सत्यमेव जयते

Brain Storming Session on

DST – NSTMIS Supported Innovation Projects

18th August 2017

India International Centre, New Delhi

Catalyzed and Supported by

Centre for Human and Organisational Resource Development (CHORD)

National Science and Technology Management Information System (NSTMIS)

Department of Science and Technology

Government of India

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Academy for Science Policy Implementation and Research (ASPIRE)

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Catalyzed and supported by CHORD- NSTMIS, DST, Academy for Science Policy Implementation and Research (ASPIRE), ASCI, organized a day-long Brain Storming Session (BSS) on 18thAugust 2017 at India International Centre (Annexe), Lodhi Road, New Delhi. The objective of the BSS was to deliberate, consolidate and understand the connecting story underlying the outcome of the eight DST-NSTMIS sponsored studies during 2014-16 and to suggest a way forward in advancing this subject of national and global importance. It was well received and attended by a range of experts and research teams who have conducted the studies. The presentations provided insights into the studies and were followed by lively discussions that brought out many aspects of experience and methodologies to the fore.

Contents

Summary

Innovation Studies: Where do we stand?

The main purpose of the Brain Storming Session (BSS) is to explore and understand the connecting story underlying the outcome of various innovation projects and to suggest a way forward in advancing this subject of national and global importance. The first National Innovation Survey (NIS) report was presented in various BSSs in different parts of the country for critical reviews before finally released by DST in 2014. While shortcomings of this first ever initiative were discussed threadbare, the need for more focussed supplementary studies were also highlighted as a desirable step towards the next round of NIS.

Subsequently, NSTMIS division of DST had initiated eight sponsored studies during 2014-16. These are:

1. Study on 'Status, Systems and Strategies of Innovation in SMEs in the Equipment and Machinery Sector; Global Projects & Services, New Delhi
2. Extent of R&D and innovation in MSMEs in West Bengal: Strategies, Determinants and Effects; Calcutta Business School, Calcutta.
3. Innovation Management and Practices in SMEs': Antecedents & Challenges; Sri Ramakrishna College of Arts and Science for Women, Coimbatore
4. Assessing Industrial Innovation Process and Suggesting Policy Support Framework in India; Foundation for MSME Clusters, Delhi
5. Innovation in Large Manufacturing Firms: In the Era of "Make in India"; Administrative Staff College of India (ASCI), Hyderabad
6. Assessment of Research & Development & Innovation Practices in Micro, Small & Medium Manufacturing Enterprises (MSMEs) in India; Market Insight Consultants (MIC), NOIDA
7. MNCs' R&D in India: A glimpse; Confederation of Indian Industries (CII), Delhi
8. Organisational Practices for Innovation in Indian Industries: A firm level case study on Human Resources and Work Culture; Centre for Knowledge, Ideas and Development Studies (KnIDS), Delhi

This brief attempts a consolidated overview and understanding derived from the above studies. In the following discussion, studies would be referred by the serial numbers shown in the above list. We shall follow the familiar project template–

a. Key questions/objectives/hypotheses
b. Methodologies
c. Data sources
d. Findings/observations
e. Conclusions/policy implications

Key questions/objectives/hypotheses

Six out of eight studies had focussed on Micro, Small & Medium Enterprises (MSMEs), one study was on MNCs initiatives on R&D and innovations and the other one was on innovations by large firms. The MSME focussed studies had dealt with four broad questions: Identification of innovative firms, types of innovation, and extent of innovation; Determinants and Strategies for innovations; Gains from innovations; Constraints and challenges of innovation.

A general hypothesis that emerges from the studies is that while firm level parameters are important for innovativeness of the firms, there is an overall inertia towards innovation as the driving force for creating competitive advantage. The inertia is reinforced by the disconnect between the innovation support system and the firms' production system. Firms operate in the comfort zone of competition by adopting the practices in the market place. In brief, the innovation ecosystem is inadequate for innovative drives of the firm.

Methodologies

Methodologies adopted by the studies have interesting variations in approaches. Broadly, while some studies approaches the issue by verifying the determinants that are known from earlier studies and literature; the other look at the issue for how to activate the determinants in the Indian ecosystem. Either ways, most of the studies try to capture the process of innovation and/or firms' strategies for innovation in terms of mobilisation and deployment of resources (physical, financial, knowledge/information and Human resources), and accessing the sources and support system for the same – tracing and evaluating the innovation value chain.

Important take away from the methodologies adopted by these studies is the need for developing a micro level (firm level) system of innovation that will complement NIS, RIS and SIS. It is the firm level system of innovation that effectively brings out, as most of the studies suggest, the inadequacy of the innovation systems at higher level of aggregation. In other words the need for articulation of the macro level systems of innovations.

Data/information Sources

Two distinct ways of collection of data/information are discernible. One was based on questionnaire structured on the basis of theoretical understanding of the issues that were to be addressed, and the other was empirical exploration of the insights to the questions to be investigated. The first set of studies adopted sample survey either for a state or for a selected set of states, or a selected sector in a state. Three studies used the innovative firms identified in the NIS for further exploration of the issues underlined above. Others have identified own set of innovative firms and their innovations and innovativeness. The second set of studies, on the other hand, used case study method to delineate the and after innovation.

Findings and observations

- Overarching observation of the studies is the passive approach to innovation in Indian industries, especially among the MSMEs. However, growing realisation of the need for innovation for sustenance in a globalised market place is palpable. Different studies have arrived at this observation through different routes. Study on Machinery and Equipment industry (study 1) suggests that innovation is essentially driven by the foresight and dynamism of the owner of the firm. Even in such cases innovation is reactive as opposed to proactive.
- Most of the innovative firms do not have any formal internal system of promoting innovations; customer requirements and/or market prompts are the main driving force for innovation. Study 3 arrives at the similar findings suggesting that success in innovation is achieved through continuous monitoring and quality improvement of the products – the

initiative that depends much on the owner's drive for innovation. The same study shows that innovation happens when there is a internal system of promoting innovations.

- Similar are the findings from the Human Resource and work culture related study (study 8), which takes the human resource perspective of innovation and finds few evidence of creating firm specific human resource development strategies of the firms across industries and states.
- Study 2 has found some evidence suggesting firm size as an advantage for innovation. The study also finds sector specific dynamics for types of innovations, namely, product and/or process innovations. Study 3 suggests positive relationship between age/gender and innovativeness. Study 1, however, does not support any such observations.
- Study 2 examines relationship between skill base of the firms and innovation and finds evidences suggestive of positive relations between the two. Study 8 also presents positive relation between skill base of the firms and firm size, and also with types of innovations. It has been observed that firms with low skill base and/or small firms do engage mostly in marketing innovations. Study 3 also suggests similar observations.
- Study 4 examines the five stages of innovation at the enterprise level, from ideation to sustainability, for both successful and failure cases and suggests that the ideation remains the most important driving force for innovation. The study 8 resonates similar observation for what it calls firm level system of innovation. In addition, the study treats Human Resource in a firm as source of ideas for innovation and much of the success depends on work culture of the firm in deploying, nurturing and effective utilisation of HR. The study observes that Indian firms are far away from the ideal practices in this regard. In fact, the emphasis on the ownership of the firm as driving force of innovation, as it is in Study 1 can be interpreted as similar to the above.
- Study 6 examines MSMEs in terms of different indicators of innovation and innovativeness. The sample survey assesses present state of MSMEs' in terms of size, ownership, manpower (S&T and others), training, R&D expenditure etc. This study finds survival in the market as the main driving force innovation. Innovative firms try to follow changes in the practices in the industry and also market signals on changes in the consumer preferences.
- Study 7 focuses on the MNCs contribution to Indian innovation system. The study suggests that MNCs' interest in R&D in India is mainly product centric development. However, the

study does not report a very encouraging scenario of MNCs' R&D collaborations with Indian institutions.

- Study 5 focuses on large firms' R&D behaviour, innovation and related issues using both quantitative and qualitative analysis to tests some of the well-articulated hypotheses on innovativeness and firm size. The study also identified the industry sector specific gaps and constraints in the policies and the related suggestions of the industry.
- Most of the studies reported availability of finance, risk funding, market uncertainty, support for training, skilled manpower and development, information etc as main barriers to innovations.

Conclusion and policy implications

- Except study 5 and 7, remaining 6 studies focussed on MSMEs. The overall scenario that emerges is that of innovation dynamics essentially led by the instinct to survive in the market. However, creating market advantage by building enterprise specific assets is yet to be caught up as a firm level strategy in the MSMEs. The studies highlight the disconnect between innovation support system and the MSMEs' innovations, as reflected in the findings as most of the firms essentially depend on internal resources for skill development, training, finances, access to new information and knowledge. Internal resources are complemented with the feedback received from customers and vendors.
- Among others, important barrier to innovation appears to be lack of skilled manpower and availability of finances. The most important take away from the studies is that MSMEs are aware of the importance of innovation for their survival in the market in the wake of local and global competition. What they appear to be unsure of is about handling of associated challenges and uncertainties that come with new initiatives.
- Strengthening of the existing innovation support system and its reach at the local level requires a major policy thrust; encouraging large firms including MNCs to bring into their fold MSMEs as part of their innovation value chain emerges as a suitable option leading to a win-win situation.

- Skill development is another area that requires serious attention if innovations in Indian industries is expected to be the future dynamics. The initiatives in this regard, require to be taken up in consultation with the demands from the MSMEs. Suitable organisational structure has to be planned towards this end.

