CHAPER - 3

METHODOLOGY AND CONCEPTUAL BASE

3.1 SCOPE OF THE THESIS

The thesis is designed as a theoretical and empirical exploration to understand the dynamics of change in industrial clusters in India through two case studies. In particular the exploration is focused on understanding technological change, innovation and development of two clusters, namely Moradabad Metal Art-ware cluster and the Textile cluster of Panipat.

Two case studies on the clusters and the empirical research that is presented in this chapter and others (chapters 4 and 5), have been developed as a way of empirically ‘grounding’ the analytical review of relevant literature and theoretical framework or perspectives developed in the preceding chapters, particularly chapter 2. For a theoretical frame of reference, this Ph.D. project has drawn from economics (neo classical, evolutionary and development), cluster studies, science and technological policy and innovation studies, culminating in what may be termed as inter disciplinary perspective. However, as we will see, much of the exploration and analysis is loaded from the perspective of economics relevant to technological change and innovation in the context of industrial clusters (ICs).

'Cluster studies' has drawn considerable attention from researchers in last few decades. The cluster approach is an eclectic term used for the methodological pluralism that has cropped up as a result of practitioners of different disciplines in social science engaged in cluster studies. Not only do they have different perceptions about methodological tools, but they draw on field work and empirical research tools from different streams in social science. The defining characteristic of a cluster study is that the unit of study in this approach is neither a micro unit like a firm or an individual, nor is it a macro unit like an economy or a society, but a meso unit; a cluster or a region. The cluster approach, as different from the 'sectoral approach', studies a cluster of the same sector industrial units concentrated in a given geographical location, rather than studying the entire industrial sector/sub-sector. Secondly, unlike the sectoral approach, which concentrates on a single industry branch, the cluster approach simultaneously studies all
the actors in the value chain, like the producers of final good, manufacturers / suppliers of equipment and other inputs, service providers and specialized knowledge instructions located within a specified geographical area.\textsuperscript{95}

The primary reason for choosing an industrial cluster as a unit of study in this Ph.D. project is rather a tautological one; the focus of the study is industrial clusters in India.\textsuperscript{96} The ease with which a meso level cluster study can handle the key concepts of this project; namely innovation and technological change made it particularly attractive for the project in hand.

Thirdly, in this approach the phenomenon of industrial clustering is studied as an interactive process between different actors in the value chain, rather than as a simple total of a certain number of stand alone firm. This characteristic of the approach makes it eminently suitable for studying the process of innovation activity, which is an inter-active process.\textsuperscript{97} As the cluster approach is focused on networks, a concept which occupies very central position in the approach, it offers great methodological convenience in studying the central phenomenon of the thesis.

Unlike the main stream economics, cluster approach uses concepts and tools of economic as well as sociology, history and S&T policy analysis in exploring the economic phenomenon and economic processors. Like other cluster studies the present project has borrowed both conceptual bases as well as methodological tools from the above-mentioned disciplines. Within economics it has borrowed tools from sub-disciplines traditionally belonging to main stream as well as non main stream economics. It has borrowed from fields as diverse as the firm theory, trade theory, innovation studies and economic organization etc.

From the methodological frame of reference, empirical research and analysis is undertaken in so as to assign equal importance to 'objective' data (responses to questionnaire, factual data and quantitative assessment of various parameters of the firms), subjective data (interviews, participant observations, options of experts, among other insights) and evidence or historical data ( history and cultural background of firms and clusters). This is in line with the

\textsuperscript{95} For detail on conceptual and methodological aspects of cluster approach see Bergman and Feser (1999).
\textsuperscript{96} The very basis of this research project is the conviction that the industrial clusters are extremely important components of the SSI in India, deserving attention in their own right.
\textsuperscript{97} The inter-dependency hypothesis of innovation theory which emphasizes that networking is important aspect of the innovative activity has gained near universal acceptance. For detail see Lundvall (1988), DeBresson (1996), Roelandt and Hertog (1998).
approach adopted by cluster studies, which attempt to marry expert opinion data with firm level economic data.

The theoretical framework was developed after the selection of case studies, taking into account the broad objectives and the focus of the study to explore and understand the process underlying technological change and innovation, both at the level of firms and clusters. The exercise of developing a theoretical framework was useful in identifying gaps in literature relevant to industrial clusters in the Indian context and to articulate a set of hypothesis, issues and questions for empirical research. (See section 2.7) Before we get down to spell out various facets and components of methodology, such as sampling, data collection, concepts and definitions etc., it is pertinent to briefly point out the theoretical insights in social sciences which guided empirical research and analysis in this Ph.D. project. This assumes significant from the point of view of recurrent revisions undertaken in methodological frames and quantitative and qualitative tools employed in the empirical research. This part of the chapter is organized as follows:

- Relevance of institutional economics
- Emphasis on process
- Relevance of interpretive sociology
- Case study framework
- Quantitative and qualitative tools
- Study design, sample and Data Collection
- Questionnaire / interview schedule
- Fieldwork challenges

Relevance of Institutional Economics

Development economics, unlike the main stream economics is receptive to multiplicity of approaches to different concepts and methodological tools. One of the approaches being increasingly used by the practitioner of Development Economics is the Institutional Economics.98 The cluster approach fits well in the broad analytical frame work of the institutional economics. One important reason for this is that, unlike the main stream neo-classical economics, Institutional Economics is not in search of methodological individualism.

98 As Mookherjee (2005: 4332) observes “finally, now we (development economists) have come to accept that institutions matter." and that (ibid: 3431), “increasingly, scholars are going to the field to get a feel for ground level institutions".
Nor does it believe that a micro unit represents miniaturized universal truth. More importantly, it acknowledges the role of both economic and non-economic institutions, and is capable of incorporating them as integral part of the analysis, rather than keeping them on the sidelines, by treating them as the cases of market failure, as is done by the mainstream economists. In fact this approach is capable of going beyond the 'market failure, government failure syndrome' of the neo-classical economics and is capable of treating all institutions, (market and government being two such institutions) in a generalized analytical framework. The approach attaches importance to institutional and cultural factors. To the extent that the institutional approach concerns itself with the processes of the evolution and change in economic as well as non-economic institutions, it is extremely useful for cluster studies in which social institutions are accorded special place. Institutional approach also recognizes the role of historical process in determining economic and other phenomenon. This is particularly useful for cluster studies.

The institutional approach has a lot in common with the evolutionary perspective. Like evolutionary theory, institutional economics is biased towards explaining open ended, dynamic processes involving interactive and partially malleable agents. Both institutions and individuals are seen to mold each other and are molded by each other. In institutional economics, like in the evolutionary paradigm, there are no models for explaining the state of equilibrium, achieved by the rational utility maximizing agents. Also, like evolutionary economics, and unlike mainstream economics, the arrow of causation in the institutional economics is not necessarily unidirectional. It allows for feedback loops between various variables; there are no clear-cut sets of the independent and the dependent variables. To the extent that evolutionary economics has contributed very significantly towards the understanding of technological innovation, synthesizing the two approach was a highly rewarding exercise.

Both, evolutionary economics and institutional approach are specially endowed to deal with the question of innovation and technological change. Technological change is a knowledge based activity and building up of technological capabilities is an evolutionary process which depends upon the manner in which various institutions interact with each other. As Hodgson (ibid) observes transformation of technological knowledge from individual to individual, from an institution to individual, and from the individuals/ institutions of one country to those of

99 The definition of an institution is not confined to organization like corporations, banks, universities and government etc. but also includes social entities like language, culture and legal framework. Learned skills and tacit knowledge, being considered to be rooted in the habits of a group, are also institutions.

100 For detail on approach of institutional economics see Hodgson (1998).
another country is impossible without the presence of some knowledge transferring institutions and organizations. The list of such institutions can include a language for communication and an institution (used in the sense of an organization). The institution may be public or a private institution. The organization/ institution may be located in the firm, like an in-house R&D facility, it can itself be a firm, such as a technology transfer firm, or it can be a non-firm organization such as an educational or a technological institution. Similarly, Evolutionary Economics places great emphasis on tacit knowledge for explaining the process of innovation. Learned skilled become partially embedded in habits. When habits become a common part of a group or social culture, they grow into routines or customs. Institutions are formed as durable and integrated complexes of customs and routines. Habits and routines thus preserve knowledge, particularly tacit knowledge in relation to skills and institutions act through time as their transmission belt. Thus for the understanding of the transmission of both, the codified knowledge and the tacit knowledge, institutional approach is highly relevant. The knowledge system in a cluster or in an economy rests on the nature of the institutions involved in the creation and transmission of technological knowledge. It would thus be impossible to treat the process of innovation and technological change in the neo-classical framework, which has, at best, a peripheral role for institutions.

