that it should always be near to 0, on a scale of 0 **to** 1.

$$PEf = \frac{[\text{Actual Effort} - \text{Estimated Effort}]}{\text{Estimated Effort}}$$

Quality Function Deployment (QFD)

QFD is the number of functional points or kilo lines of code defined (estimated) versus the delivered (actual). The project QFD is defined as the ratio of "the functional points variation between estimated & the actual FPs and the estimated FPs.

$$PQf = \frac{[\text{Actual FP - Estimated FP}]}{\text{Estimated FP}}$$

The following steps will explain the equation:

Estimated Time = t1

Time Overrun = t2

(Actual Time - Estimated Time)

Time Factor Tf = t2 / tl

Project Time Factor PTf = Total of (Tf) / Total number of project

Effort (Number of man-days)

Estimated Effort = el

Effort Overrun = e2

(Actual Effort - Estimated Effort)

Effort Factor Ef = e2 / el

Project Effort Factor PEf = Total of (Ef) / Total number of project

QFD (Quality Function Deployment)

Number of functional points defined and delivered

Functional Points Defined = f1

Functional Points Delivered = f2

QFD factor of £2 / f1

Project QFD factor PQf = Total (Qf) / Total Number of projects

Software Development Index $SDI = \sum(1/\sum PTf) + (1 / \sum PEf) + (1 / \sum PQf)$

where

$\sum$PTf is the sum of project time factor

$\sum$PEf is the sum of project effort factor

$\sum$PQf is the sum of project quality function deployment

8.2.2 Collaboration Strength Index (CSI)

The collaboration strength index is the combination of three variables and they are — basis for collaboration, collaboration duration and the number of projects executed with the collaborator. The basis for collaboration is calculated by allocating values depending upon the alternatives.

The following are the values assigned to each alternatives as basis for collaboration (CB) based on their degree of significance given by software companies in the study.

Risk	2.0
Resource	1.5
Technology	1.5
Outsourcing	1.0

Note: For a given company the basis can be one or more of the above. In case of more than one, all items are added.

Duration of collaboration (CD) is the duration of collaboration in number of calendar years in numbers

Total number of projects completed in the present collaboration (CP)

Collaboration Strength Index (CSI) = CB + CD + CP

8.2.3 Organisational Learning Index (OLI)

OLI is a representation of the depth of an organisation's learning and is combination of number of learning days, number of people attended the training program, and the total number of people (employees).

OLI = NLD + NLP + NTP

Total Number of Learning Days (for each project and general) (NLD)

NLD = Project Specific {Number of Days} + General {Number of Days}

Total Number of People who attended the training programs (NLP)

Total Number of People (Employees) - NTP

Organisational Learning Index (OLI) = NLP + NLD + LM

8.3 Age, Size and People

There are three important factors that contribute to the making of a software organisation and they are age, size, & people. Age is the number of years of existence of the organisation or the difference between the present year and the year of establishment. Size is the combination of financial turnover of the organisation and the number of people employed and is classified in terms of small, medium & big. People is the total number of employees in an organisation at the time of the study. The following tables represent the classification and the frequency of these variables in the 32 software companies studied.

Table No 8.1: Age of software development companies

S No	Class	Frequency	Percentage
1	< 2.5 Years	3	9.37
2	2.6 - 5.0 Years	15	46.87
3	5.1 – 7.5 Years	10	31.25
4	> 7.6 Years	4	12.5
	Total	32	100

Table No 8.2: Size of software development companies

S No	Class	Frequency	Percentage
1	Small	5	15.62
2	Medium	11	34.38
3	Big	16	50.00
	Total	32	100.00

Table 8.3: Distribution of technical people in the software development companies

S No	Class	Frequency	Percentage
1	< 24 People	12	37.5
2	25 - 99 People	12	37.5
3	100 - 199 People	3	9.38
4	> 200 People	5	15.62
	Total	32	100.00

8.4 Indices: SDI, CSI, & OLI

By using formulae index values are calculated for all companies in the sample. Percentages of frequencies for the same are calculated. For the software development index the minimum index value is 0.629, the maximum values is 0.995, range is 0.366 and the index is divided in to four equal classes with a class difference of 0.091. For the collaboration strength index the minimum index value is 0.389, the maximum values is 0.806, range is 0.417 and the index is divided in to four equal classes with a class difference of 0.104. For the organisational learning index the minimum index value is 0.370, the maximum value is 0.930, range is 0.560 and the index is divided in to four equal classes with a class difference of 0.140.

8.4.1 SDI Frequencies

The software development index values are classified into four equal class interval groups and they are from 0.629 to 0.720, from 0.721 to 0.811, from 0.812 to 0.902 and from 0.903 to 0.995.

Table No 8.4: SDI Frequencies

	Frequency	Per cent
0.629 to 0.720	5	15.63
0.721 to 0.811	8	25
0.812 to 0.902	11	34.36
0.903 to 0.995	8	25
Total	32	100

From Table No 8.4 it is evident that more than 60% of the companies have high index values indicating a level of maturity of software development and related activities. In the first group (0.629 to 0.720) there are five companies (15.625%), in the second group (0.721 to 0.811) there are eight companies (25%), in the third group (0.812 to 0.902) there are eleven companies (34.375%) and in the fourth group (0.903 to 0.995) there are eight companies (25%).