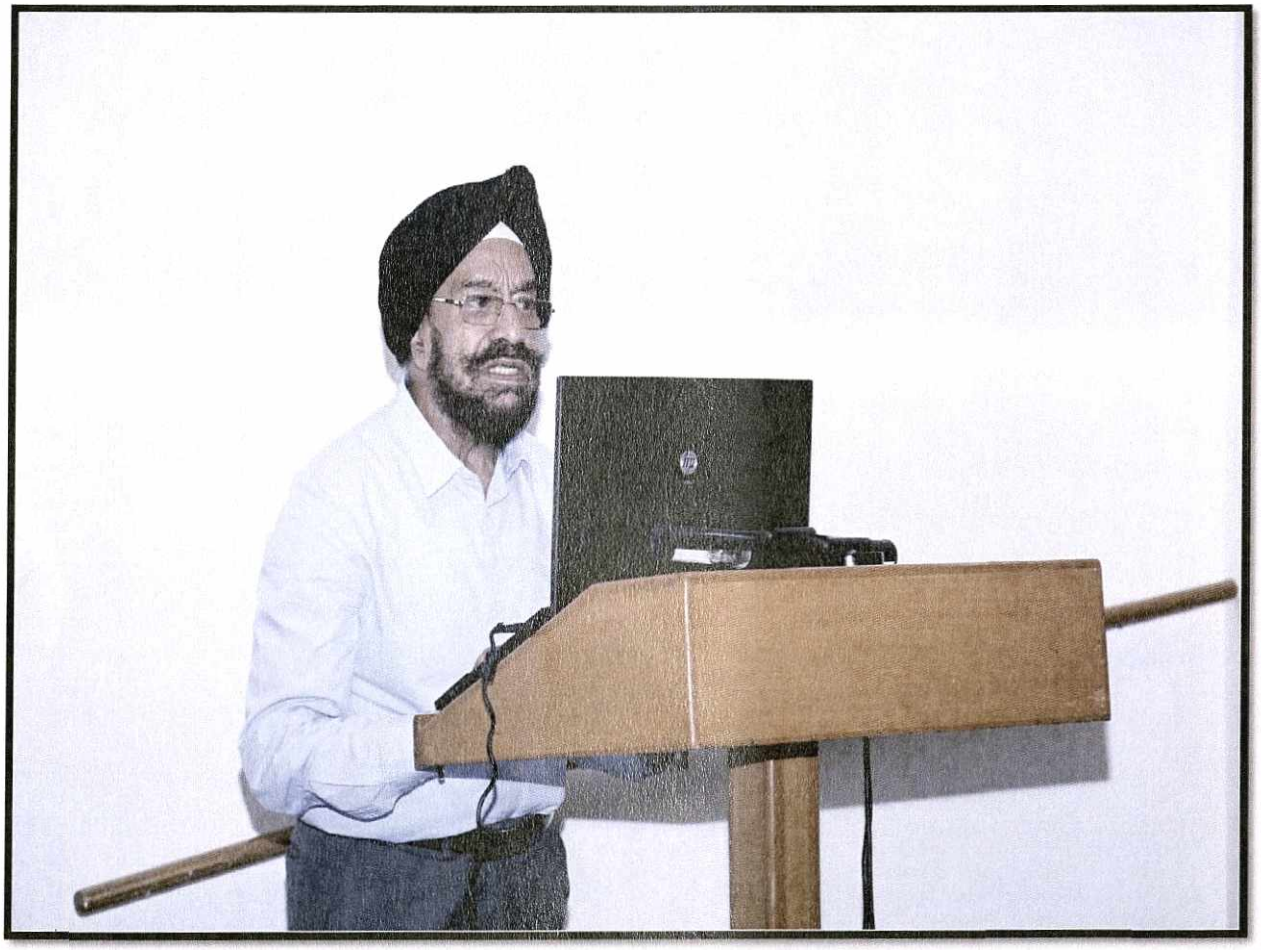
Brain Storming Session at Indian International Centre (IIC), New Delhi

Brain Storming Session – CHORD-NSTMIS, DST Supported Innovation Projects

Innovation Studies sponsored by NSTMIS, DST

Status, Systems and Strategies of Innovation in SMEs in the Equipment and Machinery Sector

Brain Storming Session – CHORD-NSTMIS, DST Supported Innovation Projects



*Presentation delivered by **Dr. J. S. Juneja** on "Study on Status, Systems and Strategies of Innovation in SMEs in the Equipment and Machinery Sector"*

Project Title: Study on 'Status, Systems and Strategies of Innovation in SMEs in the Equipment and Machinery Sector

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Year of completion of Study: 2016

Objectives of the Study:

To carry out an in-depth knowledge-based study at firm level, on the following:

- Status, processes and strategies of innovation;
- Innovation and types of innovation vis-a-vis size of the firm, manpower/skills available, funds/support systems (institutional, policy and others) deployed;
- Outcome of innovation in terms of gains to the company and customers to assess the effectiveness of innovation systems;
- Stimulants and Retardants of innovation and support systems(institutional and others) availed of and/or needed to enhance innovation;
- Developing indicators, both from input and output sides to assess the status and systems of innovation and more importantly discern the stimulants and retardants to enable devising of appropriate policy and support mechanisms.

Methodology of the Study

i. One of the findings of the National Innovation Survey sponsored by DST was that for two-thirds of the innovative firms, the innovation is in introducing new machines and production equipment. The Survey also identified equipment and machinery being among the top 5 innovative sectors in the states such as Delhi, Andhra Pradesh, Chhattisgarh, Gujarat, Haryana, Karnataka, Maharashtra, U.P, Rajasthan, West Bengal, Punjab and Tamil Nadu.
The present Study, building further on the above finding of the Survey, relates to an in-depth study of innovation and its process **at firm level** to discern the status of innovation, the systems of innovation and the innovation strategies adopted by SME firms in the equipment

and machinery. SME clusters in the regions of Ahmedabad-Vadodara (Gujarat), Mumbai-Pune (Maharashtra), Ludhiana-Batala (Punjab) and Chennai-Coimbatore (Tamil Nadu) and the NCR were selected for the Study. A desk study by the Investigators showed that around 300 SMEs manufacturing equipment and machinery are distributed among the four sectors of Pharmaceutical, Chemicals, Plastics, and Machine Tools among these five regions. These SMEs thus formed the target population for the Study.

ii. The Study comprised two Phases; the **Phase-I** pertained to identifying 'Innovative' SME firms in the above four sectors in the five geographical clusters and **Phase-II** comprised in depth person based studies of select 'Innovative Firms' identified in the Phase-I. ***The Oslo definitions of 'Innovation' and 'Innovative firms' have been used to identify innovations and innovative firms.*** Thus product, process, marketing and organisational innovations made and implemented by the firms have been considered for the purpose of this study.

iii. Since the data collection was knowledge based and not census or statistical oriented it required understanding and comprehension of the sectors to be surveyed and empathy for innovation. Thus five Knowledge Experts (senior persons from the industry, R&D, consultancy organizations etc.) were engaged. The Phase I survey was conducted through postal and electronic mails including web based portal, followed by person based survey by the concerned Knowledge Experts. Before proceeding with survey of all the firms, a pilot survey of the SMEs in the NCR with its findings was presented to the DST constituted Local Project Advisory Committee (LPAC) for its guidance and advice.

iv. The Innovative Firms identified in Phase I were approached for detailed in-depth studies/discussions as Phase II. However most of the firms were not responsive to such visits and it was only after extensive follow up by the concerned Knowledge Experts and personal contacts that only 30 owner-innovators agreed to visits & in-depth discussions. The discussions focused on the evolution of the firm, the innovations (products, processes, marketing and organizational) carried out, their implementation, systems and strategies of innovations & their management, economic impacts, IPRs and issues with the Government etc. The workshops/factory areas (wherever permitted by the firm) were visited to observe their shop floor practices, managing of material, manpower etc. The visits varied from half a day to full day depending upon the firm's willingness to participate in the discussions and to the extent it was willing to share the information and show their shop floor practices.

Data Sources

The Study commenced in July, 2014 and covered data period of three years from 2011-12 to 2013-14. The data sources comprised both Primary and Secondary sources. The information pertaining to the SME firms in the concerned region was collected from:

I. State Commissioners of Industries,
II. DICs and the regional offices of NSIC,
III. Relevant Industries Associations.

The other Secondary sources comprise various printed and electronic literature including Annual Reports of the concerned Ministries, Working Group Report on Capital Goods & Engineering sector of the Govt. of India etc. all available in the open source. A list of such sources is given in the main Report of the Study.

The primary sources comprise the data generated through actual field survey and discussions/interaction with the participating SMEs in the Study.

Brief Findings

The Study studied the status, systems prevalent in the SMEs and the strategies if any followed by these firms for the innovation. It also examined the stimulants and retardants faced by the SMEs which either help or retard their efforts for innovation. The firms during the Study shared their experiences/opinions on the large National Innovation System in promoting or furthering innovation in the SMEs. The Study also tried to identify the possible indicators, both input as well as output indicators in a firm that will give indication of its inclination or disposition towards innovation. It tried to assess the relationship if any, exists between the firm's size, turnover, age, ownership etc. and its performance in innovation. The findings are summarised below:

1. **Status, Systems and Strategy of Innovations**

1a. Status of Innovation

i. Product and Process innovations form the bulk, 47% of the Innovations, marketing 34% and organizational innovation only19%.

ii. The firms have been adept at reverse engineering; most Innovations are 'New to Firm's types and incremental in nature. Though some firms claimed 'New to Industry' i.e. novel innovations however they were unable to back up their claims with proof of novelty such as patents, design or copy rights etc.

iii. Brighter side of this picture is the growing realization by the firms that innovation is needed for sustenance in the market and some of SMEs studied are working in this direction.

1b. System of Innovation

i. There are no discernible or formal systems of innovations instituted in most of the SMEs.

ii. A few SMEs have small design and development units however most outsource their requirement/ assistance and prefer individual consultants/experts rather than formal R&D systems for the same.

iii. The entire process of innovation from idea generation to development and implementation is mainly owner driven.

1c. Strategy of Innovation

i. Innovation Strategy' in SMEs is highly 'Customer Centered'- the customers' requirements or market needs are the drivers for innovation.

ii. Most SMEs would not take development and manufacturing unless there is identified customer and market.

iii. Intelligence for innovation on new product & process is gathered from visits to national and international fairs & exhibitions.

2 Stimulants and Retardants for Innovation

i. Markets and customers being the main stimulants to innovate.

ii. Lack of finance found to be the main retardant for innovation.

iii. Lack of availability of trained or skilled manpower especially with multi disciplinary skills for R&D being other retardants.

iv. The Government's present policies on tax, imports, higher cost of land for expansion etc. are among the other inhibitors for innovation.

3 Innovation Indicators

The 'Innovation Indicators' on output side are many which are discernible and identifiable in terms of new products, processes, IPRs, economic gains etc. however on the input side it is mainly the owner's inclination, initiative and zeal to go in for innovation which is the determining but a non-discernible factor.

4 Interaction with Publicly Funded R&D System

Most SMEs have very small design and development set ups/facilities, often outsource design and development or technical advice/consultancy from individual consultants/ experts (especially retired from the public and private sectors) as they find it more convenient, faster and cost effective as against seeking assistance of publicly funded R&D institutions/system. The reasons cited being lack of awareness on the part of the SMEs themselves of the

existence of such a support system or the infrastructure/facilities available with these institutions besides lack of adequate or updated technical knowledge/information with such institutions, non adherence of delivery schedules, bureaucratic procedures and significant paper work involved and also services of these institutions being comparatively costlier.

5 Effects of Firm's characteristics and innovation performance

The analysis of the data of the survey shows that:

i. Size of the firm in terms of investment on plant and machinery does not appear to have effect on innovation performance of firms as firms with capital investments of about Rs. 10-15 lakh have been as successful in developing/ commercializing innovations as the firms with much larger investments of Rs.12,000 lakh have been.

ii. The innovation is owner driven as the proprietary firms (including the partnership and family firms) form the largest shares among the Innovative firms.
   a. No significant effect found of owner's or firm's educational assets on its performance in innovation; firms with owners having qualifications of school leaving certificate or a graduation in humanities only, have successful innovations to their credit.

iii. Sales turnover does not appear to have a bearing on firm's performance in innovations as firms with a turnover of around Rs.100-150 lakh are successful as their counter parts with much larger turnover of Rs. 5000 lakh and above.

iv. Younger firms (in terms of year of establishment) have larger share among innovative firms, may be due to increased awareness/access to new knowledge, outlook, better and modern infrastructural facilities increasingly available.

v. Innovation helped firms in increasing their production; 56% of the Innovative Firms claimed increase in the range of 5-10% as against 29% of the Non Innovative Firms showing a decline.

vi. Manpower deployed also does not appear to have an effect on performance in innovation; firms with engineering/ technical manpower of only around 2-3 persons have developed and commercialized equipment and machinery successfully.