Emphasis on the Process

According to Hodgson (ibid: 185), evolutionary thinking in economics since 1980s has been an attempt to break away from the ‘two fixed point’ approach to the problem of causality insisting on a fixed cause and effect relation. Recognizing the possibility of the feedback loops between the so-called cause and effect, the research question need no more be what is cause and what is effect, but what process explains their dynamics. This implies a movement away from the comparative-static and towards a more evolutionary and open-ended framework of analysis. As Hodgson (ibid) observe, some prominent institutionalists like Hayek and North have already brought a considerable degree of convergence between the evolutionary and the institutional framework, which in turn, can be conveniently and meaningfully adopted for cluster analysis. The present project accepts the underlying logic of such a framework with open-ended processes, and uses it extensively.

Hodgson defines Organizations as special sub-sets of institutions, involving deliberate co-ordination for achieving an objective, such as transferring the knowledge, in a comprehensible manner.
**Relevance of Interpretive Sociology**

Closely related to Institutional Economics, interpretive Sociological insights of Max Weber (1962) and Alfred Schultz (1966) have been useful to the analysis of empirical research and field data, including interview material. The subjective articulation of the firms and entrepreneurs in the two clusters, tapped through interviews (subjective meanings of action of actors) is as important as the objective meanings which were subjected to qualifications in various forms (the quantitative data in tables in two case studies; chapter 4 and 5).

What is constitutive of this consideration is the fact that any action or exploration of social and empirical reality should take into account the social and historical context. This assumes significance given the craft based skills and techniques in the production process of two clusters which are embedded in tradition, culture and history of the clusters.

**The Case Study Framework**

The present project has opted for case study framework for carrying out research about innovation and technological change in Indian clusters. The case studies framework as a research methodology is used in several disciplines including sociology, political science, management studies, public administration research, and regional planning research etc. Though not extensively used by the mainstream economist, the approach has great scope for being used by the development economists. It is one of the most frequently used methodological frameworks for studying industrial clusters.

Case studies framework is particularly in alignment and is complimentary with the institutional approach. The institutional approach moves from the general ideas concerning economic processes to specific ideas and theories emanating from specific institutions. Keeping in tune with the spirit of the institutional approach and the case studies framework, there is no attempt in this study towards model building or formulation of a generalized theory of innovation and technological change, applicable to all the clusters of the developing countries. Nor is there an attempt to present each cluster as exotica, described completely by the institutions and historical processes unique to it. Because such an attempt would have been only be a description, or a snap shot of specific reality, bereft of any analytical value. Rather there is an attempt to draw some broad implications on the basis of the case studies on real life facts about the chosen cluster, rather than creating a purely stylized picture based on limiting assumptions. The focus is on studying the dynamics of the technological change in the cluster,
in terms of the interplay of economic and non-economic forces; both endogenous and exogenous to the cluster. Market is treated as one of the institutions relevant to the process; albeit an important institution. But there is no attempt at according symmetrical weights to demand side and supply side forces, as is the case in neo classical economics. Moreover, the so called supply side is not explained purely in terms of market relations. Non market variables are factored in the main analytical frame, rather than being confined to footnotes.

Cluster studies are often subjected to the criticism that due to lack of sufficient rigour, they are not very useful for getting policy insights. (Schmitz 1999) By introducing a formal component to the field survey, and then trying to present the findings in a statistically meaningful manner it has tried to lend rigor to the analysis. It has tried to study the role of various actor/institutions involved in the process of innovation; the governments; central and local, the R&D and technological institutes and the industry associations, in a holistic and yet formal manner, so as to be able to get policy insights.

More importantly, an attempt is made to have a look at the processes involved. In brief, the enquiry is not only about who are the actors, and how do they interact with each other to produce the process of change, but it also try to see how dose their interaction translate in being a part of the process of innovation and technological change. For example, the case study framework enables to understand the question about the extent to which the non market horizontal links are translated in economic co-operation, but also the manner in which they facilitate creation or diffusion of innovation. The evidence collected is not merely by way of the subjective assessments of the respondents, but depends on the objective reality. The question about horizontal links asks not only how much and how often do the firms interact with each other, but also which part of the innovation chain is served by the interaction, and how. The set of questions so framed, give information not only about importance of the horizontal links in absolute terms, it also allows us to see the relative importance of these links vis-à-vis other factors in the process.

Though not aimed at developing a general theory capable of predicting exact relationships, the study has made an attempt to develop a coherent analytical framework and workable methodology that will be useful for studying the process of innovation and technological change in other similar, developing country clusters belonging to traditional sectors. The case study framework enables a number of insights from both, the quantitative empirical evidence emerging from the firm level study, as well as from qualitative observations.
emerging from hundreds of formal and informal interviews. One challenge of the project has been to combine the information collected by formal methods like the questionnaire and relatively informal/semi-structured interviews. Combining meso and micro level information in such a way that the insights gained from it are greater than the sum of information provided by each part individually was equally challenging. Preparing a comprehensive policy framework for studying innovation and technological change in developing country clusters, on the basis of the insights gained from two case studies has been one of the most challenging tasks.

One persistent methodological question that has to be addressed about tools in all social sciences in general and in economics in particular is; micro tools or macro tools? To the extent that a cluster is an entity which is more than the sum total of the firms in the cluster, we can not study a cluster with the help of tools of micro/macro economics alone. For instance, in order to study the process of innovation and technological change of a cluster it is necessary to understand the meso determinants of the process, such as the technological infrastructure of the cluster/region, or its technological capabilities. Concepts relevant for cluster studies such as RIS have symbiotic relation with networks and interdependence of various economic actors can not be understood with the standard tools of neo classical economics, characterized by methodological individualism. This makes it necessary to fall back on the tools and concepts developed by cluster studies.

This however, does not mean that a project, conceived in the mode of cluster approach has to confine itself only to meso tools. Unlike the ID literature, which explains the dynamics of clustering and innovation mainly in terms of local or meso factors, the recent studies about clusters recognize the importance of macro economic determinants of dynamism f a cluster. On the other hand, technological dynamism of a cluster cannot be understood without understanding the process of change taking place in individual firms. To the extent that innovation and technological change in a cluster has to take place via its firms, it is important to understand the technological capabilities of the individual firms which can be best understood with the help of micro tools. This calls for synthesis of meso tools with micro tools. For this reason, both micro and meso tools have been used in order to understand the symbiotic relation between firm level and cluster level technological capabilities. In order to achieve this purpose a two level study is conducted; one at the firm level and the other at the cluster level.

102 Though, by and large, micro tools are used by firm theory in the understanding of the consumer choice theory and other micro concepts like commodity prices, these tools can be used and indeed are sometimes used for understanding macro concepts like distribution of income.
Qualitative vs Quantitative Tools

In social sciences theory can be presented with the help of descriptive methods or with the help of stylized models. Likewise, two related questions about the methodological tools which every researcher dealing with socio economic phenomenon has to address are about the use of empirical methods vis-à-vis theory and the use of models vis-à-vis descriptive methods. While for a long time disciplines like Development economics, confined itself to use of either descriptive empiricism, as done in the works of Lands and Kunzites etc., or devoted itself to creation of theoretical models\textsuperscript{103} New Development Economics as well as New Institutional Economics have started making extensive use of sophisticated empirical methods.

Two important lessons emanating from the debate about the tools for Development Economics, which are kept in mind while formulating the methodological structure of this project are ; (i) Both theory and empiricism are important. The two can enhance each other in the continuous attempt at improving the quality of both, through feedback loops which exist between the two. A dynamic balance between the two needs to be maintained.\textsuperscript{104} (ii) Inferences drawn on the basis of quantitative data, by itself, is not sufficient either for prediction or for policy prescription, but a good analytical tool, if used with care. More significantly, it can be effectively used for checking any undue bias that may crop up from descriptive studies in the field.\textsuperscript{105} Decision to make limited use of quantitative methods in this project is in line with the methodology of institutional economics, which differs significantly from the mainstream economics in this respect.

Quantitative data is used in this project mainly to counter the criticism leveled against cluster studies that they are descriptive accounts of reality and lack analytical and methodological rigor.\textsuperscript{106} It is also done to avoid any strong biases in causality which has a

\textsuperscript{103} Seminal works produced in the initial stages of growth of Development Economics, like those of Lewis, and Leibenstein etc were all in the form of theoretical models.

\textsuperscript{104} To some extent Institutional approach, the approach used extensively in this research project, is able to strike the balance between the two. It does not share the positivists' flair for econometric models, or for that matter, any type of models. Nor does it share the acute skepticism of the likes of Robbins etc. about econometric methods. Instead, its position is that econometric evidence of a significant co-relation between the relevant variables would be important, but far from adequate in providing a complete explanatory framework.

\textsuperscript{105} One good example is the potential use of empiricism to correct/ support the bias in assessing the exact role of local governments, or that of social capital so enthusiastically described and emphasized in the ID literature.