8.4.2 OLI Frequencies

The organisational learning index values are classified into four equal class interval groups and they are from 0.370 to 0.510, from 0.511 to 0.650, from 0.651 to 0.790 and from 0.791 to 0.930.

Table No 8.5: OLI Frequencies

	Frequency	Per cent
0.370 to 0.510	8	25
0.511 to 0.650	6	18.75
0.651 to 0.790	11	34.375
0.791 to 0.930	7	21.875
Total	32	100

From Table No 8.5 it is evident that more than 56% of the companies have high index values which indicates that organisations are committed to organisational learning. In the first group (0.370 to 0.510) there are eight companies (25%), in the second group (0.511 to 0.650) there are six companies (18.75%), in the third group (0.651 to 0.790) there are eleven companies (34.375%) and in the fourth group (0.791 to 0.930) group there are seven companies (21.875%).

8.4.3 CSI Frequencies

The Collaboration Strength Index (CSI) values are grouped into four equal class intervals. They are from 0.389 to 0.493, from 0.494 to 0.597, from 0.598 to 0.701 and from 0.702 to 0.806.

Table No 8.6: CSI Frequencies

	Frequency	Percent
0.389 to 0.493	2	6.25
0.494 to 0.597	10	31.25
0.598 to 0.701	7	21.875
0.702 to 0.806	13	40.625
Total	32	100

From Table No 8.6 it is evident that more than 62% of the companies are having high index values indicating a sign of having high collaboration relationships. In the first group (0.389 to 0.493) there are two companies (6.25%), in the second group (0.494 to 0.597) there are ten companies (31.25%), in the third group (0.598 to 0.701) there are seven companies (21.875%) and in the fourth group (0.702 to 0.806) group there are thirteen companies (40.625%).

8.5 Test of Significance

To test whether there is any association among the three indices Chi Square test was carried out. For the purpose of the Chi Square test, the frequency values of the three indices - Software Development Index (SDI), Collaboration Strength Index (CSI) and Organisational Learning Index (OLI)- are re-coded in to only two categories. Between SDI and CSI there is a strong association (a = 0.11) with a chi-square value of 2.496. Between SDI & OLI the relationship is all the more established (a = 0.002) with a chi-square value of 9.790.

Table No 8.7: SDI and CSI Cross-tabulation with Chi-square value

SDI Frequencies	CSI Frequencies		Total
	0.389 to 0.597	0.598 to 0.999	
0.629 to 0.811	7	6	13
0.812 to 0.999	5	14	19
Total	12	20	32

Chi-square = 2.496, df = 1 and **a** = 0.11

Table No 8.8: SDI and OLI Cross-tabulation with Chi-square value

SDI Frequencies	OL Frequencies		Total
	0.370 to 0.650	0.651 to 0.999	
0.629 to 0.811	10	3	13
0.812 to 0.999	4	15	19
Total	14	18	32

Chi-square = 9.790, df = 1 and **a** = 0.002

With the above results of the chi-square test the association is established between SDI as a dependent variable and CSI & OLI as independent variables. To explore **the**

strength and direction of this association correlation has been carried-out. To predict the value of dependent variable with the knowledge of independent variables regression also has been carried out.

8.6 Correlation & Regression for Collaboration Strength Index

8.6.1 Correlation among the collaboration strength variables

There are three variables that make the collaboration strength index and they are: Collaboration Duration (CD), Collaboration Basis (CB) and Collaboration Projects (CP). Multiple correlation was calculated using the computer software (Statistical Package for Social Sciences — SPSS).

Table No 8.9: Correlation matrix for collaboration strength variables

	CSI	CD	CB	CP
CSI	1.000			
CD	0.797	1.000		
CB	0.617	0.583	1.000	
CP	0.670	0.619	0.993	1.000

Note: CSI — Collaboration Strength Index, CD - Collaboration Duration, CB — Collaboration Basis and CP - Collaboration Projects.

The Table No 8.9 represents the correlation among the variables that make up the collaboration strength index and they are collaboration duration - the number of years that the company is having collaboration relationship with the collaborator company, collaboration basis - the main reason for collaboration and the no. of projects executed with the respective collaborator in the past one year. There seems to be a very strong relationship between the collaboration strength index and collaboration duration (0.797) and also

between collaboration basis and the no. of projects (0.993). From this it can be inferred that collaboration duration is the main factor in the collaboration strength index.

8.6.2 CSI Regression

To assess the relationship among the collaboration strength variables and to verify the accountability of variation regression analysis was made using SPSS.