Conclusions and Policy Implications

Innovations in the Indian SMEs in the equipment and machinery sector mostly comprise reverse engineering of equipment and machinery available in the market with some firms incorporating

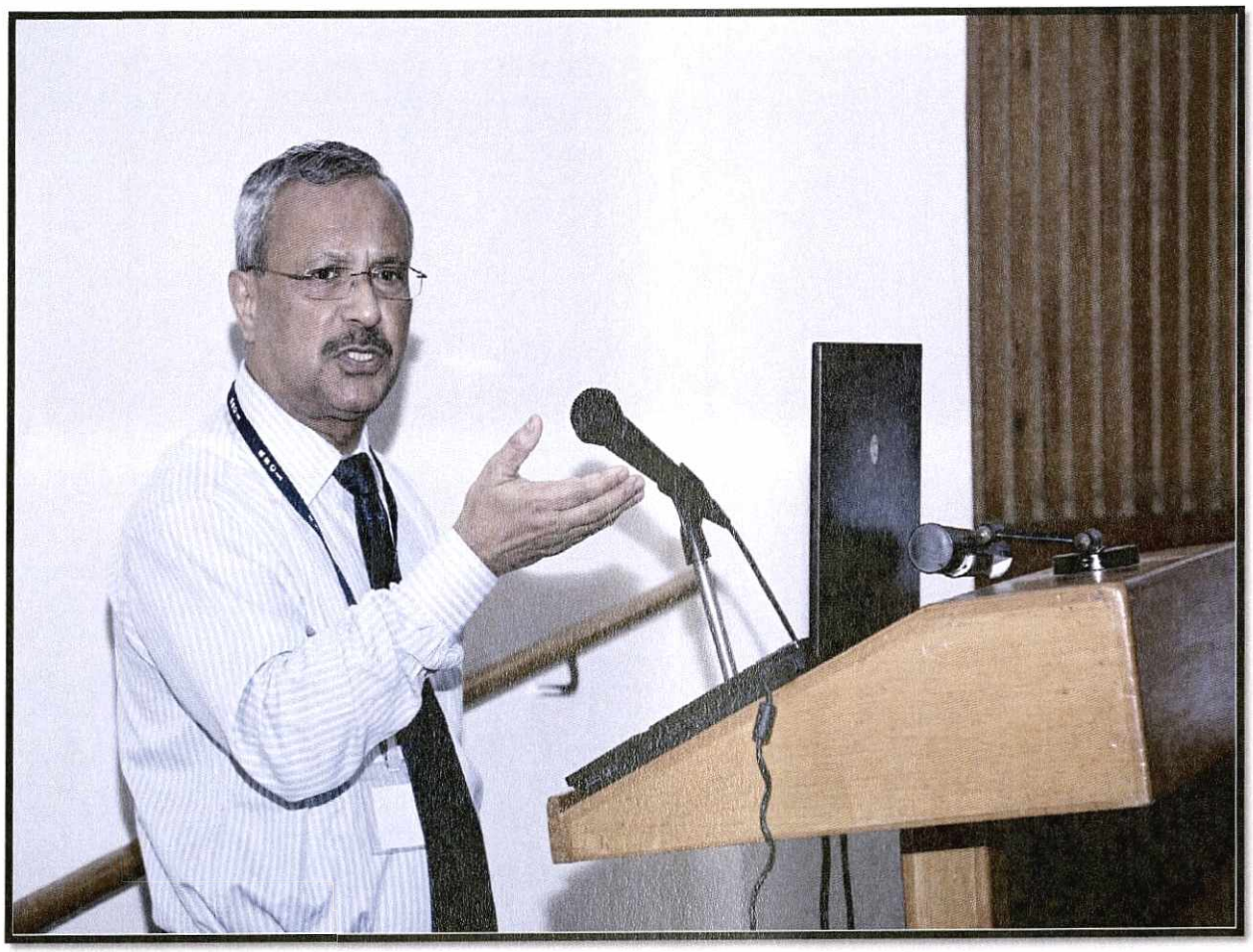
newer features and functions to suit locale-specific conditions/ environment thereby gaining in improvement of performance and savings in energy. However there is now a growing realization among some firms to go in for novel innovations to survive in the globally competitive market. The Study also reveals that there are constraints, which inhibit the growth, sustainability, competitiveness and innovativeness of SMEs. Thus one of the major constraints facing the small sector is the financial constraint. Besides, the SMEs also face the constraint of lack of new knowledge, awareness of IPRs systems/procedures etc. There is generally no interaction or awareness in the SME sector of the vast National Innovation System available in the country. In some cases, where such information exists the SMEs were skeptical in approaching these laboratories/institutions due to bureaucratic/formal procedures and systems existing in these organizations. The other issues and constraints facing the SMEs are relating to manpower, technology, IPRs and Governmental regulatory procedures etc.

Thus arising from the findings of the Study, the major policy measures to promote innovation amongst SMEs suggested are to:

- Modernization of infrastructure for promotion of innovation in the SMEs
- Set up a Meta Data/Information Referral Bank for the sources of information of relevance and utility of SMEs.
- Realign the focus of publicly funded institutions to assist SMEs on information, training, design, prototyping and testing.
- Recognize and showcase the innovation achievements of micro and small-innovators.
- Accord protection to Indian products from unfair imports, especially from China.

Extent of R&D and Innovation in MSMEs in West Bengal: Strategies, Determinants and Effects

Brain Storming Session – CHORD-NSTMIS, DST Supported Innovation Projects



*Peresentation by **Dr. Tamal Datta Chaudhuri** on "Extent of R & D and Innovation in MSMEs in West Bengal: Strategies, determinants and effects"*

Project Title: Extent of R&D and Innovation in MSMEs in West Bengal: Strategies, Determinants and Effects

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Year of Completion of Study: 2017

Key Questions/Objectives/Hypothesis of the Study:

The literature has emphasized on the innovative abilities of the MSME units and attributed this to their size, scale of operations, flexibility and low overheads. These units have been found to be adaptive, quick to respond to market changes and their success has been due to their innovativeness. Given that the state of West Bengal in India ranks second highest among all states in India with around 36.64 lakh MSMEs employing around 85.78 lakh people, it was felt that a study of the extent of innovativeness of MSMEs in the state of West Bengal would throw up interesting insights. It was also felt that such a study would shed light on the impact of various policy efforts of the governments, both state and central, in the growth of this sector.

The objective of the study was to estimate the extent of innovation, spread of innovation and the types of innovation undertaken in MSME units in the state of West Bengal. Further, we were interested in assessing whether the innovation varied depending on the location, sector, size, and skill availability of the units and also the sources of innovation. It was also our objective to study the constraints these units face, both overall, and also for innovation.

The objective was also to map the information on district-wise, size-wise, industry-wise, innovation type-wise, skill profile-wise, and source of information for innovation-wise distribution of the sampled units with growth of the units over the period 2013-14 and 2014-15. We present the data to understand whether we can combine size, source of innovation, skill profile and type of innovation with growth.

Methodological Details of the Study

This study is based on primary data collected from a ground level survey, with a structured questionnaire. These units are not listed companies and no data is available from secondary sources. The survey was conducted with the help of officials of District Industries Centers (DICs) of different districts in the State of West Bengal, as otherwise, the units would not have provided any information. As some of these units have availed subsidy from the state government, they were willing to share information. A few case studies were undertaken to have deeper insight into their innovativeness.

The units in the sample were chosen from four districts. Majority of the industrial units in the state of West Bengal are located in the districts of Howrah and Burdwan in South Bengal. Howrah has a long history of manufacturing units and Burdwan has Durgapur Steel Plant and the ancillary industries around it. Fifty percent of the units in the sample are from these districts. The other fifty per cent is from South 24 Paraganas which has a large concentration of denim units. This area has close interaction with the textile units in Metiabruz, which is one of the largest textile centres in the country. The fourth district chosen is Nadia, which has a large concentration of micro units. The units surveyed and included in the sample were chosen by the local DIC officials. They felt that these units would be relevant for the study as they may have undertaken some innovation. Further, these units would understand the relevance of the study and would be willing to share information. Thus, selective sampling was done as random sampling would not work.

The response to the questionnaire was collated by the DIC officials. More often than not, multiple visits were required to explain some of the questions. The PI also made visits to the units to explain the purpose and the nature of the questions.

Data Sources: Primary; Collected over the period 2015-16.

Brief Findings/Observations:

If we take size wise distribution of innovation, the medium scale units have, proportionately, innovated more. The number of units not innovating is concentrated more in the micro and small scale sector. As against 90% of the firms innovating in the medium scale sector, the figure for the micro and small scale sector is around 82%.

We observe that manufacture of wearing apparel has gone in relatively more for product and marketing innovation, as compared to process innovation. Units involved in manufacture of chemicals and chemical products have gone in more for process innovation. Units involved in manufacture of rubber and plastic products, manufacture of other non-metallic mineral products, manufacture of basic metals, manufacture of fabricated metal products, except machinery and equipment, manufacture of electrical equipment and manufacture of machinery and equipment n.e.c. have all undertaken all the three types of innovation. Interestingly, manufacture of other non-metallic mineral products has not seen much of marketing innovation. Electricity, gas, steam and air conditioning supply units have gone more for process innovation.

The literature has related innovation to availability of skilled manpower and also education. Our findings show that

1. Across all sizes, "no innovation" is associated with low skill levels present in the units. This finding is consistent as innovativeness requires some extent of skill and training.
2. The skill sets in the medium scale units were moderate to high. This follows from 1.
3. The skill sets in the micro and small units were low to moderate.
4. While product innovation required relatively high skill sets, process only required low to moderate skill sets. The latter is not consistent as process innovation requires skill. For example, the medium scale units required moderate skill sets for process innovation.
5. Only marketing innovation required moderate to high skill. As the product and the process were standardized, it was marketing skills that could make the units survive.
6. Medium scale units, whether undertaking only marketing innovation or process and marketing innovation or all three kinds of innovation, had moderate to high skill sets.
7. Some non-innovating firms did have moderate to high skilled manpower. It is possible that at the time of conducting the survey, they were not engaged in any form of innovation.

One of the objectives of the study was to relate innovation with skill intensity of the units. For the units in Howrah and South 24 Paraganas that have innovated, skill intensity was higher. On the other hand, in the districts of Burdwan and Nadia, units with low skill intensity have also innovated, but their nature of innovation was more market innovation. Further, the proportion of skilled manpower is higher in units which have gone for process and product innovation. Units going in for marketing innovation are such units whose technical skill requirement is low.

While trying to relate innovation with growth, or increased production of goods and services, or savings in labour or other costs, we get the overall impression that units with higher skill intensity and with some form of innovation, have grown. Further, in house source of information or qualified engineers have helped the units to innovate with information on changes in techniques of production or advanced machinery.

For all the 217 units, price competition and adequate source of funding came out to be the most important constraints. This was followed by high cost of labour, poor infrastructure, lack of suitable personnel and technological competition. Lack of information dissemination or availability of raw material was not perceived as binding constraints.