\textsuperscript{106} This criticism is also shared by the evolutionary theory from which this project borrows extensively. There are a few exceptions among the cluster case studies, done mainly by economists, which have gone beyond the descriptive methods and used empirical methods in order to test some of the hypothesis implied in earlier descriptive studies on IDs. A few studies, for example, Schmitz (1995), Rabellotti (1999) and Visser (1999) have tried to examine the presence of a co-relation between; the cluster based horizontal and vertical links of a firm.
tendency to crop up in descriptive studies. For example, according to some critics of ID model, the role of the non-market relations/actors, such as local governments, social capital, trust and cultural milieu etc. tends to get disproportionate attention. Schmitz and Musyck (1994) are clearly pointing out towards a bias when they observe that there seems to be a considerable mismatch between the professed role of the local governments and the ground reality. The reason for this is that there is insufficient investigation about the exact manner in which the local governments contribute in the innovative activity. Similarly, there are doubts expressed about the exact relevance of certain other concepts such as trust, horizontal co-operation and (the distinction between) the passive and the active collective efficiency etc. (see Schmitz and Musyck, *ibid*) There is not much systematic work done to develop methodological tools which will help in either accepting or rejecting several implicit hypothesis going around in the ID model. There is a great deal of confusion about the role of trust that can be, at least partially, sorted out by resorting to more precise tools. Similar confusion prevails with regard to question does the presence of strong trade unions in the ID in the Third Italy justify the inclusion of strong trade unions in the list of defining characteristic of an ID? In all such cases the real question perhaps is not about the presence or absence of a particular factor but how much importance does it deserve. Since descriptive tools are obviously inadequate for answering the questions about ‘how much’, there is urgent need for generating some quantitative/semi quantitative data in order to bridge this gap between perception and reality with greater precision. Cluster studies, like evolutionary approach are also criticized for not being sufficiently policy oriented, due to lack of necessary conceptual and methodological tools to incorporate policy dimensions. Due to this it becomes difficult to draw definitive conclusions and make generalized policy prescriptions from these studies. 107 Unlike most other cluster studies, the present project does not stop at the mere claim of the presence, or a mere description of the non-market factors. Instead there is a systematic attempt to make quantitatively meaningful inferences. An attempt is made to present the information collected about non-market factors, such as role of social networks in terms of empirically usable characteristics/quantities.

Another question that has to be addressed in a project with interdisciplinary moorings is; what mix of qualitative and quantitative data/ tools will serve the purpose in hand most
effectively. Though mathematical and econometric models are the main tools used by the main stream economist, quantitative data are no more considered to be their monopoly. But due to the obvious methodological and analytical thinking (which has implicit acceptance in this project) in which explanation in terms of evolutionary, open ended processes is considered superior to mechanical deterministic causation, there is no attempt at model building.

Another reason for not using quantitative models is that both qualitative and quantitative data are used in this project. Till recently it was generally believed that while it is the legitimate right of sociologist and anthropologist to use qualitative methods and soft data, economist must confine themselves to hard data. However it is being increasingly recognized that economist have no monopoly on methodological rigor. Nor are they debarred from use of the so called soft data. Keeping this in mind this project, which is embedded in development economics, has made extensive use of soft data. Quantitative data is combined with qualitative data to enhance the richness of the analysis and to highlight the stylized facts emerging from the analysis. This is done with full appreciation of the fact that the quantitative variables typically used to explain technical change/innovative activity cannot provide a very accurate or sufficiently detailed picture of the process involved in creation of technological knowledge or its diffusion.

The revision in position about the extent of use of quantitative/econometric methods persisted and re-surfaced quite often during the entire period. Use of quantitative methods in this project was constrained by the fact that factors like tacit knowledge, trust and social embeddedness of the entrepreneur, which are hypothesized to play important role in creating technological dynamism in industrial clusters, do not lend themselves to be converted in empirically usable quantities. The conceptual question that had to be resolved in this respect was; can the concepts like innovation and technological change on the one hand and their determinants like networks etc. can/should be quantified to an extent that they can lend themselves useful for creation of quantitative indices or for a firm level regression model? The temptation to do so was almost irresistible. However, after much deliberation it was decided that even after using the expert opinion extensively, innovative/technological activity of different firms can be placed in different semi quantitative categories, rather than assigning them absolute number. It was decided that lumping together of technological, organizational and market innovation in a single number did not serve any analytical purpose. Similarly product/raw material innovation could not be clubbed with the process innovation to assign a unique number to the technological innovation of a firm, though it is possible, with the help of
the expert opinion, to determine the level of technological innovation of a firm, by looking at its three components in unison. Similarly it was decided that though the level of the technological capabilities located in a firm links could be captured, it was not possible to assign a unique number to them. Similarly technological capabilities of a cluster, coming from disparate factors like accumulated skills and in inter-firm links could not be lumped together to get a quantitative index. As a result an almost irresistible temptation to incorporate an elegant regression model for explaining innovative activity of firms had to be sacrificed. This temptation had also to be resisted because soon it was realized that there existed feed back loops between various variables which made the identification of the explanatory and the explained variable difficult.

**Study Design: Sample and Data Collection**

The study is based on field work and data collected from two industrial clusters, Moradabad in the state of U.P, and Panipat in the state of Haryana. Both clusters are located within 200 km from New Delhi (place of Ph.D. research).

The entire empirical research was designed in three phases. The first phase involved preliminary visits in two clusters in the year 2001 and 2002 to survey and hold initial discussions with different actors. This phase was very crucial to understand the background and have preliminary experience of the clusters before embarking upon the study. In this phase main sources of data, such as industry associations, government officials and trade related associations and groups were identified. The starting point of the field work was attending a seminar, organized by ILO in order to get an overview of the cluster. This was of great help in getting familiarizing with the structure of the cluster, various actors in the cluster, various strengths and various weaknesses of the cluster in one go. Subsequently a few more visits were made to the cluster for having greater insight in the morphological aspects of the cluster, structure of the industry, identifying the end products and raw materials used, various production processes and the technologies used. These visits also helped in the absorption of the sense of history, which was there every-where in the cluster. It helped in the formation of impressionistic views about the type of social and economic networks present in the cluster.

Visit to the DIC (District Industrial Center) provided the data of the registered SSI units.

---

The participants in the seminar included representatives of all sections of the cluster; the industries minister of the state, the secretary industries, the DM of the district, officials from the office of DC (Handicrafts) and NPC (National Productivity Council), the representatives of the industry associations, the representatives of the artisans association, the labour leaders, NGOs, and of course, the ILO representatives.
Similar, pre-survey visits were made to Panipat in order to comprehend the structure of the industry and to understand the nature of economic and social networks.

The second phase comprised of visits to a few units, for a pilot study and interviews with few key persons in the cluster. This served the purpose of gaining greater clarity with respect to detailed outline for the field work. These visits were helpful in refining the questionnaire and making it more comprehensive and more comprehendible from the point of view of respondents.

Third phase of field work included visits to sample firms for the formal and informal interviews and for direct observations. Hundreds of household units and workshops were also visited for interviews and observations during this phase of field work.

**Data Collection**

This study depends mainly on the primary data, though it does make use of some secondary data. While the cluster level data is obtained both from the primary and the secondary sources, the firm level data is generated entirely through primary sources. The secondary sources used for data collection in this project include government documents such as various publications of the Ministry of Small Scale Industry and the information provided by the DICs of two clusters. Information provided by the trade associations and development agencies like UNIDO/Textile Committee in Panipat and ILO office in Moradabad is also incorporated. Directory of Metal Art Ware Exporters, brought out by HEPC was used for providing information about the universe of firms from which the sample was picked. Similarly, directory of Panipat textile industry, prepared by a private scholar was used to get some basic information about the cluster. Primary data was collected through a three fold effort, making use of both micro and meso techniques. One of the techniques used in this project is the Delphi technique for expert opinion, which is both cost saving and time saving. This technique is used extensively in cluster studies and is particularly useful for collecting cluster-related intelligence. It includes interviews of experts from the industry, academics, research institutions, and administration. It also includes information in trade journals and publications by industry associations' etc. Primary information about the cluster was collected by interviewing a large number of firm and non firm actors in the clusters. They belonged to the government as well as

---

110 See Bergman and Feser (1999) for detail on Delphi method
non government organizations. Structured questionnaire, structured formal interviews and informal and semi-structured interviews were used for the collection of firm level primary data. In addition, direct observations made during the visits of the factories and other production spaces are also used.

The Study Sample

A sample survey of 45 firms from each cluster was conducted in order to collect firm level data. As it had became quite obvious in a few preliminary visits to the clusters that in order to get information about technological change and innovation, only the first tier firms producing the end product need to be included in the formal survey, only the end producers were included in the formal survey.