Table No 8.10: Model Summary [b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.8672[a]	0.752	0.7255	0.0727

a. Predictors: (Constant), Number of Projects, Duration of Collaboration, Basis for Collaboration
b. Dependent Variable: Collaboration Strength Index

Table No 8.11: Results of the Multiple Regression Analysis for CSI

S No	Dependent Variable	Independent Variables	Estimates	Standard Error
1	Collaboration Strength Index	Constant	0.5119	0.0421
2		Basis for Collaboration	-0.134	0.0488
3		Duration of Collaboration	0.0343	0.0087
4		Number of Projects	0.0632	0.0208

The estimated multiple regression coefficients for the collaboration strength index is shown in the table 8.11. The value of R square is found to be 0.752 and the adjusted R square is 0.7255 and the standard error for the estimate is 0.0727. The model accounts for 75.2 per cent of the variability in the collaboration strength index with independent variables such as basis for collaboration, duration of collaboration and the number of projects. The model considers only the quantitative variables and thus it accounts for seventy-five per cent of variation. The remaining twenty-five per cent of the variation can be accounted for with the help of the following qualitative factors: Inter organisational collaboration is more of a social process that primarily involves interaction between employees of both **the**

collaborating companies. Also collaboration depends upon the people and their capabilities; needs and requirements of the participating companies, and organisational dynamics among key people. These social factors can not be measured and quantified and this accounts for the remaining twenty-five per cent of unexplained variation.

The multiple regression analysis suggests that, one unit increase in number of projects will lead to increase in collaboration strength index (values vary from 0 to 1) by 0.0632 units; similarly one unit increase in duration of collaboration will lead to increase in collaboration strength index by 0.0343 units and there seems to be a negative association between collaboration basis and CSI. The results show that one unit increase in basis for collaboration will lead to a decrease of 0.134 units of collaboration strength index.

8.7 Correlation & Regression for Organisational Learning Index

8.7.1 Correlation among organisational learning variables

There are three variables that make the organisational learning index and they are: Number of Total People (NTP), Number of Learning People (NLP) and Number of Learning Days (NLD). Multiple correlation was calculated using the computer software — SPSS.

Table No 8.12: Correlation among the organisational learning variables

	OLI	NTP	NLP	NLD
OLI	1.000			
NTP	0.393	1.000		
LNP	0.497	0.974	1.000	
LND	0.507	0.869	0.868	1.000

Note: OLI - Organisational Learning Index, NTP - Number of Total People, NLP - Number of Learning People and NLD - Number of Learning Days.

Table No 8.12 indicates the correlation among the organisational learning index variables and they are number of learning people, number of learning days and total number of people. Among organisational learning index variables strong correlations exists between number of total people and number of learning people (0.974) indicating the more the number of people the more scope for learning programmes. The other relationship can be observed between the number of people and the number of learning days (0.869) indicating the similar trend. There also exists a relationship between number of learning people and number of learning days (0.868) meaning that the more the number of learning people the more will be the number of learning days.

8.4.2 OLI Regression

Table No 8.13: OLI Regression Model Summary [b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.687[a]	0.472	0.416	0.12188

a. Predictors: (Constant), Learning Program - No Days , Learning Program - Number of People
b. Dependent Variable: Organisational Learning Index

Table No 8.14: Results of the Multiple Regression Analysis for OLI

S No	Dependent Variable	Independent Variables	Estimates	Standard Error
1	Organisational Learning **Index**	Constant	0.4915	0.0664
2		Learning program - No of days	0.0098	0.0055
3		Learning program - No of people	0.0017	0.0005
4		Number of technical people	0.0002	0.0007

The estimated multiple regression coefficients for the collaboration strength index are shown in the table 8.14. The value of R square is found to be 0.472 and the adjusted R square is 0.416 and the standard error for the estimate is 0.12188. The model accounts for 47.2 per cent of the variability in the organisational learning index with independent variables such as number of learning days, total number of people and the number of people who attended the training. The model considers only the quantitative variables and thus it accounts for nearly fifty per cent of variation. The remaining fifty per cent of the variation can be accounted for with the help of the following qualitative factors:

The learning outcomes can not be measured in quantitative terms exclusively and even if measured will not be effective as the real results can be perceived only when the learning is applied in a real software development situation which can not be quantified. Also if learning is not immediately put in to practice some portion of the learning may get diluted and it is directly related to the gap between learning and implementation. More so learning is a social process which includes other aspects like - culture of the people, learning capabilities of the people, and the values of the people which can not be quantified.

The multiple regression analysis suggests that - one unit increase in number of learning days will lead to increase in organisational learning index (values vary from 0 to 1) by 0.0098 units; similarly one unit increase in the number of learning people will lead to increase in organisational learning index by 0.0017 units. The results show that one unit increase in the total number of people will lead to increase of 0.0002 units of organisational learning index.

8.8 Correlation & Regression for Software Development Index

8.8.1 Correlation among software development variables:

There are six variables that make the software development index and they are: Software Development Estimated Time (SET), Software Development Actual Time (SAT), Software Development Estimated Effort (SEE), Software Development Actual Effort (SAE), Software Development Estimated Functional Points (SEF) and Software Development Actual Functional Points (SAF). Multiple correlation was calculated using the computer software — SPSS.