Conclusion/Policy Implications

a. There a large number of MSME units in the state of West Bengal providing employment to many. Their overall financial condition, however, is not great and most of the efforts of the Government have not reached them. Many do not have the time to look at options to try and upgrade. An overall macro approach will not work for these units. A more micro granular approach is required to understand their position and their issues. The policy makers will have to devise methods of delivery by going to these units, individually. In this regard, in the sampled districts, the DICs are doing a wonderful job. But more needs to be done.
b. For all the 217 units, price competition and adequate source of funding came out to be the most important constraints. This was followed by high cost of labour, poor infrastructure, lack of suitable personnel and technological competition. Lack of information dissemination or availability of raw material was not perceived as binding constraints.
c. Discussions with a few entrepreneurs revealed that there is not much help that these units have received from engineering and research institutes. The government of West Bengal is trying to get the various stakeholders together, with the help of DICs, in this regard - but this movement has not led to any perceptible effect yet.
d. Of the various sources of information, mostly information on technological advances has been sourced by the company themselves or has been procured from qualified engineers. It is thus a very micro oriented result and does not reflect systematic institutional intervention. Machinery suppliers have helped with providing information on updated machinery and innovation has taken shape.

e. First, lack of information was mostly in the case of micro or small units. Second, micro and small units depended mostly on in-house information for innovation. Third, the role of qualified engineers was more in medium and small units. These results are expected as micro units do not have the wherewithal to approach institutions for help and have to depend on in house expertise. Medium scale units require the help of qualified engineers as their scale of operations are large. The small scale units seeking the help of qualified engineers are the ones that are aspiring for growth.

Innovation Management and Practices in SMEs: Antecedents & Challenges

Brain Storming Session – CHORD-NSTMIS, DST Supported Innovation Projects

Presentation by Dr. K. Chitra on "Innovation in Management and Practices in SMEs: Antecedents and Challenges"

Project Title: Innovation Management and Practices in SMEs': Antecedents & Challenges

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Year of Completion of Study: July 2017

Objectives of the Study:

- To identify the innovative and non-innovative SMEs involved in manufacturing of engineering goods in Tamil Nadu
- To understand the level of innovativeness in SMEs and the antecedents leading to innovative practices and process in SMEs
- To identify the challenges encountered by SMEs in deploying innovative practices and process
- To understand the relationship between innovative practices and process and the SMEs performance
- To understand the reasons for lack of innovative practices and process among the non-innovative firms
- To develop a model based on the findings

Methodological details of Study:

Tamil Nadu has 83,348 of SMEs' as of April 2013 dealing in Manufacturing Sector. A sample size of 400 was arrived at using the statistical formula. Data was collected from 407 sample units identified using proportionate stratified random sampling, with a criteria of having at least 15 firms from each of the districts.

Data Sources:

a. **Primary**: Primary data is collected from SMEs using a specially designed interview schedule. The interview schedule deals with various sections relevant to innovativeness scale, antecedents, challenges and performances of SMEs.

b. **Secondary**: Secondary data is collected through desk research, review of literature relevant to innovation, antecedents, challenges and performances of SMEs.

c. **Data collection period**: 2017

Brief Findings / Observations:

Profile of the Entrepreneurs:

- 94.1% of the entrepreneurs are male and belong to the age group of 31-40 years.
- In the case of innovative firms 21.6% of the firm owners have educational qualification up to graduation whereas in the case of non-innovative firms 24.5% have educational qualification up to matriculation level.
- In the case of innovative firms, 57.5% of the entrepreneurs have work experience of below 10 years in present firm whereas it is 62.8% the case of non-innovative firms.
- 90.7% of the SME owners are first generation entrepreneurs.

Profile of the Firms:

- 16.46% of the innovative firms are in Coimbatore district and 13.02% of the non innovative firms are in Trichy district
- 64.1% of the firms are small enterprise involved in manufacturing of engineering, electrical and electronics goods
- 50.4% of the firms are in existence for a duration of less than 10 years and 71.3% of the firms run on sole proprietorship
- 82.6% of the firms are located in urban area
- 70.5% of the firm owners have invested above 50 % of the capital requirements from their own funds
- 67.3% of the firm owners have invested less than 10% of capital requirement through borrowed funds

- 69.5% of the entrepreneurs borrowed funds from banks
- 78.6% of the firms are involved in operations at regional level and 77.4% of the firms involved in direct distribution
- 85% of the firms have more that 50% of employees working on full time basis employees

Association between Profile of the entrepreneurs and innovativeness of the firm:

- It is found that there exists a moderate association between age, gender and a very low association between the educational background, first generation entrepreneur and Innovativeness of the firm.
- It is inferred that there exists very strong association between location of the firm, type of ownership, Investment proportion, Mix of Employees and Innovativeness of the Firm.

Level of innovativeness of the firm:

- The level of Innovativeness of firms is measured using 27 statements on a 5 point scale and based on the scores the firms are categorized into 3 levels as low, medium and high. Findings reveal that the level of innovation is at a higher level in case of product (60.3% of firms); process (51.4% of firms); service & manpower innovation(63.1% of firms); marketing innovation(57.5% of firms) and at medium level in the of technology innovation(58.9% of firms)
- Friedman Test is used to determine the importance of variables contributing to the level of innovativeness and finding reveal the variables viz., continuous monitoring and improvement in the quality of the product; acceptance of the products introduced by the firm; changes made in the promotional techniques; ability of the staff to introduce innovative practices and the support extended for innovative practices by the manager

Antecedents leading to innovative practices and Process

- Antecedents contributing to the innovativeness of the firm are identified through a set of 35 statements grouped into five major categories for which responses are collected in a 5 point scale. The scores are calculated based on which the factors are categorized as contributing at Low, Medium or High level. Findings reveal that antecedents related to manpower (71.3% of the firms) and updated technology& stakeholders(61.6% of the firms) has contributed to

Innovation at a higher level; infrastructure & competitors(80.1% of firms) and training offered in the firm (56.8% of the firms) has contributed at a medium level; external collaboration has contributed at a low level (68.4% of the firms).

- Friedman Test was carried out and the highly contributing variables leading to Innovative practices in the firms are identified viz.,interaction and monitoring the needs of the customer; coordination and proper dissemination of information among the staff members; flexibility in approaching the staff irrespective of the position they hold and consciously managed age diversity.

Challenges encountered in deploying innovative practices and Process

- The Challenges encountered by SMEs in deploying innovative practices and process are measured using 34 statements on a 5 point scale and are categorized into 3 levels as low, medium and high. Findings reveal that time and perceptual challenges (37.6% of the firms) and lack of awareness (47.3% of the firms) contribute at a medium level; economic factors(50.6% of the firms); manpower related challenges(39.1 % of the firms); Technology and market(39.7% of the firms) and Infrastructure and government related challenges(52.1% of the firms) contribute at a higher level to the challenges faced by the SMEs.
- Friedman test reveals the following variables perceived as Challenge by SMEs in deploying innovative practices and process in the firms ; Procedural delay in receiving funds and subsidies; Inadequate government supportive schemes and policies; Inadequate financial assistance from government; Lack of awareness about various government schemes and Inadequate monetary and non-monetary incentives.

Relationship between innovative practices and process and the SMEs performance:

- Finding reveals that the performance of the innovative firms are higher than the performance of the non innovative firms in terms product performance, operations ,return on investment (ROI)/financial performance, and other measures;
- Positive and significant relationship exists between Innovative practices and process and the SMEs performance.

Reasons for lack of innovative practices and process among the Non - Innovative firms

- The reasons for lack of innovative practices and process among the Non –Innovative firms are measured using 50 statements on a 5 point scale and are categorized into 3 levels as low, medium and high. Findings reveal that time and perceptual Challenges (50.6% of the firms) ; Economical constraints(72.1% of the firms); manpower related reasons (65.5 % of the firms); lack of awareness (66.6% of the firms); Technology and market related reasons(63.9% of the firms) and Infrastructure and Government (75.8% of the firm) contribute at high level to the challenges faced by non innovative firms.
- The Friedman test reveals the following as the highly contributing variables for lack of innovative practices and process in the Non-Innovative firms ;Inadequate financial assistance from government; Inadequate government supportive schemes and policies; Procedural delay in receiving funds and subsidies; Inadequate monetary and non-monetary incentives and Inadequate government supportive centers and agencies for skill development.

Conclusion / Policy Implications:

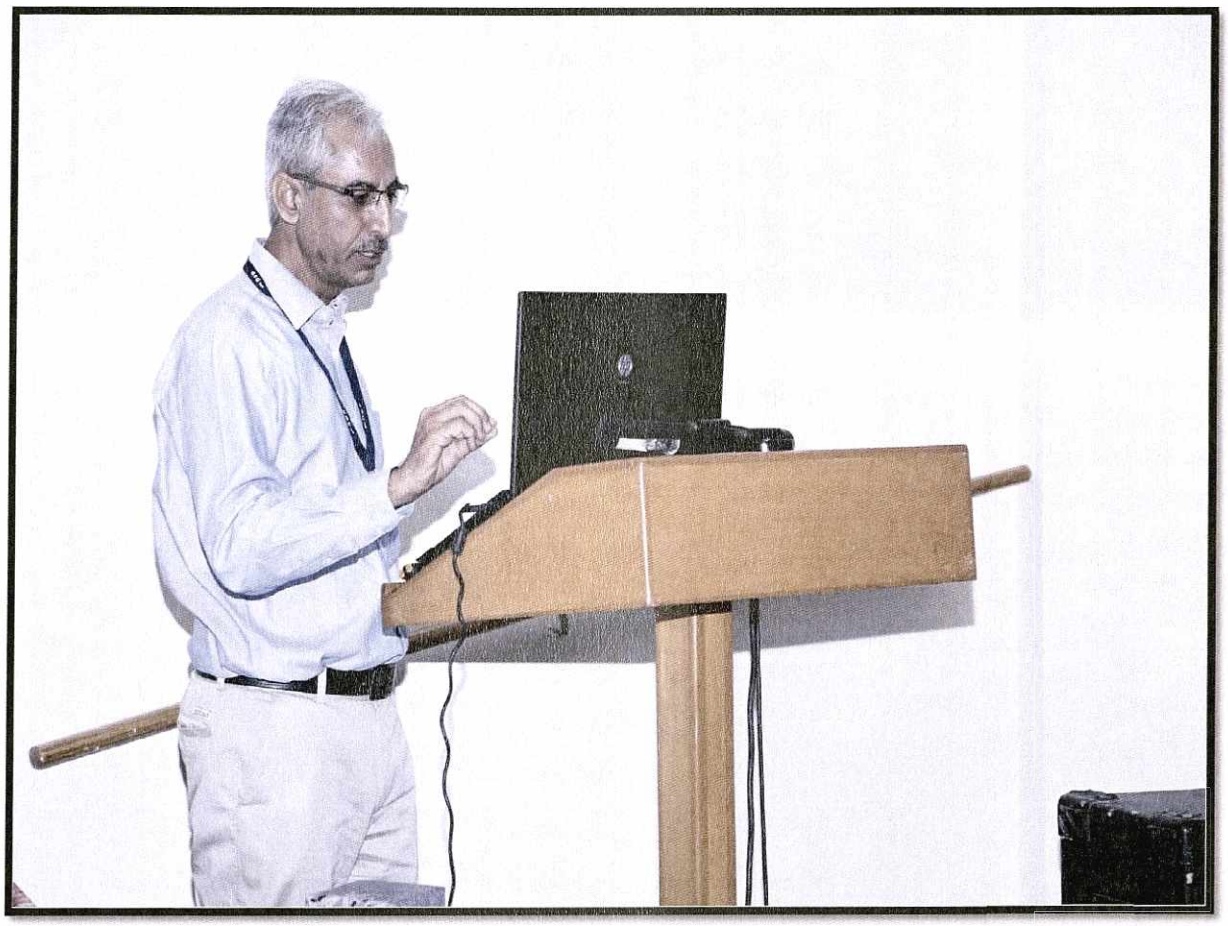
Following suggestions provided based on the findings may be considered for policy purpose;

- In order to increase the level of innovativeness in the firm support schemes for introducing new products in the company and to solve processing/functional issues with innovative solutions may be provided.
- SME entrepreneurs should be educated to forecast and assess the changes happening in the market and technology space, perform market need analysis to explore the market trends and design digital marketing solutions.
- The SMEs' should appreciate, reward and recognize the employees by providing attractive monetary and non-monetary incentives so that they can retain the qualified staff. Tie-up / collaboration with training agencies/consultancies for training the internal staff may also be explored to enhance the innovative ambience.
- Leadership intervention/training may be provided to enable changing/review the strategies, developing vision towards defining effective policies or plans to accommodate innovative practices etc.,
- Various schemes offered by the government has not reached the entrepreneurs. Hence, the appropriate measures through nodal agencies can be initiated so that the schemes/subsidies/ financial assistance may be availed by the SME's to undertake/carry out innovations.