Initially DICs (District Industrial Centers) in two cities were contacted in order to get the information about the ‘universe’ of the population of firms. However, this source was abandoned for two reasons. Firstly, the list of SSI units registered with the DICs included a very large number of units which had seized to exist. Secondly, since the list of SSI units registered with the DICs did not indicate the stage of production chain at which the firms were operating, it was not very useful in identifying the end producers. Eventually the information about the ‘universe’ of the population of firms was obtained from the industry/cluster based directories. For Moradabad the ‘Export Directory of District Moradabad 2001’, prepared by EPCH for information about Metal Art-ware Exporters, was used in order to pick up the survey firms. The directory of Panipat industry used for this purpose is prepared by an individual researcher.

The formal sample in Moradabad included only the end producing firms. These firms termed as manufactures and exporters, or more simply, just exporters, are leading and managing the entire local supply chain. Not only were all decisions about product innovation and technological change taken by these firms, the technology intensive/ quality critical processes were concentrated at their premises. Since it had became clear in the preliminary visits that there

---

111 Appendix – 1a.1 provides the list of the firms and Appendix – 1a.2 the list of some of the persons interviewed in/for the two clusters.

112 As per the information collected by the DICs for the Third census of SSI, of the 7010 SSI units registered with Moradabad DIC only 2570 were working in the year 2001. Similarly of the 3958 SSI units registered with Panipat DIC only 2828 were working in the year 2001. The centers could not provide the list of working units.

113 Chauhan (2001)
were virtually no firms which could be identified as catering to the domestic markets directly.\footnote{Some of the so called suppliers were supplying to firms based in Delhi and Bombay etc., which in turn were catering to the domestic market.}

This meant that our universe for the formal survey for Moradabad was 437 manufacturers and exporters listed in the directory of the metal art-ware exporters prepared by the EPCH (Export Promotion Council, Handicrafts), from which a sample of 45 firms was subsequently drawn.

Unlike Moradabad, where all the end producers were producing for exports, in Panipat composition of firms with regard to their market orientation was more nuanced. There were end producers, producing either exclusively for the domestic market or exclusively for the export market. Then there were units producing for both the domestic and the export market. In Panipat the distinction between the supplier and the end producer was quite blurred. Unlike in Moradabad, where the set of suppliers and end producers was almost mutually exclusive, in Panipat several firms supplying to the exporters were also direct exporters in part. In fact the dynamics of vertical mobility; moving to being an exporter from being a supplier to exporter, was much more pronounced in Panipat as compared to Moradabad. So the sample firms had to include all the four categories; the exporters; the units catering to both the markets, the suppliers-cum-exporters, and the firms catering only to the domestic market. Panipat also has considerable inter-firm division of labour in terms of the products.\footnote{There are several product categories such as blankets, furnishing fabric (FF), carpets/durries and made ups which are produced by firms specializing in these products as well as by firms with product diversity. Almost all the firms producing for only the domestic market specialized in the FF category. Similarly blankets is a specializes category; the units specializing in blankets generally do not produce other products. Although Panipat is possibly the biggest shoddy yarn cluster in the whole world and it supplies nearly 90\% of the blankets made from the shoddy wool in the country, for delimitation purpose we have not taken into account the shoddy wool and blankets made from shoddy wool in our study. For its sheer size, the shoddy industry deserves to be studied separately.} Care was taken to make the sample as inclusive as possible, both in terms of the product range as well in terms of market orientation of the firms. The sample includes firms specializing in one of the major product categories and also the diversified firms. The end producers in Panipat belonged to three distinct categories; the firms catering exclusively to the export market, the firms catering to both, the domestic and the export market and finally the firms catering exclusively to the domestic/local market. Though the exact number of the end producers could not be ascertained, their approximate number, according to experts is 500. The sample of 45 firms has representation from all the three categories from Panipat.

The sample firms in Moradabad as well as Panipat are divided in four size categories on the basis of their turnover/exports. Care was taken to accommodate all the size groups in the
sample. The firm level survey had three components; the formal questionnaire, the semi-structured interview, and the visit to the factory.

Though random sample is the most commonly used sample frame by economists, the use of non-probability samples is common among many social scientist, including sociologist, political scientist and anthropologist. Despite the appeal of a random sample theoretical level, the idea of using a random sample, was not entertained due several practical and conceptual reasons the idea of using a random sample. Not only would a random sample have been cost and time intensive, in the present case of small but heterogeneous and stratified population, it would have increased the probability of non-sampling error and would have been difficult to handle. Moreover, in the present interdisciplinary study, where the nature of some of the information sought was less straightforward and less precise than the information sought in most of the economic studies, it may not have been easy to illicit response readily and from all the individuals picked in a random fashion. In many cases the influence of a gatekeeper like a government official or an industry representative had to be used to persuade respondents to provide information. In such a case random sample seemed neither feasible nor very effective. Therefore it was decided to work with a Purposive Sample

An attempt was made to select a purposive sample which represented all the typical cases, even if it was not representative in the sense in which a random or a probability sample is. Both judgment and prior knowledge collected by the Delphi method was used to select a sample which would serve the purpose in the best possible manner; to gain maximum insight in the process as well as the nature and extent of innovation and technological change in two clusters. In this respect the sample chosen was perhaps superior to one which would have been selected on the basis of the probability distribution. A random sample could have meant inadequate representation of the innovative firms, which in turn would have meant smaller pool of information for studying the process of innovation and technological change. For this reason, there was no attempt to create a sample with similar size distribution as the population, though great care was taken to make the sample as representative of the population as possible in the sense of giving representation to all categories of firms. In fact a deliberate bias was introduced in favour of the relatively more innovative units. This was done in accordance with the direct knowledge collected by the pre-survey visits in the clusters and also on the basis of knowledge.

Random sample can be considered as ideal sample in the sense that in a random or a probability sample each member of the population has an equal and non-zero chance of selection. For a detailed discussion on random versus non random sample see Ward (1993).
collected by the Delphi method. For example in Moradabad, the innovative firms were identified during the discussions with the officials of the ongoing ILO project in Moradabad, MHSC, and the association secretary etc. In Panipat the technological leaders were identified during the discussions with the officials in NITRA, Textile Commission, NHDC and the WSC. In addition to this, discussions with Mr. Chavan, a technical consultant and the compiler of the directory of the Panipat industry was also helpful. There were clear suggestions that the bulk of innovative activity was concentrated in the relatively bigger units. Since the objective of the study was to understand the qualitative dimensions of innovation, leading to up-gradation and to understand the process of innovation and technological change, there was a deliberate attempt to include firms which were repeatedly mentioned to be innovative by the experts and other interviewees, subject to their willingness to respond.

The task of fixing appointments with the entrepreneurs of the identified firms was not easy. In several cases the influence of the association secretary, DIC MD and several other gatekeepers was used to fix appointments with the owners/MDs of the firms. Snow ball technique was used in certain cases to get to the next respondent. But throughout the process care was taken to neutralize any bias that may enter in deciding the sample. So the snow ball was not allowed to roll much. Conscious care was taken to ensure representation of entrepreneurs from all the social and economic groups. Attempt was also made to maintain a morphological balance by including firms from different areas.

The survey of the sample firms was carried out during the period 4th February 2003 to 13th March 2003 in the Moradabad cluster and from 21st April 2003 to 8th May 2003 in the Panipat cluster. Structured questionnaires, as well as semi structured interviews were used for collecting firm level information. In almost all the cases visits were made to the production facilities of the firms to make direct observations, which were useful in verifying some of the information provided by the entrepreneurs, even as they provided many new insights.

In line with the cluster approach, the task of data collection went far beyond the firm level survey. It was clear right at the onset that the information provided by the firm level survey, by itself, cannot provide a holistic picture of technological change/innovative activity at the cluster level. Nor could it provide a very accurate or sufficiently detailed picture of the process involved in creation of technological knowledge or its diffusion. The study therefore depends heavily on hundred of semi-structured interviews and informal discussions carried out with different actors in the cluster in order to get the insight in the process of technological
change taking place in the two clusters, and also to look for factors inhibiting such process. In line with the approach adopted by studies on industrial clusters, which are known to adopt Delphi survey techniques, opinion of regional experts- industry leaders, public officials, reports of the industry associations are an important aspect of the methodological tools used in this project.