Table No 8.15: Correlation among software development variables

	SDI	SET	SAT	SEE	SAE	SEF	SAF
SDI	1.000						
SET	0.378	1.000					
SAT	0.277	0.991	1.000				
SEE	0.417	0.340	0.266	1.000			
SAE	0.410	0.335	0.263	0.999	1.000		
SEF	0.377	0.375	0.310	0.984	0.983	1.000	
SAF	0.364	0.374	0.312	0.981	0.981	0.999	1.000

Note: SDI - Software Development Index, SET - Software Development Estimated Time, SAT - Software Development Actual Time, SEE - Software Development Estimated Effort, SAE - Software Development Actual Effort, SEF - Software Development Estimated Functional Points and SAF - Software Development Actual Functional Points.

Table No 8.15 represents partial correlation among the variables that contribute to software development index and they are - Software Development Estimated Time, Software Development Actual Time, Software Development Estimated Effort, Software Development Actual Effort, Software Development Estimated Functional Points and

Software Development Actual Functional Points. Among SDI variables strong correlation can be observed between estimated time and actual time (0.991), between estimated effort and actual effort (0.999) and between estimated functional points and actual functional points (0.999) indicating the maturity of the software organisations in planning and executing the projects with reference to time, effort and functional points. The strong correlation value near to one clearly indicates that the gap between the estimated vs actual is almost negligible and demonstrates the quality and time consciousness of the software companies.

8.3.2 SDI Regression

Table No 8.16: SDI Regression Model Summary [b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.910[a]	0.828	0.787	0.04992402703425

a. Predictors: (Constant), SD - Project Estimated Time, SD Project Actual Effort, SD Project - Actual Functional Points, SD - Project Actual Time, SD Project Effort Estimation , SD Project - Estimated Functional Points
b. Dependent Variable: Software Development Index

The estimated multiple regression coefficients for the software development index are shown in the table 8.16. The value of R square is found to be 0.828 and the adjusted R square is 0.787 and the standard error for the estimate is 0.0499. The model accounts for 82.8 per cent of the variability in the software development index with independent variables such as Project Estimated Time, Project Actual Effort, Project - Actual Functional Points, Project Actual Time, Project Effort Estimation , Project - Estimated Functional Points. The model considers only the quantitative variables and thus it accounts for nearly eighty per cent of variation.

Table No 8.17: Results of the Multiple Regression Analysis for SDI

S No	Dependent Variable	Independent Variables	Estimates	Standard Error
1	Software Development Index	(Constant)	0.8383	0.0175
		Project Estimated Time	0.1864	0.0218
		Project Actual Time	-0.1623	0.0195
		Project Estimated Effort	0.0009	0.0021
2		Project Actual Effort	-0.0010	0.0020
3		Project - Estimated Functional Points	-0.0044	0.0016
4		Project -Actual Functional Points	0.0043	0.0015

The multiple regression analysis suggests that - one unit increase in project estimated time will lead to increase in software development index (values vary from 0 to 1) by 0.1864 units. Whereas there seems to be negative association between actual project time and software development index by — 0.1623 units; Similarly, one unit increase in project estimated effort will lead to increase in software development index (values vary from 0 to 1) by 0.0009 units, whereas there seems to be negative association between actual project effort and software development index by - 0.0010 units; and one unit increase in the project estimated functional points will lead to decrease in software development index by 0.0044 units and one unit increase in the project actual functional points will lead to increase in software development index by 0.0043 units.

8.9 Age, Size, People and Indices:

There exists a positive correlation among the key variables that helps in testing the hypothesis and they are age, size, people, CSI, OLI and SDI. The age of the organisations is highly correlated with duration of the collaboration (0.835) and collaboration strength index (0.739). Size of the organisation is positively related with collaboration basis (0.854) and collaboration projects. Number of people is related to collaboration basis (0.896) and

collaboration projects (0.854). From this it is clearly evident that the older organisations tend to have collaboration of longer duration and thus more strength in the collaboration. Size has no influence on duration or strength of collaboration. On the other hand the size has stronger influence on the basis and the number of projects which indicates that big organisations tend to go for risky collaborations compared to small organisations. That is why small size companies favour outsourcing collaboration relationship and they can not bear the risk to same extent as big or medium companies.

When we look at the organisation learning process there is a correlation between age of the organisation and the number of learning days (0.733). Size is correlated with the number of total people (0.982), number of learning programmes (0.940) and number of learning days (0.816). Total number of people is related to number of technical people (0.997), number of learning programmes (0.957) and number of learning days (0.857). This clearly indicates that organisational learning takes place regardless of the age of the organisation but is strongly related to size and number of people employed by the organisation.

Interestingly there is no positive correlation between the age of the company and any of the software development index variables. Size and number of people are correlated with effort and functional points. It can be inferred from the analysis that the software companies are quality and time conscious regardless of the age of their company where as the bigger companies are more effort conscious than time conscious.