- Steps should be taken to avoid the procedural delays / bureaucracy so that the entrepreneur will not face any issue with regard to delay in receiving government subsidies.
- It is evident from the analysis that, there exists a significant difference in performance between innovative and non-innovative firms in terms of product related performance, operations, return on investment (ROI)/financial performance, and other performance measures. Hence, the SMEs' have to be educated about the same so that they may be motivated to innovate.
- Venture capital/Angel investor is a highly preferred supportive measure by the entrepreneurs to facilitate innovative activities, Hence, measures to bring such highly preferred supportive schemes in the form of public, social and private partnership (PSPP) may be considered, so that it will help the entrepreneurs in accommodating innovative practices in the firm.

Assessing Industrial Innovation Process and Suggesting Policy Support Framework in India

Brain Storming Session – CHORD-NSTMIS, DST Supported Innovation Projects



Presentation by Mr. Mukesh Gulati on Assessing Industrial Innovation Process and Suggesting Policy Support Framework in India

Project Title: Assessing Industrial Innovation Process and Suggesting Policy Support Framework in India

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Year of completion of Study: 2016

Key questions / objectives / hypothesis of the Study:

This study was designed to assess mainly the process of industrial innovation along with a few cases of service sector as well, where the contribution of MSMEs is more significant to the national GDP as also the employment. The objective of the study was to provide inputs to the policy support framework for stimulating innovation in the specific context of the MSME sector in India. The study through 20 detailed case studies of as many enterprises (12 successful and 8 failure cases of innovation from MSME sector) was intended to complement and supplement the findings of the 'National Innovation Survey' and suggest ways to stimulate innovation through central and state governments.

Methodological details of Study:

A case study based research method was used to assess the process of innovation and understand causalities of factors driving the same. Both successful cases of enterprises (12 successful cases) who have undertaken innovations sustainably and also failure cases where enterprises (8 failure cases) tried but could not sustain it were studied. All the 20 case studies of innovators and their innovations were undertaken from among four states, viz. -West Bengal, Gujarat, Punjab and Telangana from four regions viz. -East, West, North and South respectively. One industrial city from each of the four states was selected viz. - Kolkata, Ahmedabad, Ludhiana and Hyderabad that have high concentration of MSMEs cutting across various industrial and service sectors. These case studies were drawn from among eight manufacturing sub-sectors and three service

sub-sectors (viz. - **Manufacturing Sector:** 1. Food Products; 2. Textiles; 3. Basic Metals; 4. Non-metallic mineral products; 5. Fabricated metal products, except machinery and equipment; 6. Machinery and equipment n.e.c.; 7. Leather and related products; 8. Chemicals and chemical products; **Service Sector-**1. ICT; 2. Printing and reproduction of recorded media; 3. Waste collection, treatment and disposal activities; materials recovery) based on their importance in the state and national economy, measured through the three factors viz. no. of enterprises in operation, total output and employment generated by the sectors.

Though innovator was the focus of every case study, several other key stakeholders having direct value chain linkage with the innovator's enterprise and also those supporting its innovation process were personally interviewed to understand the key elements of enterprise innovation system within and without. The identification of the innovator enterprise was itself undertaken by scanning the local eco-system by contacting the local stake-holders viz. industry association representatives, development support institutions and bankers. A list of innovations undertaken successfully and abandoned in the identified locations was drawn up for selection across sectors that could help understand the innovation system in its entirety. The data capturing innovation process was done through personal interviews and focused group discussions (FGDs). Three sets of questionnaires were used for: a- innovators, b-similar enterprises, and c-support institutions, to capture elements of information required. Using the questionnaires, a total of 229 stakeholders, comprising of buyers, sellers, competitors, bankers, service providers, DICs and other support institutions were interviewed for developing the 20 case studies.

The study used a **5-stage innovation model within an enterprise** comprising of (i) **'Ideation'** of the innovation required, (ii) **'Research & Development'** on the idea generated (iii) In-house **'Demonstration** of the Proof' of concept for creating a prototype or model of innovation (iv) In-house **'Diffusion'** for scaling up production or marketing or management concept and (v) **'Sustainability'** signalling successful commercialisation. The process of innovation across these 5 stages of in-house innovation model was thereafter mapped across **4 levels of innovation** influencing innovation at any one of the 5 stages. These 4 levels are 1) **Enterprise** Innovator System (EIS) 2) **Cluster** Innovation System (CIS) 3) **Regional** or State level Innovation System (RIS) and 4) **National** Innovation System (NIS). Accordingly it is possible to visualise a 5X4

matrix to draw up the influencing factors from any of the 4 innovation systems influencing innovation at any of the 5 different stages within an enterprise.

Data Sources:

a. Primary: As explained above in the methodology
b. Data Collection Period: 2015-16

Brief findings/observations:

Both for the successful and failed cases, the study identified that the most important drivers of innovation have been at the enterprise level when compared with cluster, regional and national levels. **In one way**, this looks natural where the size of enterprises is small and its circle of influence and interaction is largely local. **Secondly,** major markets in the value chains of MSMEs' products & services are local to regional with limited extensions to national and international levels. **Third,** this probably reflects a weak cluster, regional and national innovation eco system that envelops an innovating enterprise, leaving bulk of the responsibility with the entrepreneur and enterprise specific systems. It therefore also reflects limited local outreach by the Regional/National Institutions.

The **three key determinant factors** of innovation at all stages but more so at the ideation stage were found to be those that were derived from the enterprise level ecosystem and these were (i) **national or international exposure** to similar enterprises and demanding markets, (ii) **prior experience** of the innovator in the sector and the (iii) **choice of the markets** & its sophistication that the enterprise deals with. Cluster innovation system (CIS) factors have played a strong enabling role in some cases at the 2nd to 5th stages of development, demonstration, diffusion and sustainability. The key CIS actors in terms of their importance are business membership organisations (BMOs) often called industry associations, business development service providers (BDSPs) often called consultants, raw material and equipment suppliers, local buyers and labour input providers. The regional innovation system (RIS) and the national innovation system (NIS) factors were found to be less important at the enterprise level innovation in most of the cases. This has thus limited the rate of replication of innovations among other MSMEs at the regional, sectoral and national level. There are several cases where a select few enterprises have

successfully innovated in a sector either within a cluster or a bigger region but this has not been replicated due to lack of spread of information or non-availability of other support conditions required to facilitate the replication. It is therefore within an enterprise and replication of innovation among other potential MSMEs that the policy can play a significant role.

Conclusion / Policy Implications:

Every type of innovating enterprise has a different set of key driving factors relevant to its unique internal strengths/ weaknesses, the sector & its advancements, the market conditions and the support mechanisms that this & similar enterprises have access to. It is therefore neither feasible nor the intent to generalise the success determining factors even within two enterprises in the same sector and local geography. The study however threw up a range of factors that reflect the need for improving a set of support & commercial services and strengthening delivery systems through coordination and collaboration across key stakeholders, both public and private for innovation replication across sectors and regions. There are **six sets of policy recommendations** and relevant action points elaborated thereafter.

First among the factors is the lack of **good quality business development service providers (BDSPs),** particularly at the local level who can provide customised techno managerial inputs required for innovation stages, particularly from development to sustainability.

Second, public procurement has a strong potential to support innovators who can in turn offer new products, better designs, reduced environmental consequences and longer life cycles thus giving scope for better offerings. Often rigid standards for public procurement create un-intended barriers. A small share in the overall procurement requirements should be reserved for enabling new options that have a strong success potential.

Third, there is need for a more stringent enforcement of laws to prevent social and environmental consequences of various products that are made in the MSME sector.

Fourth, Linkages with the Global value chain/ market has played a significant role in some of the innovations. This has been leveraged mainly by the enterprise specific factors only. Supporting enterprises to help build an understanding of the international requirements and linkages can thus help several potential innovations to be unleashed. There are already some

schemes of the Govt. of India that enable exposure building but the scale and scope are limited by the number and the purpose which is mostly limited to marketing of existing products. Ministry of Science & Technology has conceived and implemented several schemes of assistance and drawn tools, methodologies and experiences to draw upon. Such initiatives should be scaled up by the state governments and sectoral ministries in their respective geographical and sectoral domains.

Fifth, access to institutional finance as a big driver. Access to institutional finance remains a general challenge for MSMEs. Moreover, Institutional financing continues to remain dominated by collateral based lending other than primary security of the equipment financed. MSMEs in general and innovator enterprises are often unable to offer additional collateral security. This becomes therefore the primary reason for the witnessed gap. Service sector enterprises and more so start-ups who have little to offer in terms of tangible equipment thus face even a bigger challenge. It therefore requires a policy shift at national level to encourage banks to move towards project based financing rather than asset based financing. Many of the innovator enterprises are unable to write bankable proposals and are further constrained by poor documentation of financial records by the enterprises to avoid payment of legitimate taxes.

Sixth, there is need to undertake integrated initiatives that help connect diverse actors at various levels; viz. clusters, regions and sectors. Innovation/ innovative solutions are there but replication is limited because of no or limited information and knowledge flow between enterprises within the clusters or regions and between different clusters or regions. Globally it has been researched that failures to create awareness, building capacities of support actors and poor networking are some of the key innovation system factors that when addressed in a concerted manner can unlock opportunities that are waiting to be realised.

Innovation in Large Manufacturing Firms – In the Era of 'Make in India'

Brain Storming Session – CHORD-NSTMIS, DST Supported Innovation Projects

Presentation by Dr. Nirmalya bagchi on Innovation in Large Manufacturing Firms – In the Era of 'Make in India'

Project Title: Innovation in Large Manufacturing Firms – In the Era of 'Make in India'

PI/Co-PI:

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Year of completion of Study: 2016

Objective of the Study:

- The study aimed at identifying determinants of R&D investment in large Indian manufacturing firms
- The study tried to understand the innovation behaviour and the critical issues associated with innovation of large firms in the country.