In Moradabad, in addition to the first tier firms included in the formal sample, visits to several workshops, suppliers and single process units were also made. The preliminary visits to several workshops, suppliers and single process units; both HH (house-hold) and non-HH units, made it clear that the differences in these units with respect to the concerns of this project; such as technological change, technological capabilities, and the nature of networks they belong to was marginal. Instead of using a formal investigation on the basis of a given sample and a structured questionnaire, the methodology used to understand the process of innovation and technological change (or rather lack of it) in them was to use the methods of direct observation and the semi-structured/ unstructured informal interviews with a large number of unit owners, individually or in groups. Visits were made to a number of stage manufacturers and suppliers. Areas which have dense population of HH units, such as Karola and Peerzada Lajpatnagar etc., were visited several times for seeing the artisans at work, with their tools and technologies, and to get the artisans’ perspective about change and up-gradation. The artisans/suppliers were all told the purpose of visits clearly. Sometimes identity card was produced to ally their suspicion. Though it took time before they could be drawn in a frank discussion, these discussions were very useful in understanding the labour processes in the context of innovation and technological change. In the case of the HH units the investigation was facilitated by the geographical concentration of these units in common spaces, often within the bounds of a boundary wall. In the case of the multi-process workshops/suppliers geographical demarcation for units is much more marked, as compared to the HH units but in the majority of cases they did happen to be contiguous. Though, by and large, chunk selection was done the HH units, in some cases, the choice of the sub-contracting units was purposive; the whole value chain of some innovative exporters was studied by visiting the units in the backward links. In a few cases these supplier/subcontractors were dedicated to a single firm, but in most of the cases they were free to work for any exporter and served several exporters.

Interaction with the members of the working/artisan class was constrained in Panipat, since Panipat has very few HH units, and virtually all the manual labour is performed by the
hired labour, most of it comprising of migrant labourers, employed in the factory set up. Even when the factories were visited, it was always under the guidance of some one deputed by the management. This made free and frank discussions with the workers difficult. Like-wise the information about wages and employment, received in response to the questionnaire, could not be cross checked in a detailed manner from the workers. But since the labour market in Panipat is quite competitive, the confirmation of information from the meso sources, like the official statistical bulletins could be treated as a good approximation of trends in wage rate employment etc.

The Questionnaire/ Interview Schedule

Several visits to the cluster were made before finalizing the questionnaire. The visits were useful in framing the questions about the processes/ stages of production, the prevalent technologies, the main products produced and the institutions present in the cluster. A tentative questionnaire was prepared for the pilot study on the basis of these visits. The responses in the pilot study brought out some deficiencies in the preliminary questionnaire. In certain cases the options given in the questionnaire were not exhaustive. In certain other cases they had to be suitably modified. For example the question about the organizational change (question number 6) had in the list of organizational changes the options such as JIT, TQM etc. with which most of the respondents were not familiar. The questions had to be reframed and the options put down in less technical terms to get response. Certain additional questions, such as the question about the rejection rate were added after the pilot study. Since the information about drop in rejection rate was being offered as a part of the semi-structured interviews in all the pilot cases, it became clear that reduction in the rejection rate is seen and pursued as an important aspect of maintaining competitiveness by the firms, and as such needs to be investigated.

Since there are many aspects of the innovative process; its components, determinants, and networks etc., which had to be investigated, the number of questions incorporated in the formal questionnaire was large. For this reason extra care was required to keep the questions simple, precise and non-repetitive. For the questions which could not be answered in yes or no, and required the respondent to give specific information, as far as possible, a comprehensive list of alternatives was provided to choose from. Though an attempt was made to make such lists exhaustive, additional knowledge was always welcomed through the ‘any other’ option. The number of open ended questions was kept low. Each question had several parts; each part pertaining to different dimensions of the same variable .The questions were designed to obtain
the information that is summed up in Table 3.1. The actual questionnaire used can be seen in Appendix-Ia and Ib.

Field Work: The Challenges

Getting appointments for the interviews was a challenge. An attempt to fix appointments with the entrepreneurs through E-mail met with near total failure. In several cases it meant several phone calls before the interviews could be fixed. Gaining entry in the high wall premises of the exporters guarded by two or more formidable looking security guards was one of the biggest challenges, met with the help of several devises improvised on the spot.

During the interviews extra care was taken to bring the respondent to a comfort level, and keep her/him at that level till the end. In at least four cases the pre-questionnaire stage used up all the allotted time. Therefore it became necessary to fix another time slot. At least in three cases the questionnaire had to be left with the respondent, to be filled later. In two of these three cases the questionnaire was eventually completed in the presence of the researcher only. In one important case the formal questionnaire was never responded to, even after four visits, though there were lot of information collected by way of direct observation and informal interviews. So the firm in question had to be dropped as a sample firms. In another important case though the detailed interview did take place, and questionnaire was responded to, albeit after some reluctance, the owners refused to grant the factory visit. In the case of several big firms, while the responsibility of responding to the routine part of the questionnaire was passed on to some one less senior in the company hierarchy the informal interviews were conducted with the entrepreneurs/ general managers, who responded to some ‘subjective’ information or non-routine detail. In several cases the semi-structured interview was held in presence of suppliers of machinery and raw materials, or the subcontractors. This was very fruitful. Though meant spending much longer time at the interview, it also meant gaining valuable insight as a result of the participation of the third party.

117 The detailed questionnaire which the sample firms in the two clusters had to respond to is given in the Appendix -Ia and Ib.
3.2 THE CONCEPTS DEVELOPED / USED IN THE STUDY

Two main concepts around which the project revolves are innovation, technological change and technological capabilities. While the two concepts have been discussed at the theoretical level in chapter II, this section provides an account of the manner in which various indices concerning the measurement of these two variables are developed. It gives the definitions of the concepts used and the components entering in the various indices used in the project.

3.2.1 Innovation

3.2.1.1 'Measurement' of Innovative Activity

Since this project is focused on innovation and technological change in industrial clusters of SSI units, finding a suitable measure of innovative activity was one of the biggest challenges. The term measurement used here is somewhat indicative rather than statistical. More so, because identification and measurement of the innovative activity is, conceptually one of the least developed areas, both in the mainstream as well as evolutionary economics. The commonly used measures of innovative activity by the firm theory studies are not suitable for measuring innovative activity of small and medium firms in clusters.\(^{118}\) On the other hand, cluster studies, which are generally about SMEs, have no clear cut notion of quantitative or measurable connotations of the technological change or innovation for assessing the extent/level of innovative activity. While the literature in the fields such as industrial organization and innovation studies has thrown a large body of work concerning the propensity to innovate of a firm, ID literature, though very emphatic about the process of perpetual innovation taking place in IDs, has little to say about the extent of innovative activity taking place in IDs. By and large, ID/IC literature stops at pointing out higher propensity to innovate in a clustering vis-à-vis non clustering industrial organization. Cluster studies do not even have any clear cut definition of technological innovation/change. In-fact several cluster studies have implicitly projected technological change being equal to change in machine and equipment.\(^{119}\)

\(^{118}\) For detail on measurement of technological activity see Patel and Pavitt (1983)

\(^{119}\) Albu (1998) brings out the inadequacy of the concept of technological innovation used in several cluster studies, such as Cawthrone (1995), Rabelotti (1992) etc, where the term is used synonymously with the acquisition of new type of machinery.
Limitations of Conventional Measures

One of the challenges of this project was to devise a measure for innovative activity of the cluster firms. The conventionally used indicators for measuring innovative activity; R&D expenditure, R&D employment, and number of patents and publication could not be used for this study as they are particularly unsatisfactory in the context of SSI units belonging to the traditional sectors. Secondly, the role of other innovative activities such as design work and engineering development are frequently neglected at the cost of R&D.

The practical problem in using R&D intensity as a proxy for innovative activity is that, the percentage of SSI units in the two clusters, having formal R&D is very small. As several studies about small industrial units suggest that a large number of non-R&D firms do innovate, there is no justification for keeping SSI units without formal R&D out of the study. Alessandro Strelacchini’s (1999) study of 143 SMEs (of which 118 belonged to supplier dominated sectors such as clothing, knitwear, furniture and footwear) in the Marche region of Italy, shows that R&D was not an important activity for these SMEs and the percentage of innovative cost on R&D was near zero. The major innovative costs were; purchase of innovative capital goods, followed, with a big margin, by design engineering and pre production product development. This is consistent with the findings of the CSI survey of all Italian industries, which finds that the acquisition of innovative capital goods takes the lion’s share of the innovative cost of the innovative Italian SMEs. Nearer home, study on 1358 non tiny SSI units and 648 SSI units in Karnataka finds that even though only 0.79% of tiny units and 0.99% of SSI firms have formal R&D facilities, an overwhelmingly large number percentage of these units; 81% and 75% respectively are reported doing innovative activity. Most of this activity is undertaken as a part of the manufacturing operations/ routines, rather than formal R&D. (Bala Subrahmanya et al. 2002)

Near zero expenditure on formal R&D in SSI units is not surprising. As pointed out by Pavitt (1984) R&D is not an important source of innovation in supplier dominated sectors such as textiles and simple metal work. Since both the clusters in this study belong to supplier