Table No 8.18: Correlation among - Age, Size, People & CSI, OLI, SDI

	Age	Size	NP	CSI	CD	CB	CP	OLI	NTP	LNP	LND	SDI	SET	SAT	SEE	SAE	SEF	SAF
Age	1.000																	
Size	**0.539**	1.000																
NP	**0.598**	**0.982**	**1.000**															
CSI	**0.739**	**0.378**	**0.397**	**1.000**														
CD	**0.835**	0.450	**0.468**	**0.797**	1.000													
CB	**0.664**	0.858	0.896	**0.617**	**0.583**	**1.000**												
CP	0.677	0.819	**0.854**	0.670	0.619	0.993	**1.000**											
OLI	0.701	**0.357**	**0.367**	0.865	0.851	0.535	0.579	**1.000**										
NTP	**0.613**	0.982	**0.997**	0.431	**0.499**	0.912	**0.87A**	**0.393**	**1.000**									
LNP	0.688	**0.940**	**0.957**	0.548	0.618	0.941	**0.916**	0.497	**0.974**	**1.000**								
LND	0.733	**0.816**	**0.857**	0.570	0.562	**0.807**	0.776	**0.507**	**0.869**	**0.868**	**1.000**							
SDI	**0.692**	**0.317**	**0.336**	**0.732**	**0.802**	**0.456**	**0.509**	**0.823**	**0.364**	**0.471**	**0.476**	**1.000**						
SET	**0.185**	0.314	**0.321**	**0.192**	0.130	**0.324**	**0.327**	**0.156**	**0.327**	**0.318**	**0.391**	**0.378**	**1.000**					
SAT	**0.087**	0.248	**0.252**	**0.100**	0.028	**0.247**	**0.247**	0.065	**0.254**	**0.233**	**0.299**	**0.277**	**0.991**	**1.000**				
SEE	**0.649**	0.978	**0.982**	**0.485**	**0.538**	**0.885**	**0.850**	**0.459**	**0.983**	**0.954**	**0.874**	**0.417**	**0.340**	**0.266**	**1.000**			
SAE	0.647	**0.973**	0.977	**0.483**	**0.535**	**0.881**	**0.845**	**0.459**	**0.978**	**0.947**	**0.866**	**0.410**	**0.335**	**0.263**	**0.999**	**1.000**		
SEF	0.586	0961	0.983	**0.431**	**0.462**	0.898	**0.859**	**0.398**	**0.981**	**0.941**	**0.852**	**0.377**	**0.375**	**0.310**	**0.984**	**0.983**	**1.000**	
SAF	0.575	0.956	0.977	**0.423**	**0.449**	**0.893**	**0.853**	**0.391**	**0.974**	**0.931**	**0.841**	**0.364**	**0.374**	**0.312**	**0.981**	**0.981**	**0.999**	**1.000**

Note: Age - Age of the company, Size - Size of the company in terms of turnover, NP - Number of People employed, CSI - Collaboration Strength Index, CD - Collaboration Duration, CB - Collaboration Basis, CP - Collaboration Projects, OLI - Organisational Learning Index, NTP - No. of Technical People, LNP - No. of Learning Programmes, LND - No. of Learning Days, SDI - Software Development Index, SET - Software Development Estimated Time, SAT - Software Development Actual Time, SEE - Software Development Estimated Effort, SAE - Software Development Actual Effort, SEF - Software Development Estimated Functional Points and SAF - Software Development Actual Functional Points.

8.10 Relationship Among Indices:

We can also observe strong relationship among the three indices — collaboration strength index, organisational learning index and software development index. Collaboration strength index is positively correlated with organisational learning index (0.866) as well as software development index (0.732). Similarly organisational learning index is correlated with software development index (0.832).

The present hypothesis that "software development is positively related with and result of the interorganisational collaboration and organisational learning" can be tested in four stages using the following steps:

Table No 8.19: Correlation among CSI, OLI & SDI

	CSI	OLI	SDI
CSI	1		
OLI	0.866	1	
SDI	0.732	0.823	1

Step One: Organisational collaboration and organisational learning are correlated with each other. The correlation values for collaboration strength index and organisational learning index is 0.866 indicating very high value of the relationship. From this it can be inferred that the more the number of collaborations, with strong basis for collaboration, long duration and more projects, the more will be the scope for the organisational learning with more learning programs & more learning days. Organisational learning is a result of collaboration and the converse is also valid for the software industry.

Step Two: Organisational collaboration and software development are directly correlated with each other. The correlation values for collaboration strength index and the software development index is 0.732 indicating high value of the relationship. This implies that the process of software development is facilitated by the collaboration relationships and also the impetus for interorganisational collaboration is software development.

Step Three: Organisational learning and software development are directly related to each other. The correlation values for organisational index and the software development index is 0.823 indicating high value of the relationship. This implies that the process of software development is strengthened by the organisational learning and also mostly the impetus for learning is software development.

Step Four: Organisational collaboration, learning and software development are directly correlated with each other as discussed in the above three steps. The average {(CSI-OLI + CSI-SDI+OLI-SDI)/3} correlation values for these relationships {(0.866 + 0.732 + 0.823) / 3 = 0.807 } indicate very positive correlationship among these variables and thus the present hypothesis "software development is positively related to and result **of** the interorganisational collaboration and organisational learning" is tested positive and hence proved.

8.11 Regression for CSI, OLI & SDI

Table No 8.20: Model Summary [b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.824[a]	0.679	0.657	0.06331149876238

a. Predictors: (Constant), CSI, Organisational Learning Index
b. Dependent Variable: Software Development Index

The estimated multiple regression coefficients for the software development index are shown in the table 8.22. The value of R square is found to be 0.679 and the adjusted R square is 0.657 and the standard error for the estimate is 0.0633. The model accounts for 67.9 per cent of the variability in the software development index with independent variables such as collaboration strength index and organisational learning index. The model considers only the quantitative variables and thus it accounts for nearly sixty-eight per cent of variation.