Methodological details of Study:

The study primarily focused on the large firms who have been continuously investing in R&D between 2009 and 2014.[1]

Identification of large firms:

The Manufacturing Enterprise is **defined in terms of investment in Plant & Machinery. General definition is as follows.**

[1] Continuous R&D spender - The firms which invested for at least for 5 years within mentioned time period (2009-2014)

Different levels of Manufacturing Enterprises in India:

Manufacturing Sector	
Enterprises	**Investment in plant & machinery (Book Value)**
Micro Enterprises	Does not exceed twenty five lakh rupees
Small Enterprises	More than twenty five lakh rupees but does not exceed five crore rupees
Medium Enterprises	More than five crore rupees but does not exceed ten crore rupees

Source: Ministry of Micro, Small and Medium Enterprises

Adopting these criteria of Government of India, firms investing more than Rs. 10 crore in plant and machinery are the large firms. The firms report investment in plant and machinery on their balance sheet under fixed asset. Plant and machinery data of the firms have been extracted from the Prowess Database (CMIE). Firms numbering 4526 out of 26,885 listed in Prowess Database meet the criteria of large firms. These firms have invested Rs. 10 crore (or more) in plant and machinery in 2013-14. Out of these 4526 large firms, 610 have maintained a continuous R&D spend (more than or equal to 5 years) during 2009-2014 period.

Table showing large firms who have continuously invested in R&D –

	Large Firms: Investing continuously in R&D during 2009 - 2014	
Large Firms (Total - 4526)	Invested in R&D for 5 Years or more during 2009-14 (no of firms)	610
	Private Indian	520
	Private Foreign (MNC)	56
	Central (PSU)	28
	Central & Private	0
	State	2
	State & Private	4

In order to understand R&D behaviour, innovation and related issues of these large firms both quantitative and qualitative analysis was made under the study.

1. **Analysis of quantitative data of these 610 large firms collected from the PROWESS database.**

Collection of Data:

Firm level data of R&D expenditure, net sales and other economic variables like export earnings, import of capital goods, profit before tax were collected at NIC 5 digit level from PROWESS Database of Centre for Monitoring Indian Economy (CMIE) of these 610 firms. **PROWESS Database** is an important source of information on financial performance of Indian companies (both listed and unlisted) and contains time-series data from 1989-90 till date.

Preparation of the panel:

Panel dataset of these 610 identified large Indian firms in manufacturing sector for period between 2009 and 2014 was prepared.

Initially, the panel consisted of 3,660 (610*6) i.e. (cross sectional unit x time point) observations. Out of those 3,660 observations, 29 had missing data on R&D expenditure. Those observations were dropped from the sample. New sample consisted of 3,631 observations after first filtration. Some observations had missing information for one or more economic variables. In some cases, some observations had cell entries filled with zero or negative values. These rows were deleted from our sample. After these filtrations, the final panel consisted of 2,536 observations.

A panel data regression model (pooled OLS) was employed with the R&D investment as dependent variable. The model tried to understand the determinants of R&D investment of large manufacturing firms.

2. **Analysis of qualitative information arrived from the case studies prepared under the study**

However, quantitative analysis of data alone is not sufficient to capture the state of affairs and innovation behavior of large firms. Hence, a qualitative approach to find out issues relating to innovation and to identify gaps in government policies was carried out.

Initially, a questionnaire was prepared in consultation with the Department of Science and Technology (DST) to capture information regarding product and process innovation as well as

issues related to innovation of the firms. **Different technological parameters mentioned in the questionnaire were derived from OSLO Manual, which is a benchmark for measurement of technological and scientific activities in Organization for Economic Cooperation Development (OECD) countries.**

The questionnaire was circulated among various large manufacturing firms across the country. However, the team had received only 30 filled in questionnaire in response. Sometimes, the quality of response was so sketchy that hardly helped to draw any meaningful inference out of the responses. Hence, case study approach[2] was adopted by the team.

52 individual cases were prepared based on the **primary survey carried out by the ASCI team after physically visiting different R&D centres/Corporate/Registered offices of several large manufacturing firms and meeting R&D Managers/Vice President/General Manager or other R&D spokespersons.**

Rationale behind selecting 52 large firms-

Two things were considered during selection of the 52 firms –

a) These 52 large firms covered 13 NICs including all major manufacturing sectors like manufacturing of food products, textiles, chemicals & chemical products, pharmaceuticals, rubber & plastic products, basic metals, electrical & electronic products, general machinery, transport vehicle and related machineries etc.
b) The sample also covered all major locations across the country considered as attractive R&D destination for the large firms. The list includes Bangalore, Hyderabad, Mumbai, Pune, Aurangabad, Nashik, Kolkata, Delhi/NCR etc.

Broadly, these 52 companies can be categorized into 9 major sectors (few related sectors are merged into the same basket). These are –

[2] The case study approach, as a part of research method, allows in-depth, multi-faceted understanding of complex issues and objects in real-life settings. Case study helps to extend the knowledge and experiences. It emphasizes a detailed analysis of a specific number of events and tries to generalize the conditions to a larger set of units. Case studies also help to find the relationships between different events or conditions. Experimental design modelling tests a specific hypothesis through manipulating the environment. On the other hand, case study approach presents information in a descriptive way. It helps in visualizing real world situations. This approach also throws insights on gaps in present system and defines proper implementation strategy over others. The value of case study approach is well accepted in fields of business, law and policy.

NIC Code (2 digit)	Name of the sectors	No. of companies visited
10 & 11	Food products & Beverages	8
20	Chemicals & Chemical products	9
21	Pharmaceuticals	4
22	Rubber & Plastics	3
23, 24 & 25	Non-metallic minerals, Basic metals & Metal products	9
27	Electrical equipments	5
28	Machinery & equipments	4
30	Other transport equipments	6
12 & 13	Others (Tobacco & Textiles)	4

The case studies prepared under the study focus on the following parameters -

- State of Innovation in these firms
- R&D focus of the firms
- Potential in R&D investment
- Gaps/Constraints observed in the policy measures taken by the government and perception of industry related to these policy measures

Data Sources

a. Primary: Field level data through stakeholder consultation
b. Secondary: PROWESS Database (CMIE)
c. Data Collection Period: 2009 to 2014

Brief findings/observations

Findings from quantitative analysis:

- 610 large firms have maintained a continuous R&D spend (more than or equal to 5 years) during 2009-2014 period.
- Out of these 610 firms, 520 are Indian private firms, 56 are MNCs and 28 belong to PSU sector.
- Average net sale of 610 large firms has increased constantly over the years since 2009 to 2014. It has increased nearly 90% in 2014 compared to its initial period in 2009.
- R&D investment of Indian large firms has increased more than 100% over the time period (2009-2014) considered in the analysis
- Average R&D expenditure and average export by 610 large firms within the time period of 2009-14 are positively correlated
- Econometric model based on the panel dataset involving the 610 large manufacturing firms has revealed that import of capital goods, R&D expenditure, royalty expenditure, export earning and age of the firm plays significant positive effect on size of the firm.
- Another model identifying determinants of R&D investment of large manufacturing firms within a stipulated time period (2009-14) has revealed that size of the firm and the R&D intensity has a positive relationship for the given sample of large firms.
- Young firms are more responsive to R&D investment.
- Import of capital goods positively influences R&D intensity of the Indian industry.
- Export earning significantly enhances the need for an in-house R&D effort to support overseas operations.
- Firms having higher profit margins have better capacity to bear the risk of R&D activity.

Findings from qualitative discussions:

Findings can be broadly classified into two categories.

A. General findings
B. Industry specific findings

A. General findings –

The findings (issues and recommendations) from the study have been segregated into four major baskets.

1. **Issues relating to government policies and tax structure and recommendations to counter those challenges:** The companies raised several issues pertaining to the government

policies like delay in new product registration, unavailability of single window system for product approval, absence of centralized R&D facility etc.

a) Issues and recommendation related to ease of doing business / government policies

- Longer time required for new product registrations, regulatory clearances, longer approval process for airworthiness certification, third party validation tests and unavailability of land are some major impediments to innovation
- Bureaucratic work culture, problem of corruption, lack of domain expertise is evident in every step of the licensing approval process
- The whole price fixing method for sugarcane needs a revision. Due to regulation on sugarcane price, companies have to purchase sugarcane on a higher price and sell the sugar at a lower price resulting a huge loss. Pricing policy for sugarcane should be determined judiciously so that it does not affect the companies.
- A single window system is required, which should ensure simple and transparent process for product approval, manufacturing license, IP registration and IP protection. A single window approval system like Industrial Entrepreneur Memorandum (IEM) may be introduced for production and sale of new products in the chemical industry.

b) Simplification of taxes and benefits (including import & export)

- **A simple tax structure like GST** is need of the hour that would bring relief in the form of clarity. It would cutback in prices by removing cascading effect of taxes.
- Import duty should be exempted on life-saving drugs.

c) Government responsibilities toward skill development

- Creation of state of the art 'Centre of Excellence' through industry-academia-government partnership is recommended in order to meet a huge unmet need of industry and building competitiveness among the engineering students.
- A dedicated engineering curriculum towards manpower creation in the specializations like packaging or rubber is needed.

d) Absence of R&D infrastructure

- Creation of sector specific state of the art R&D centres equipped with modern facilities and infrastructure is highly recommended to promote innovation in high-tech sectors
- Model pilot plant should be established along with the R&D centre in Public Private Partnership (PPP) mode.

e) Other issues and recommendation

- Drip irrigation can be promoted for effective supply of fertilizer to the soil
- A separate ministry is recommended for pharmaceutical industry
- A proper evaluation system is required where R&D projects of a DSIR certified lab is judged based on critical parameters like proper utilization of funds, risk involved with the project, timeliness, exclusiveness, cutting edge technology development, patent filing, standard of ethics and so on
- Creation of 'futures group' is recommended in the cable industry to identify the emerging areas of R&D.

2. **Industry specific issues relating to innovation:** Other than policy related issues, key stakeholders have mentioned issues specific to industry (dearth of skilled manpower in R&D, unavailability of raw materials, absence of industry to manufacture machineries etc.).

   - Dearth of skilled manpower in R&D is one of the major impediments to innovation in India. CSR fund can be effectively utilized in skill development. Industry should bring the concept of sponsoring skill development trainings/course in specialized areas.
   - Strong initiatives from the Government are required to establish an industry dedicated to manufacturing of high-end products to counter imports that currently dictate the industries like pharmaceutical.
   - Sector specific consortium of companies may be formed to carry out research in the areas of national importance.
   - Low scale of production capacity is hampering R&D in India