---

120 Since the seminal works of Pavitt’s (1984) seminal work it is generally realized that emphasizing R&D expenditure results in undermines other sources of innovative activity such as learning by doing, learning by interacting and using. Rosenberg (1982) observes that low R&D dose not necessarily mean low innovation. Metalife (1995) points out; not all technological training takes place through R&D.
121 Sterlecchini (1999), Ramasastry and Krishnaswami study (1979), Bala Subrahmanya et al. (2001).
122 Sterlecchini lumps together R&D, design work and engineering developments as various components of innovative activity.
dominated sectors, the process innovation in these two clusters, using mature technologies, depends essentially on developments in the capital good industry. The product/raw material upgradation needed for the survival of these firms are mostly of the incremental nature, and are not dependent on formal R&D. Several innovative ideas for product innovation, which is the main form of innovative activity in the clusters operating in the supplier dominated sectors, may come from interaction of buyers and suppliers, rather than from formal R&D. Given the fact that SMEs in the supplier dominated sectors, even in developed countries, (where, on an average, SMEs are considerably bigger than SSI units in India), seldom do any formal R&D, the view taken in the present work is that R&D intensity, which is anyway an unsatisfactory index to be used as a proxy for an index of innovation, is much less suitable for of SSI units of the two clusters. In exploring the extent of R&D in a somewhat scaled-down version (compared to formal/conventional notions of R&D), the study has attempted to explore whether the firms maintain a small laboratory with equipments and qualified technicians and engineers. We need a different framework which is not dependent on the traditionally used indicators such as expenditure on R&D, patents and publications etc. for measuring their innovative activities.

**Direct Measure of Innovation**

In recent times several studies going under the rubric of direct innovation count studies\(^{123}\) have concentrated on direct measurement of innovative output. The studies using direct innovation count measure can be divided in two categories on the basis of their approach; **objective based approach** which begins by identifying innovation from existing information/databases on patents etc, or the **subjective based approach**\(^{124}\) which begins by identifying firms and asking them about their innovative activity. In spite of some of the criticisms levied against the direct innovation count measure, such as its bias towards product innovation, the measure appeared to be superior to the traditional measures such as R&D intensity for measuring the level of innovative activity in the two clusters comprising of small units belonging to traditional industrial sectors. Therefore this project has used, what can be termed as a variant of direct innovation count measure for measuring innovative activity. The project uses the subjective based approach. The reasons for using subjective based approach in preference to objective based approach are two fold. Not only is there lack of a comprehensive data-base on innovations undertaken by SSI units in India, but the definition of innovation used in this study

\(^{123}\) For details see Tether (1998).

\(^{124}\) The measure was proposed by Archibugi. For detail see Tether (1998).
goes far beyond what is entered in databases. Second reason for using subjective based approach is that the objective of this study is to not only understand technological innovation, but also to see where it is absent and to understand the reasons for its absence. For this reason this study cannot be confined only to innovative firms. Both, innovative and non-innovative, firms had to be included in it.

A modified form of direct innovation count measure is used in this project. Unlike the original approach, this study is not confined to product innovation, but also includes process/raw material innovation. A significant conceptual fact to be noted is that while measuring innovation undertaken by a firm the project does not confine to the acts of creation of new product/process; imitation of innovation created elsewhere; in the cluster, or outside, is counted as innovation by the firm. Again, unlike the original approach which attaches equal weight to all innovations, in this study minor, significant and major innovations are placed in three different categories.

Definitions

Innovation

This section of the chapter gives precise definitions of various concepts as they are used in the study; the definitions which are borrowed from the existing literature, as well as the definitions of the concepts which have been developed during this study.

The term ‘innovation’ as used in this project means doing new things or doing things in a new way. The project uses a broad definition of the term ‘innovation’ which is not confined to technological innovation. Three forms of innovation which are subject matter of this project are technological innovation, organizational innovation and market innovation

Following the insights from evolutionary school, both creation and adoption of technological knowledge are considered at par. No distinction is drawn between leaders and imitators. In other words, terms technological innovation and technological change are used

---

125 Though the concepts of organizational and market innovation used in this project has resemblance to the broad definition of innovation used by Schumpeter, unlike Schumpeter, this study, does not include institutional innovation in its scope of enquiry. Institutional change, which is a long term phenomenon, can not be handled in this study concerning medium term changes.

126 For detail see Chapter.2

127 In neo classical economics term technological change, refers to changes along a given production function, and technical progress; referring to northward shift in the production function. Term technical progress used in this manner is equivalent to use of a new process resulting in increase in productivity of one or more factors, leading to the reduction in unit cost of production of a given product at given factor prices. This is a narrow definition of technological innovation and is confined only to process innovation. The evolutionary economics on the other hand, draws no distinction between technological change and technical progress. Following the later, we use the
interchangeably for assessing the level of innovative activity of firms. However the entrepreneurs who was the first one to introduce a change in the cluster, is identified with the help of a separate question. This is done in order to identify innovations at the cluster level as against firm level innovation.

*Technological Change*

The term technological change includes change in the in process technologies, as well as product technologies. Three components of technological change of a firm are; product change, process change and raw material change. Each one of these three components of technological change is measured at three levels; minor, significant and major. Though there is considerable conceptual similarity between the categories of technological change used in this study and the standard categories used in evolutionary economics; incremental, radical and paradigmatic change they are not identical. Minor, significant and major, used in this project are quantitative categories. Expert opinion is used for categorizing changes as minor, significant or major.

*Product Change:* It means introduction of a new artifact not previously manufactured by the firm or introducing changes in the characteristics of existing artifacts. The definition of product innovation used in this study goes far beyond the Schumpeterian concept of product innovation which was as equivalent to introducing a radically different/new product, created on the basis of some radical invention. Both, creation and imitation of new products is included in the category of product innovation. Product innovation includes creation of an artifact to perform functions not performed by earlier products, or to have some characteristics not possessed by the previously produced artifact. Even the extension of scale of the artifact can also be seen as a product change. PDC can assume three levels. **Minor Product Change** means introducing a new product in the same functional category. **Significant Product Change** means entering a new functional category, e.g. a firm specializing in furnishing fabric entering the carpets sector.

---

128 Detail about incremental, radical and paradigmatical change are given on Chapter 2.

129 The categories have been systematically arrived at after discussions with various entrepreneurs, academicians and professionals.

130 For example, broad width bed sheets, requiring different equipment are treated as a product innovation in this project.

131 Very minor changes in the product; such as the shape or the feel or finish of the same artifact is not included in the category of product change. They may however appear in the measure of technological change as minor raw material changes or minor process changes, as the case may be. Detailed description of what is included in the three categories is provided in chapter IV and V.
Major Product Change means diversifying in a different product group, e.g. a firm specializing in home furnishing entering the RMG (ready-made garments) sector.\textsuperscript{132}

Raw Material Change: means introducing use of a new raw material in the production process of the products being already produced. RMC can assume three levels. Minor Raw Material Change means introducing new secondary materials, e.g. new chemicals or a new dyes etc. Significant Raw Material Change means introducing new basic material of the same category such as iron/aluminum in place of brass or synthetic fiber in place of natural fiber. Major Raw Material Change: means introducing a radically different raw material, such as wood or glass in place of metal.

Process Change: means introducing a new process/method for producing a product or introducing new type of machinery and/or both. Expert advice is taken for categorizing various machine based changes as minor, significant or major changes. In general incremental changes in machinery/process, such as improvement in loom design are labeled as minor process changes. Movement from manual/semi automatic machines to automatic machines is considered a significant process change. The category of major process changes includes replacing the existing machines belonging to electro-mechanical controls with machines with electronic controls, as well as major investment in new type of machinery with for starting a new stage of production, such as purchase of a processing plant.

While determining the level of innovative activity of each firm special care was taken to avoid double counting. Possibility of double counting arises because in some cases product, process and raw material changes are inextricably linked with each other. It is not possible to bring about change in the characteristics of an artifact or introduction of new artifact without undertaking either process change or raw material change. In many cases process change as well as raw material change is required for the introduction of product change. Similarly, contrary to the neo-classical myth, which allows for process change without an iota of change in the product characteristics/functioning, practically all the changes in process technologies change one or more characteristics of the product. In most cases the changes in process technologies may not be possible without change in the set of raw materials used. In fact, in a large number

\textsuperscript{132} The list of product categories is drawn on the basis of their uses. Detailed description of what is included in the three categories is provided in chapters IV and V. In general all process changes in manufacturing activities, involving use of equipment with micro electronic controls in both the clusters were placed under the category of major process change.
of cases a process change is introduced only to bring about a change in some of the characteristics rather than for cost reduction, as is believed by the neo-classical economist. For example the main reason for using of shuttle-less looms in place of conventional power loom by several firms in Panipat, is to produce finer quality fabric. Secondly, since shuttle-less loom cannot be used while working with low quality yarn, the change in process technology is necessarily accompanied by raw material change. Care is taken not to double count it on both accounts; as process change and as production of new type of fabric/use of new raw material. Certain type of changes in the product characteristic, such as a special finish to metal art-ware, are not considered as a part of product change, not because they are unimportant, but because they appear as a part of process change. The conceptual problem with this type of convention is that it may lead to slight de-emphasis of product change. But so long as the bias created is marginal, and is incapable of reversing the conclusions, it does not pose a serious problem.