Table No 8.21: Results of the Multiple Regression Analysis for CSI, OLI & SDI

S No	Dependent Variable	Independent Variables	Estimates	Standard Error
1	Software Development Index	Constant	0.4540	0.0560
2		Organisational Learning Index	0.5117	0.1422
3		Collaboration Strength Index	0.0610	0.1636

The multiple regression analysis suggests that - one unit increase in the organisational learning will lead to increase in software development index (values range from 0 to 1) by 0.5117 units. Similarly one unit increase in the collaboration strength index will lead to increase in software development index by 0.0610 units. These values provide support to the hypothesis which says that software development is a function and result of inter-organisational collaboration and organisational learning. In other words, the more the strength of collaboration and organisational learning the more profound will be the software development.

Chapter 9: Conclusion

9. Conclusion

Knowledge and information are increasingly becoming the key factors of production and exchange, and this has major implications for knowledge-based organisations. Rapid technological innovations have been bringing about changes in business organizations and social and economic institutions. Driving this rapid change are dramatic improvements in information and communication technologies, aided by advances in the tools of scientific inquiry and in the application of knowledge.

The most immediate consequence of these developments is the increase in the speed of production and productivity. Time and speed are now more central to competitive success, providing an advantage to producers with the best links to the markets and the greatest flexibility. In addition, the continuing rapid decline in the costs of transporting information and goods due to advances in telecommunications and the use of information technology have led to the growing irrelevance of the boundaries of geography and even of time, unifying national economies in to a fast-moving, highly interdependent world economy.

The ever-evolving and increasingly powerful information and communication technologies have fundamentally changed the nature of relationships among the global organisations in terms of sources of competitive advantage and opportunities for economic and social development. Organisations in the developed world have to sustain competitive advantage and continuously grow. To achieve their targets they continuously utilise the resources in the developing countries and in the information technology industry. Mostly the human resources are utilised for this purpose. Thus the emergence of outsourcing has

occurred as a new tool for collaborative development among software companies in the western countries with companies in India.

In recent times India has emerged as a major actor in the field of information and communication technologies (ICT) and especially in the software sector. Much of the success can be attributed to the collaborations that the Indian companies have with the companies in US, Europe and other countries. The very fact that the industry is able to survive and develop at a significant rate implies that collaborations are working. Some of the major factors that account for the success of the Indian IT companies are — fast learning curve, availability of qualified manpower and adaptability to the emerging situations. When collaboration is the key issue and possibly the strategic factor for the success of software industry, it is essential to look into the relationship among the other key factors involved in collaboration and thus examine the relationship between interorganisational collaboration and organisational learning. To look into these aspects in detail, this study began with an assumption that interorganisational collaboration and organisational learning are direcdy proportional to each other and a change in one will affect the other and vice-versa.

In an organisational context collaboration can only be a beginning or in some cases collaboration might be a means to achieve the ends. Organisational learning facilitates the process of collaboration, that is, it is a means to achieve the end goals. The end goal in any technology-based company is technology development itself. It was assumed that the greater the strength of collaborations, both forward and backward and vertical and horizontal, the more is the necessity for organisational learning. Organisational learning is a natural response of interorganisational collaboration. Based upon the type of organisational collaboration

certain methods of organisational learning processes naturally emerge as a response. So there is a strong correlation between collaboration types and associated learning methods. Once the need for learning is fulfilled then the process of technology development takes place. Finally the stronger the density of collaboration and scientific the method of learning, the more profound will be the technology development. Technology development is positively related to and is influenced by interorganisational collaboration and organisational learning. Therefore it was hypothesized that interorganisational collaboration and organisational learning are related to each other and in turn they influence technology development.

Changes in the structure and functions of the organisations

In congruence with the emerging technologies, software companies have erected appropriate organisation structures and functions. Software organisations in the study were found to have few levels in their hierarchy and thus have flat organisational structures compared to that of the industrial manufacturing organisations. The software organisations are compelled to evolve and dismantle temporary organisational structures based upon the situations. They are known for creating special organisational units or groups based upon the situation and market conditions. The companies have redefined the organisational boundaries and in most of the cases, they extend beyond the geographical boundaries. Some software organisations have virtual organisations which are those with no physical infrastructure, no people sitting at one place, and no office. Software organisations have got very high division of labour with every person catering to a specialised kind of job which requires high degree of skill and expertise. In response to the changes in organisational structures there has been change in functions in terms of additional job responsibilities, job

redesign, job enrichment, change in the positions, cross-functional responsibilities, core competency, job content, etc.

More than eighty per cent of the software companies in the study cater to the US market and nearly fifty per cent of companies offer enterprise-wide solutions with one-third of the companies targeting the services market (includes - hospitality, entertainment, health, courier & cargo, media, transportation etc.). The minimum age of the organisation in the sample is 1 year, maximum 14 years and the mean age of the sample is 5.4 years. Total number of employees ranged from a minimum number of 20 among the sample organisations and a maximum of 9300 employees. Similarly number of technical people ranged from 16 to a maximum of 7616 and the number of managerial people ranged from 4 to a maximum of 1684. The mean number of technical people is 378.88, the mean number of managerial people is 70.35 and the mean total number of people is 449.22. Thus the average ratio of technical people to managerial people is 83:17.