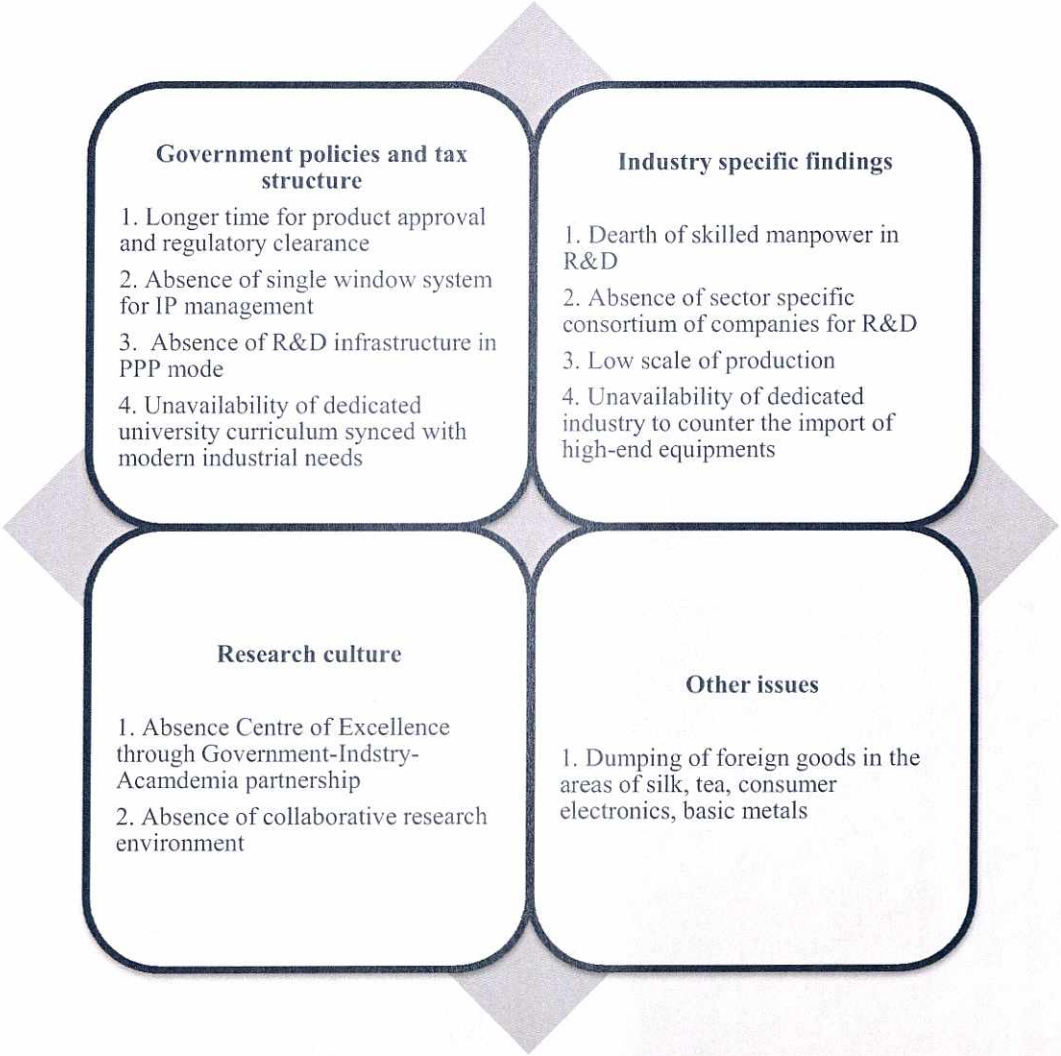
3. **Issues relating to absence of collaborative research environment in the country:** Absence of collaborative research environment is affecting innovation in the country. Recommendations were suggested to bring in three major stakeholders – Industry, academia & research institutes – under a single platform.

   - The longer gestation period and massive investment required for R&D are the reason why companies restrain them from new product development and shows interest only in process development. It is highly recommended to establish a common platform involving the private industry, public sector units and the academia to encourage collaborative research projects for new product development in the country. Central Government should be in the focal point of this collaboration. Government should bear at least some risk (say 50%) of high-end projects carrying national importance.
   - Cross country collaborative research should be promoted.

4. **Other issues:** This part deals with the issues specific to industries like Silk, Tea, and Consumer electronics etc.

- Government should take action by enforcing stringent rules against 'dumping' in the sectors like steel or silk and rubber.

Key issues segregated as per stakeholders' perspective:



B. Industry specific findings –

The following table summarizes industry specific findings from the study –

Industry Name	Key issues
Food products & beverages manufacturing	• Absence of proper ethanol policy • Deduction in tax benefit for R&D • Lengthy FSSAI approval process
Chemicals & Chemical Products Manufacturing	• Lengthy product approval procedure • Unavailability of centralized R&D facility • Absence of collaborative research • Dearth of domestic raw materials
Pharmaceutical Products Manufacturing	• Lengthy product approval process • Ambiguity in IP registration & protection
Plastics & Rubber products Manufacturing	• Absence of dedicated curriculum toward skilled manpower creation • Unavailability of model pilot plant adjacent to R&D centres
Metals & Metal Products Manufacturing	• Improper rules against dumping • Lack of collaboration with foreign institutions in research
Electrical Equipment Manufacturing	• Less number of testing facilities for CE certification • Dumping of electrical goods from Chinese market
Machinery & Equipments Manufacturing	• Lack of collaborative research in machinery manufacturing
Transport Equipment Manufacturing	• Long wait time for new product approval • Delay in regulatory clearance
Other Sectors – Tobacco & Textile Products Manufacturers	• Absence of modern technologies in the industry • Import of cheap textile form China hampers the growth of domestic market

Conclusion / Policy Implications

Industry Name	Key suggestions
Food products & beverages manufacturing	• Government could establish centralized R&D centers and pilot plants in PPP model
Chemicals & Chemical Products Manufacturing	• Single window system for product approval • Registration, Evaluation, Authorization and Restriction of Chemicals (REACH) registration procedure to export in European market • Creating Industry-Academia-Government collaboration to foster research • Consortium of companies to focus on research areas of national interest
Pharmaceutical Products Manufacturing	• Create a separate ministry for pharmaceutical industry • Single window system to bring transparency in product approval, IP registration & protection • Exemption of import duty on life saving drugs • Building state-of-the-art central laboratories • Foster collaborative research through Industry-academia collaboration
Plastics & Rubber products Manufacturing	• Building model pilot plant in PPP model • Promotion of synthetic latex over natural rubber • Policy for approval of packaging materials
Metals & Metal Products Manufacturing	• Imposing stringent rules against dumping • Creation of "Centre of Excellence" through Government-Industry-Academia collaboration
Electrical Equipment Manufacturing	• Stringent dumping rules • Creation of future groups to bring cutting edge innovation in manufacturing
Machinery & Equipments Manufacturing	• Creation of state of the art R&D centers • Creation of centre of excellence • Restructuring core engineering curriculum to get industry ready manpower
Transport Equipment Manufacturing	• Creation of state of the art R&D centre in PPP model • Government initiative to help MNCs to purchase indigenous equipments rather importing from abroad
Other Sectors – Tobacco & Textile Products Manufacturers	• Development of R&D infrastructure • Imposing proper duty structure to scale down import from China

Assessment of Research & Development & Innovation Practices in Micro, Small & Medium Manufacturing Enterprises (MSMEs) in India

Brain Storming Session – CHORD-NSTMIS, DST Supported Innovation Projects

Presentation by Mr. Sanjay Nagi on Assessment of Research & Development & Innovation Practices in Micro, Small & Medium Manufacturing Enterprises (MSMEs) in India

Brain Storming Session – CHORD-NSTMIS, DST Supported Innovation Projects

Project Title: Assessment of Research & Development & Innovation Practices in Micro, Small & Medium Manufacturing Enterprises (MSMEs) in India

Principal Investigator /Co-Principal Investigator: Name: Shri Sanjay Nagi

(Principal Investigator)
Market Insight Consultants,
B-3, Sector-2, Noida – 201301 (UP)

Year of completion of Study: 2017

Objective of the Study:

1. To have an appreciation of total number of MSMEs in India in terms of:
   a.Functional, Non-Functional & Non-Traceable MSMEs
   b.Size (Micro, Small & Medium) & Ownership patterns (Private limited, Proprietorship etc.)
2. To understand the engagement levels of MSMEs in R&D and Innovation activities
3. To develop a National R&D Index pertaining to MSME sector
4. To understand the levels of expenditure on R&D activities in MSMEs
5. To have a comparative assessment of R&D expenditure in India vis-à-vis other comparable nations
6. To understand funding sources for R&D and innovation activities in Indian MSMEs
7. To understand the scenario of manpower deployment in R&D jobs in MSME sector in India
8. To understand the scenario of training of R&D personnel in Indian MSMEs
9. To assess drivers of innovation & R&D activity at a firm level
10. To assess barriers to innovation & R&D at a firm level
11. To provide policy inputs for development of appropriate eco system at a national level to boost R&D and innovation in Indian MSME sector of India
12. To assess industry wise and state wise scenario of R&D and Innovation in MSMEs on defined parameters
13. To assess the scenario with respect to adoption of quality standards (BIS, ISO etc.) by Indian MSMEs
14. To assess the gains from innovation & R&D from MSME perspective
15. To present case studies in context of R&D & Innovative initiatives in MSME sector in India

Methodological details of Study:

A total of 20 states and 1 UT were taken into consideration for the study. The state of Telangana is represented by Andhra Pradesh as its existence came into effect during the study. The North-Eastern States including Assam were not part of this study. NE states require a separate intervention and is bound by challenges that were outside the purview of this study. Also, from the analysis point of view, the data representing the NE states would largely affect and dilute the overall scenario of the Industries that are more prevalent in other states.

Literature review was conducted on the latest census conducted on Micro, Small and Medium Enterprises (MSME) - The Fourth All India Census of MSME 2006-07. The data was collected till 2009, results of which were published in 2011-12. The census adopted different methodology for Registered and Unregistered Sectors. While complete enumeration of enterprises was adopted in Registered Sector, Sample Survey was resorted to in Unregistered Sector. However, for activities under Wholesale/Retail trade, legal, educational & social services, hotel & restaurants, transports and storage & warehousing (except cold storage), which were excluded from the coverage of Fourth All India Census of MSME 2006-07, data was extracted from Economic Census 2005 conducted by Central Statistics Office, Ministry of Statistics and Programme Implementation for finalising the report on MSME Sector.

Data Sources:

Brief findings/observations

1. To have an appreciation of total number of MSMEs in India in terms of:

a. Functional, Non-Functional & Non-Traceable MSMEs

Registered Sector

A total of 22,11,958 enterprises were found to be relevant to MSME, of which 15,52,491 units (70.19%) were found working, 4,80,946 units (21.74%) permanently closed and 1,78,522 units (8.07%) non-traceable. The data reveals that closure among MSMEs has gone down by about 17% and working unit's percentage has gone up by about 9% as compared to the 3rd Census 2001-02

Of the total working enterprises, the proportion of micro, small and medium enterprises were 95.05%, 4.74% and 0.21% respectively. Data also reveals that 10,35,103 (66.67%) units were manufacturing enterprises and 5,17,389 (33.33%) services. About 8.21% (76,654) of the

manufacturing enterprises were ancillary enterprises. The proportion of the enterprises operating the rural areas was 45.38%.

In terms of no. of working units, twelve States, viz., Tamil Nadu (15.07%), Gujarat (14.80%), Uttar Pradesh (12.08%), Kerala (9.65%), Karnataka (8.99%), Madhya Pradesh (7.01%), Maharashtra (5.58%), Rajasthan (3.55%), Bihar (3.36%), Punjab (3.23%), West Bengal (2.75%) and Haryana (2.18%) had a share of 88.25%.

With regard to closed units, 14 States, viz., Tamil Nadu (16.59%), Uttar Pradesh (15.73%), Karnataka (8.80%), Maharashtra (7.80%), Madhya Pradesh (7.29%), Kerala (7.16%), Gujarat (6.91%), Punjab (4.59%), Rajasthan (3.32%), Bihar (3.15%), Chhattisgarh (3.14%), Andhra Pradesh (2.78%), Haryana (2.22%) and West Bengal (1.85%) had a share of 91.31%.