In the same manner, product and raw material changes in certain cases are inseparable in the sense that one necessarily implies the other; e.g. moving to furniture category for a firm previously engaged in decorative metal items implies both a major product change and a major raw material change. In-fact the overlap in certain cases is so great that several studies tend to club them together. Our understanding is that a product change associated with raw material change can be very different in terms of requirement of technological capabilities, as compared to a product change depending on process change. So it is decided to keep product change and raw material change as two separate categories, even as care is taken to avoid double counting. It must be noted that not in all cases does a product change imply raw material change. For example introduction of ready made garments in a cluster previously specializing in home furnishing is considered a radical product change. But it may not involve any significant change in raw material.

**Innovativeness of a Cluster**

From a micro perspective it is important to find out what percentage of firms introduces new products/raw materials/process. Therefore innovations at the firm level include all the changes which are introduced for the first time by any cluster firm, as well as the imitation of changes which have already been introduced by some other firms of the cluster. But from the perspective of looking at the technological up-gradation of the cluster, it is not enough to use horizontal summation of firm level changes as a proxy for the index of technological change of the cluster. For a cluster to be termed as a technologically innovative cluster, at least some of the
cluster firms should be introducing new product/raw material or process technologies, hitherto unknown to the cluster. The reason for this is that though the extent of diffusion of existing technologies/practices can tell us something about immediate survival chances of the cluster, it says little about long term dynamism if the cluster. There is no insistence on creation of new technological knowledge. The new technologies introduced in the cluster may be created in the cluster or may be imported in the cluster from outside the cluster; from domestic or international sources. In both cases it is viewed as technological up-gradation of the cluster.

More significantly, the concept of up-gradation of the cluster also includes its functional up-gradation by introduction of new stages of value change, in manufacturing or marketing, hitherto not undertaken in the cluster. For example, introduction of spinning or designing activity for the first time by a cluster firm is a part of innovativeness of the cluster and is seen as a part of the up-gradation process of the cluster. But more and more firms introducing a stages of production already being carried out by some cluster firms is not innovation/up-gradation from cluster point of view.

There is no attempt made to create a mechanical quantitative index for the level of innovativeness/technological change of a cluster. The overall assessment of level of technological change in the cluster is made in a more holistic manner on the combined basis of the findings from the formal survey and discussions with the experts. For instance question 5.2, (see questionnaire, Appendix-Ib); 'were you first one in the cluster to introduce any change?' is geared at scouting innovation at the cluster level. This is supplemented by expert opinion and cluster level observations to get a holistic picture of the level of technology prevalent in the cluster and the changes taking place in it. Whereas in determining the level of technological innovation at the firm level the emphasis is on change, irrespective of the distance firms' technological level from the international technological frontier the assessment of level of technological performance of the cluster has to be in terms of both; the absolute change and the distance of the most innovative firms of the cluster from the best technologies used elsewhere in the world.

A cluster starting from a very low level of technology, far from the technological frontier/globally best practices will find it difficult to survive in the global world, even if at this point of time significant level of demand driven change is taking place.133 The policy

---

133 There is no attempt to have a statistical/technical definition of the 'frontier', or a set list of best practices. Even if it was readily available, it would be difficult to measure the difference of the cluster from it. Unlike a firm which
prescriptions for such a cluster will be different from the ones for the cluster with the same rate of change, but which is already close to the frontier. It is important to know as to where does the cluster stand in relation to its global competitors in terms of technology.

Information Technology Based Change

Since ICT (information and communication technologies) is a generic technology, not only in the sense that it can be used in the manufacturing activities in all the sectors, it is used to bring about organizational and marketing innovations. Therefore the nature of its diffusion could not be assessed through the standard categories of technological change; namely product, process and raw material change. Therefore we have introduced a separate, though some what awkward change component; Information Technology Based Change (ITBC).

Though the use of ICT does appear implicitly under process innovation or marketing innovation, given the importance of information about diffusion of IT technology in SSI units in, it was considered appropriate to have a holistic picture about the diffusion of ICT based technologies in all the stages of the value chains. A holistic picture of the use of IT; depicting the diffusion of ICT in management, marketing and manufacturing is created under the broad category termed as IT based change.

Organizational Innovation (OI)

The organizational changes undertaken by the firms in two clusters are divided in three categories, on the basis of the intended objective of introducing the change; improving quality, increasing productivity or improving working conditions

Organizational Innovation for Improving Quality includes changes introduced in the organization of production which are aimed at improving the quality of the product, or improving the perception of the buyer about the quality through improved quality signals. It takes the following forms in our research; (i) Improved Quality Control System (IQCS)

134 For example, introduction of micro- electronic tools such as CAD-CAM and CNC in manufacturing is counted as a major process change. Similarly, starting a website is seen as a marketing innovation.

135 Improved quality controlled mechanisms can take many other, specific forms of organizational innovation, such as TQM, introduction of quality circles (QCs) etc. But since majority of the firms in two clusters under study
through introduction of separate quality control divisions, (ii) more extensive inspection, and (iii) acquisition of Quality Certification such as ISO 9000/ISO 14000 or about the quality of the work place, such as SA 8000.

**Organizational Innovation for Improving Working Conditions:** includes (i) **improvement in the working space** such as augmenting space per worker, and providing more ventilation and fire exits etc. (ii) **installation of devices to control pollution levels**; water, air and noise pollution at the work place, such as ETP (Effluent Treatment Plant), dust collectors etc, and providing safety equipment to workers.

**Organizational Innovation for Increasing Productivity** includes measures aimed at increased productivity/cost reduction/shortening delivery time.\(^{136}\) The measures included in this study are; (i) improvements in **human resource management** includes changes in the mode of employing persons; temporary, permanent, mode of payment, work contracts, incentives etc. (ii) improvements in **inventory management**, by bringing changes in the level of vertical integration, communication methods and contact with sub-contractors and suppliers etc.

**Market Innovation**

The market innovations undertaken by the firms to enhance their competitiveness through market related activities considered in this project include: (i) **Entering new markets.** It includes entry in new markets within the country or outside the country; (ii) opening of **new show rooms/sales outlets**; it includes opening of show rooms locally, in other cities or in other countries. (iii) **Adoption of new marketing strategies** such as launching **website, advertising** through a new electronic or print media channels or developing a brand.

**Up-gradation of a Cluster**

Up-gradation is defined as **value addition through innovation.** From the point of view of this project innovations taking place in the cluster are important because they make it possible for the cluster to upgrade itself. Three routes through which industrial clusters can achieve upgradation are: technological up-gradation, functional up-gradation and inter-sectoral up-gradation.

---

\(^{136}\) There can be several such measures falling under the rubric of JMTs such as JIT, JER, and Kaizen etc. But since the majority of the respondents were not familiar with them, they have not been explicitly included in the questionnaire.
Technological up-gradation includes up-gradation of product or process up-gradation. Product up-gradation is done by introducing product/raw material innovation i.e. for moving into more sophisticated product lines in terms of increased unit values. Process up-gradation is done by introducing Process innovation to bring improvement in the rate of conversion of inputs into outputs by introducing superior technology. Technological up-gradation of the cluster means some of the cluster firms using upgraded product or process technologies, not used by any of the cluster firms earlier.

Functional upgrading means acquiring new, high value functions in the value chain, such as design or marketing/retailing, and/or abandoning existing low-value added functions to focus on higher value added activities Functional up-gradation of the cluster refers to some of the cluster firms performing the high value stages of production chain not performed earlier in the cluster.

Inter-sectoral up-gradation refers to up-gradation through diversification into a new sector by applying the competence acquired in a particular function in the existing sector.

3.2.2 TECHNOLOGICAL CAPABILITIES OF A CLUSTER

This project has used the concept of technological capabilities of the cluster, as different from firm level capabilities. Technological capabilities of the cluster, are viewed as depending on three important components; (i) The firm level capabilities or the capabilities located in the cluster firms, (ii) Cluster level technological capabilities or the collective capabilities of the cluster which depend on the technological infrastructure and the knowledge institutions in the close proximity of the cluster and (iii) Technological capabilities located in the intra-cluster links, which in-turn comprise of different capabilities located in different parts of the knowledge system or the production system of the cluster.