The analysis showed a correlation between age, people and turnover and the correlation analysis demonstrates the strength of correlation among these variables. People and the turnover of an organisation are positively correlated to each other with strength of 0.982. This indicates that the more the number of people in general and technical in specific the more is the turnover and the corollary is that the turnover of an organisation is directly proportional to the number of people it employs. Interestingly there is no strong correlation between the turnover and the age of the organisation (the strength is only 0.539). This point is also proved from the sample organisations where companies with less age have more turnover when compared with companies with more age and less turnover. Similarly

age and people are not very much correlated with a strength of 0.598, this again indicates another characteristic feature of software organisations where in people are the assets for the organisation and are not related to the age of the organisation. That means if an organisation is old enough it might have more number of people and conversely organisations with more number of people need not be old. Finally the same argument holds good for the relationship between age and turnover.

Collaboration Profile:

The concept of collaboration has been used by the business organisations in a broader sense compared to academic theories of organisational studies in sociology. Business organisations tend to describe various kinds of inter organisational arrangements as collaborations and the scope of collaboration from the point of view of software companies includes the following - Joint venture, minority holding, cross holding, licensing of technology, joint R&D programme, joint product development, etc. The present study adopts a broader approach in defining the concept of collaboration as defined by the industry. The definition of collaboration has been adopted from the software industry and the study looks into collaboration among software companies from their perspective.

The significance of the strength of the organisational collaboration is expressed with the help of a composite index called collaboration strength index (CSI) and includes three variables viz., collaboration basis, collaboration duration and number of projects executed during the last financial year with the collaborator. CSI is represented in quantitative terms on a scale of zero to one, zero signifying no strength in the collaboration relationship and one as the perfect collaboration relationship. As envisaged, around eighty per cent of the

companies in the study had outsourcing as the basis for collaboration and seventy-five per cent of them have collaborated with American companies. Enterprise wide applications and web & internet applications are the prime areas for collaboration for sixty-five per cent of the companies. The study indicates that seventy-five percent of the companies have been collaborating since 2.6 to 7.5 years. Sixty-nine per cent of the companies have executed 4 to 9 projects with their collaborators during the last financial year i.e., 2000-01. More than two-thirds of the companies in the study have formed collaborations based upon the outsourcing relationship.

Learning Profile:

Learning plays a significant role in the success of a software organisation. As mentioned earlier technology development in the IT industry is very fast and knowledge is widely distributed among the key players of the industry. The key input factor for this industry is human resource and key performance factor of human resources directly is the learning potential and the knowledge base that people possess in an organisation at a given point of time. Learning directly influences the performance and productivity of the organisation and thus plays an important role in software development.

Still majority of the Indian software companies learn only when there is compulsion from their collaborating partners and one-third of the companies in the study have confirmed this factor. Only one-fifth of them are interested in learning a new technology and an equal number of companies learn for productivity & performance improvement. For learning eighty-five per cent of the companies in the study have partnered with an education and training company to fulfil their learning requirements with ninety per cent of them being

located in the same city i.e., Hyderabad. More than ninety per cent of the companies have adopted `Formal- organisational in-house' training method as this method is more productive and cost-effective. Fifty per cent of the companies have been collaborating for learning since 2.6 to 5 years. Around sixty-five per cent of the companies have conducted programs for less than 15 days duration and thirty per cent of them have conducted for 16-30 day duration. One-third of the companies preferred a training program with a strength of 30 people as this is the ideal span of control for formal-in-house training.

Software Development

The primary objective of the software companies is software development and the inputs for this are people and technology, the process includes learning and development of software and the outcome is the software product. There are three significant factors which will decide the success of software development and they are time, effort and magnitude. Time is measured in terms of calendar days, effort in terms of man-days and magnitude in terms of functional points

Fifty per cent of the companies in the sample were working in the Microsoft based technologies (that is - the operating system is windows based, the application development tool is visual studio, web server is IIS, database is MS SQL Server) and one-third were using Java as the technology platform. Eighty-five per cent of the companies were involved in "application - incremental" method of software development. Forty-seven percent of the companies mentioned enterprise wide solutions as their first priority followed by 21.9% offering internet and web solutions. The big companies had an average of 855.4 estimated functional points and 855.4 actual functional points delivered without any gap between the

estimated and the actual functional points. However in case of medium size companies the average functional points estimated were 114.73 and they had actually delivered 137 functional points, thus over shooting the estimated functional points by 18.56% as compared to the actual functional points delivered. The small size companies tend to show a huge difference. The difference between the average estimated functional points (81.63) and the average actual functional points delivered (103.94) were 44.66%.

Similarly the average estimated effort for the big companies was 636 man-days and the actual average effort was 636.8 with a negligible difference of 0.34 per cent. However, the same for the medium size companies was 84.01 average estimated man-days and 93.82 average actual delivered man-days with a difference of 12.57 per cent. The small companies have a huge difference of 34.71 per cent between the average estimated man-days (27.5) and the average actual delivered man-days (33.34) at the time of study.

The schedule difference between the average estimated time (13.7 months) and the average actual delivered time (13.75 months) for the big companies was 0.53 per cent. For the medium companies the average estimated time was 8.9 months and the average actual delivered time was 10.31 months with a difference of 11.1 per cent. For the small companies the difference between the average estimated time (8.45 months) and the average actual delivered time (10.35 months) was 31.55 percent.

Testing of Hypothesis:

There are six significant variables that help in testing the hypotheses viz., age, size, people, software development index, collaboration strength index and organisational learning index. This hypothesis has been tested using the following equation:

Equation: SDI a OLI a CSI

Where, SDI is software development index, OLI is organisational learning index and CSI is collaboration strength index. To test whether there is any association among the three indices (SDI, CSI and OLI) Chi Square test was carried out and the chi-square values established a strong association among these variables. To explore the strength and direction of this association correlation has been carried-out. To predict the value of dependent variable with the knowledge of independent variables regression also has been carried out.

Organisational collaboration and organisational learning are correlated with each other. The correlation values for collaboration strength index and organisational learning index is 0.866 indicating very high value of the relationship. From this it can be drawn that the more the number of collaborations, with strong basis for collaboration, long duration and more projects, the more is the scope for the organisational learning with more learning programs & more learning days.

Organisational collaboration and software development are directly correlated with each other. The correlation values for collaboration strength index and the software development index is 0.732 indicating high value of the relationship. This implies that the process of software development is facilitated by the collaboration relationship and also the impetus for interorganisational collaboration is software development.

Organisational learning and software development are directly correlated with each other. The correlation value for organisational index and the software development index is 0.823 indicating high degree of relationship. This implies that the process of software

development is strengthened by the organisational learning and also most of the times the impetus for software development is learning.

The multiple regression analysis suggests that - one unit increase in the organisational learning will lead to increase in software development index (values vary from 0 to 1) by 0.5117 units. Similarly one unit increase in the collaboration strength index will lead to increase in software development index by 0.0610 units.

The software development index model accounts for 82.4 per cent of variation, the organisational learning index model accounts for 47.2 per cent of variation and the collaboration strength index accounts for 75.2 per cent of variation as dependent variables. When software development index is the dependent variable and collaboration strength index and organisational learning index are independent variables, the R square value is 67.9 per cent. That means the model accounts for sixty-seven per cent of variation in software development index with two other independent variables.

Organisational collaboration, learning and software development are positively related to each other as discussed in the above three steps. The average {(CSI-OLI + CSI-SDI+OLI-SDI)/3} correlation values for these relationships {(0.866 + 0.732 + 0.823) / 3 = 0.807 } indicate very strong positive relationship among these variables and thus the present hypothesis "software development is positively related and influenced by the interorganisational collaboration and organisational learning" is tested positive and hence proved.

Limitations of the Study:

The sample companies chosen were from the state of Andhra Pradesh in India and does not comprise companies in other states like - Karnataka, Tamil Nadu and Maharashtra where there are good number of companies with collaborations. Studying software companies requires huge amount of personal time and efforts and thus was not possible. The study could not cover the counterparts of the Indian software companies with whom they were collaborating. Most of the companies included in the study have refused to disclose the name, address, phone numbers and e-mail addresses of their collaborators in other countries as this might lead to conflicts and competition. Finally the study is restricted to pure software service companies and the same can be extended to all information and communication technology companies.

Thus it is learnt from this study that software companies are a new species of production organisations, which have human resources as inputs and information or knowledge as the output. The study focuses on how the collaboration behaviour and organisational learning process, which are predominantly sociological in nature, influence software development in software development companies. The study has considerable contributions for the sociology of organisations with focus on collaborations and organisational learning.

The concept of collaboration has been studied by many sociologists but not in the context of software organisations. Companies collaborate for various reasons and there has been a major paradigm shift in the nature of technology development as the software industry is moving fast towards collaborative learning and software development. Also inter-

organisational collaboration provides a broader framework for people to operate and achieve the end objective in collaboration with another company. The process of inter-organisational collaboration itself is a social process in general and also the interaction of people between both the organisations within the collaboration framework is a social process. Similarly organisational learning is a social phenomenon and most significantly the collaborative learning is also sociological. Thus, software development, a positively related and influenced by two social processes like - inter-organisational collaboration and organisational learning. The sociological implication of this is - when knowledge is a key factor of production, neither learning nor development can be achieved by any one single organisation on its own. Both organisational learning and software development takes place in an environment of inter-organisational collaboration.

The study has the following contributions to the body of knowledge in the area of sociology of organisations: the traditional concepts of organisation like — structure, functions, hierarchy, division of labour, span of control, communication, inter-organisational collaboration, organisational learning and collaborative learning - have been examined in the context of the emerging software organisations. The study highlights the structural and functional changes that have taken place when compared to the industrial manufacturing organisations. Also the study has brought-out the influence of social processes like collaboration and learning on software development.

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