The presence of cluster level technological capabilities is explored with the help of micro as well as meso techniques. The structure and functioning of the collective, non-firm agents is studied with the help of meso techniques. The firm level study is used to determine the nature and extent of flows of knowledge between different firm and non-firm cluster agents. We have also made use of micro as well as meso tools to look into the strengths and the weaknesses of the technological infrastructure and technological capabilities of the two clusters.

137 The rate of conversion of inputs into outputs can also be brought by organizational innovation i.e. reorganizing the production system.
effectiveness of the cluster’s technological capabilities is explored on the basis of responses to
firm level questionnaire. The efficacy of various institutions is explored on the basis of
interviews with the experts and other relevant persons.

Components of Firm Level Technological Capabilities

The various components of entering the composite index of firm level technological
capabilities (TCAPS) are as follows;

- Educational Level of the (ELE) Entrepreneur;
- Educational Qualification of the workers (EQWs),
- Access to Technological Knowledge: Use of Books and Journals (BJ)
- Technical Support Structure, which includes the following
  - In-house R&D facility, carrying out research or testing activity
  - In-house Product Development Department, engaged in development of new products/
    product designs.
- Competence in use of Information Technology (IT)

Each one of the component of the technological capabilities of a firm is measured on
three levels: high (H), medium (M) or low (L). Absence of a particular capability is denoted by
(N). Table 3.2 indicates these factors and the index adopted to assign certain values ranging
from low (L) to medium (M) to high (H).

The overall level of the Technological Capabilities of firms (TCAPS) is determined on
the basis of levels of all the individual capabilities processed by a firm. Firms with H in at least
three capabilities are placed in the category of high (H) TCAPS. Firms with H in two
capabilities are placed in the category of medium (M) TCAPS. The remaining firms are in the
category of low (L) TCAPS.

Components of Cluster Level Technological Capabilities

The following are the components of collective or cluster level technological
capabilities.

- Educational institutions located in the cluster
- S&T/ R&D institutions and testing facilities located in the cluster
- Facilities for skill creation and training located in the cluster

The level of TCAPS of a firm is not seen as a weighted average of percentage of people with different level
educational qualifications. Presence of at least one person with a particular qualification is assumed to lend the
firm the specific level of technological capabilities associated with a particular type of education qualification.
**Table 3.2 - Components of the Technological Capabilities of the Firms**

<table>
<thead>
<tr>
<th>Components: Index Used</th>
<th>Specification of Level</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>R&amp;D intensity showing expenditure on R&amp;D as % of total turnover</td>
<td>L= less than 0-1% on M=1-2% H= more than 2%</td>
<td>R&amp;D/D intensity is represented by ratio of Expenditure on R&amp;D/PDD to Total turnover of the firm. Expenditure on research and product development is lumped together for this purpose.</td>
</tr>
<tr>
<td>ELE: Qualifications of the entrepreneur/owner of the firm</td>
<td>N= No formal education L=High School or lower M=Graduate/Diploma H= Post-Grad/Ph.D.</td>
<td>Distinction is drawn between qualifications of entrepreneur/workers in different disciplines: Technology, Science, Design, Commerce and Social Science.</td>
</tr>
<tr>
<td>EQS=Educational Qualifications of the Workers</td>
<td>N= No formal education L=High School or lower M=Graduate/Diploma H= Post-Grad/Ph.D.</td>
<td>Distinction is drawn between qualifications of workers in different disciplines: Technology, Science, Design, Commerce and Social Science.</td>
</tr>
<tr>
<td>TR: Provision for Training and Skills</td>
<td>N= None L= Low H= High</td>
<td>Occasional training e.g. participating in workshops is labeled as L and regular/annual in-house training as H.</td>
</tr>
<tr>
<td>BJ: Consulting Books and Journals</td>
<td>N= None L= Low H= High</td>
<td>Consultation of Trade journals and design magazines etc. is labeled as L and that of technical literature as H</td>
</tr>
<tr>
<td>Competency in Use of IT</td>
<td>N= None L= Low M=medium H= high</td>
<td>N= none users, L= using E-mail etc., M= using computer for administrative functions such as keeping accounts, H= Using IT in manufacturing, e.g. use of CAD/CAM.</td>
</tr>
<tr>
<td>Technological Capabilities of a firm: TCAPS</td>
<td>L=Low M=Medium H=High</td>
<td>TCAPS represents the composite index of a firm’s technological capabilities. Firms with H in at least three components are placed in H category of TCAPS, with two H in the M category and the rest in L category.</td>
</tr>
</tbody>
</table>

**Components of Technological Capabilities Located in the Intra Cluster Links**

This is an index of technological learning due to clustering, and depends on the extent and manner in which various components of the cluster interact with each other. Intra cluster interaction comprises of the formal vertical links, as well as informal horizontal links of the cluster actors with each other and with actors in the value chain located outside the cluster. Since technological learning can result from cluster firms networking with different elements of knowledge system as well as production system, interaction between all the actors in the value chain is studied. Both bilateral and multilateral links are explored for this purpose. Forms of co-operation resulting from bilateral horizontal links explored in the study include: Sharing of technological/ market knowledge, specialized equipment/ skills, joint marketing/training...

---

139 The links with actors located outside the cluster are considered separately in order to see what portion of technological learning is a result of clustering and how much of it is due to external sources, particularly international sources.

140 The details of the horizontal and vertical links are present in question number 7 of the detailed questionnaire given in Appendix – 1a and 1b.
Multilateral horizontal links explored in the study include: Public sector agencies, trade associations and others. Vertical links considered for the purpose include links with: Sub contractors, manufacturers/suppliers of equipment and repair facilities and private consultants.
## TABLE 3.1 - Summary Picture of Interview Schedule

<table>
<thead>
<tr>
<th>INFORMATION SOUGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>General Information about the firm</strong></td>
</tr>
<tr>
<td>Information about the firm: Year of establishment, registration, Membership of Associations</td>
</tr>
<tr>
<td>General information about the Entrepreneur: Qualifications, experience, embeddedness</td>
</tr>
<tr>
<td><strong>Economic information</strong></td>
</tr>
<tr>
<td>Economic information about the firm: Trends in Turnover, profits, exports</td>
</tr>
<tr>
<td><strong>Information about workers</strong></td>
</tr>
<tr>
<td>Information about workers: number, gender, wage rate, mode of payment, embeddedness</td>
</tr>
<tr>
<td><strong>Technological capabilities of the firm</strong></td>
</tr>
<tr>
<td>R&amp;D/ design, expenditure on R&amp;D, qualifications of the staff, training, technical literature, competency</td>
</tr>
<tr>
<td><strong>Type of Technological Innovation</strong></td>
</tr>
<tr>
<td>Product innovation</td>
</tr>
<tr>
<td>Raw materials innovation</td>
</tr>
<tr>
<td>Process/machinery innovation</td>
</tr>
<tr>
<td>Adoption of IT: production, management, marketing</td>
</tr>
<tr>
<td>Technological change: innovation and diffusion</td>
</tr>
<tr>
<td><strong>Technological Innovation:</strong></td>
</tr>
<tr>
<td>Stimulus for Technological change: Demand pull versus Technology push</td>
</tr>
<tr>
<td><strong>Actors in the innovation chain</strong></td>
</tr>
<tr>
<td>Innovation Process: Role of Intra-cluster links versus External links</td>
</tr>
<tr>
<td>Bilateral Horizontal links: Sharing technological/market knowledge, specialized equipment/skills, joint</td>
</tr>
<tr>
<td>Multilateral horizontal links: links with Public sector agencies, trade associations, others</td>
</tr>
<tr>
<td>Vertical links: Sub contractors, equipment suppliers, and private consultants</td>
</tr>
<tr>
<td><strong>Organizational Innovation</strong></td>
</tr>
<tr>
<td>Types, motivation</td>
</tr>
<tr>
<td>Quality up-gradation, rejection rate certification,</td>
</tr>
<tr>
<td>Quality up-gradation: pressure from the buyer</td>
</tr>
<tr>
<td><strong>Market Innovation</strong></td>
</tr>
<tr>
<td>Market orientation, market destination</td>
</tr>
<tr>
<td>Market innovation: brand name, advertisement, website, attending fairs, showrooms, consortiums</td>
</tr>
<tr>
<td><strong>Role of the governments: actual and desired</strong></td>
</tr>
<tr>
<td>Helpful Government policies/agencies: central, State and local governments</td>
</tr>
<tr>
<td>Desired government help: infrastructure, physical, technological, financial, any other</td>
</tr>
<tr>
<td><strong>Strengths and weakness of the cluster</strong></td>
</tr>
<tr>
<td>Perceived strengths of the cluster</td>
</tr>
<tr>
<td>Perceived problems in the cluster</td>
</tr>
<tr>
<td>Perceived future of the cluster</td>
</tr>
</tbody>
</table>