Unregistered MSME Sector

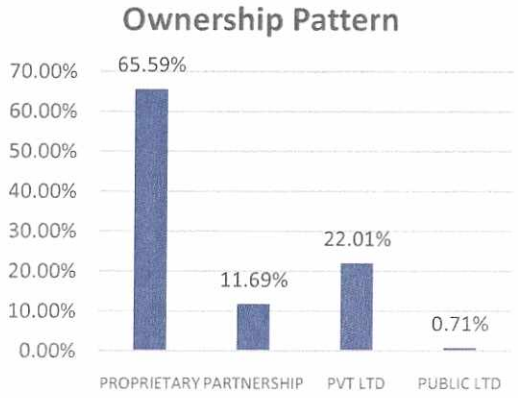
The unregistered MSMEs were provisionally estimated to be 2,45,48,305 providing employment to the tune of 5,02,57,039 persons in the country. The unregistered MSME sector was dominated by services and trade enterprises with a share of 73.85%. The proportion of Manufacturing was only 26.15%. The proportion of the units in the unregistered MSMEs operating in rural areas was 52.18%.

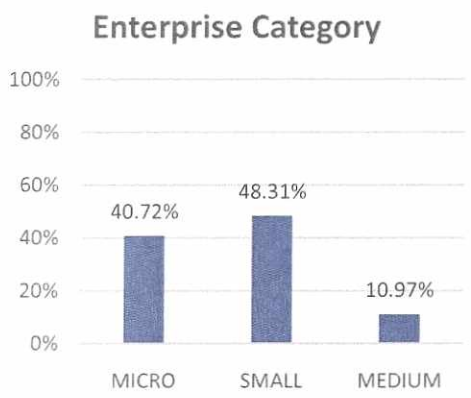
In terms of no. of working units, ten States, viz., Uttar Pradesh (11.91%), Maharashtra (10.61%), West Bengal (10.06%), Tamil Nadu (9.61%), Andhra Pradesh (8.11%), Karnataka (5.99%), Kerala (5.37%), Rajasthan (4.95%), Madhya Pradesh (4.81%) and Orissa (4.24%) had a share of 75.21%.

Out of the 2,45,48,305 unregistered units, only 26.15% were manufacturing enterprises, about 57.09% of the units were engaged in Services and the rest of the 16.76% in repair/maintenance. 94.67% of the units were proprietary units and about 0.47% of the units were partnership units.

b. Size (Micro, Small & Medium) & Ownership patterns (Private limited, Proprietorship etc.)

A total of 8024 of MSME's were surveyed in a total of 21 states. On an average 380 firms were surveyed per state. The profiles of the respondents are as below:





Majorly, the MSMEs are concentrated towards proprietorship firms, constituting approx. 65% of the total enterprises. As far as the split among the categories are concerned, micro and small enterprises constitute approx. 89%.

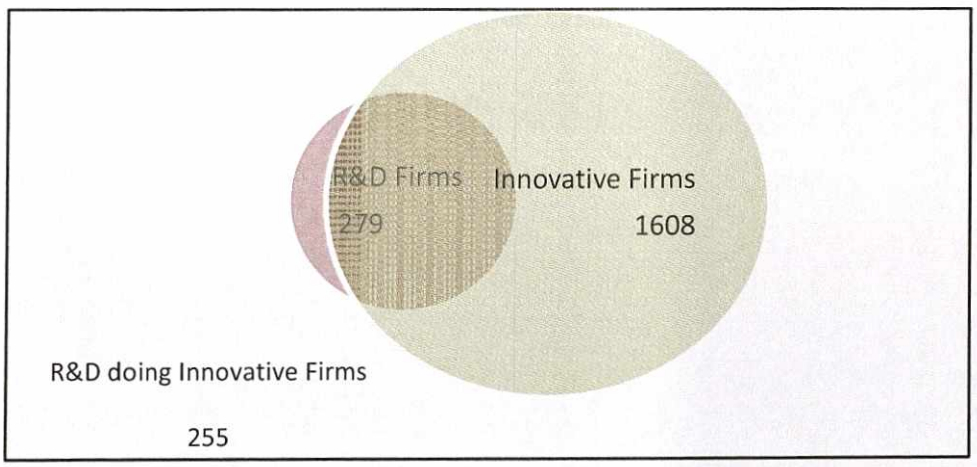
2. To understand the engagement levels of MSMEs in R&D and Innovation activities

A total sample of 8023 MSME's has been surveyed. Out of total sample

1608 firms are found to be engaged in innovation activities.

279 firms are engaged in various R&D activities.

255 firms are found to be engaged in both innovation and R&D activities.



R&D AND INNOVATION – Cross Matrix

R&D	Low	High
H	110	23
L	109	13

INNOVATION

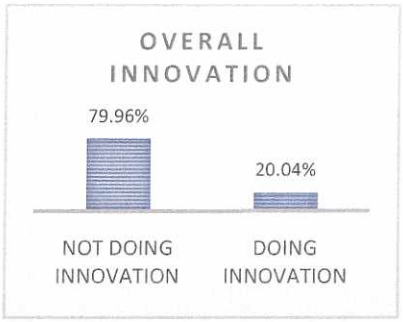
Table 1: R&D and Innovation matrix

A total of 255 firms are found to be engaged in both innovation and R&D activities.

R&D and innovation matrix shows the firms categorized in to four categories:

1. Low R&D and low innovation firms- 109
2. Low R&D and high innovation firms- 13
3. High R&D and low innovation firms- 110
4. High R&D and high innovation firms- 23

3. To develop a National R&D Index pertaining to MSME sector



National innovation survey is conducted on 8023 firms in 21 states and 27 different sectors and in 3 different categories i.e. micro, small and medium enterprises.

Out of 8023 firms surveyed, 20.04% of the firms are found to be engaged in innovation activities, while 79.96% of the firms are not engaged in any kind of innovation activities.

Firm Level Innovation & R&D Index (scale of 100)

Firm level Innovation Index	No. Of firms	As %age	Index Intensity
Below 16	1049	65.24%	Very Low
16-23	199	12.38%	Low
23-33	180	11.19%	Medium
33-40	64	3.98%	Medium
40-50	88	5.47%	High
Above 50	28	1.74%	Very High

Table 2 Innovation index of firms as per weightage

Average of innovation index of all firms is 15, out of total weighted index of 100.

More than 65% of the firms fall in below average categories that resemble very low quality innovation in most of the firms, which is a kind of a concern.

199 firms of 1608 innovative firms are in between 16 to 23 indexations, i.e. 12.3% of the firms.

180 and 64 firms out of total innovative achieved index of 23 to 33 and 33 to 40 respectively.

88 firms achieved a weightage between 40 to 50, that shows some good quality firms doing R&D and are innovative

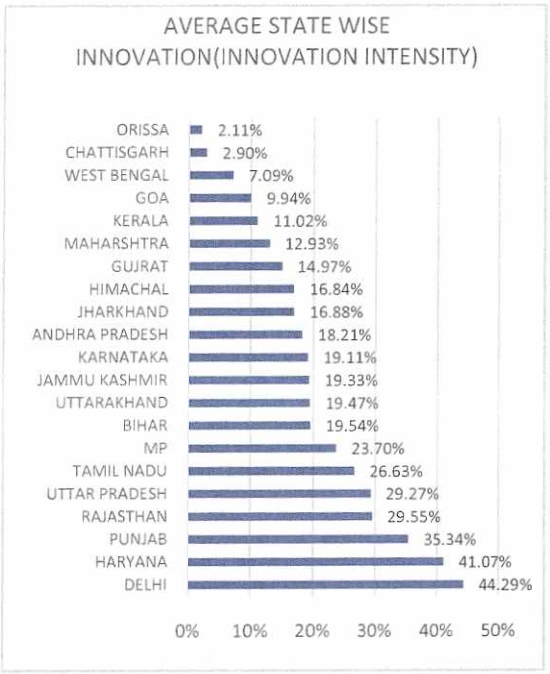
28 firms achieved an index rating of above 50 i.e. 1.7% of all R&D and Innovation doing firms, which states that very low high end innovation and R&D is being conducted.

Categorization of Innovative And R&D Firms as Per Innovation Weights

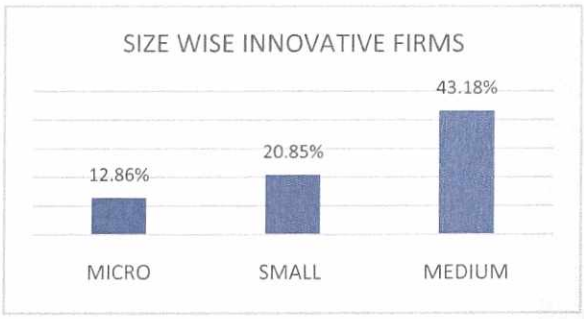
Category	Innovation Categorization	R&D Categorization
High	29	8
Low	1324	16
Grand Total	**1353**	**24**

State Wise Innovation Intensity

Among the states, Delhi, Haryana and Punjab are the top ranking states followed by Rajasthan, U.P and Tamil Nadu and Madhya Pradesh. States that are just below the nation average are Bihar, Uttarakhand, J&K, Karnataka and Andhra Pradesh. The Eastern States of Jharkhand, West Bengal, Orrisa along with Chhattisgarh show an average of below 16% and some are at the bottom of the table.



Enterprise Category Innovation Intensity



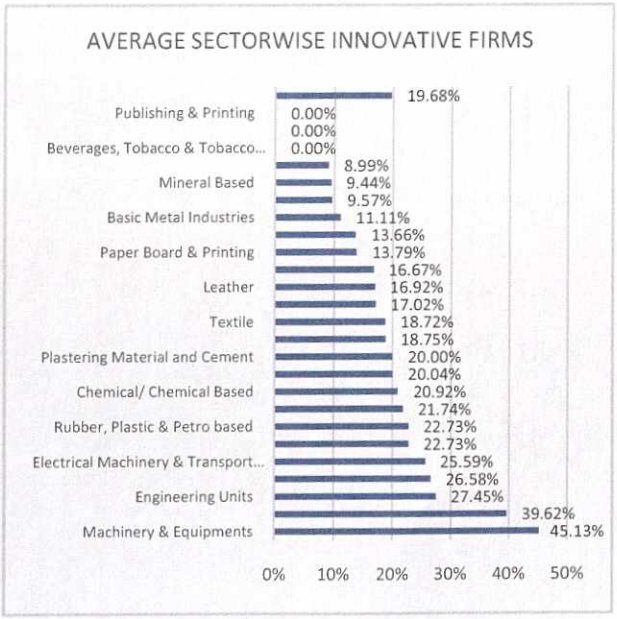
In size wise aspect, medium sized firms are most innovative firms followed by small and micro sized firms.

Innovation Intensity among sectors

Among the sectors machinery and equipment, electrical and electronics, engineering units, and wood holds the top slot in innovation activities.

Metal products, rubber, non-metallic mineral based & chemical based, have shown above average innovation.

Sectors such as plastering materials, cement, fabricated metal, textile and leather have shown innovation intensity just below the national average.



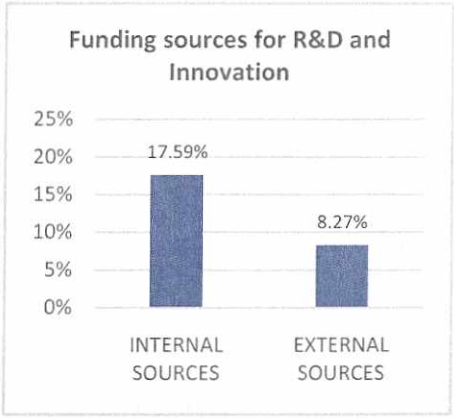
4. To understand the levels of expenditure on R&D activities in MSMEs

Share of MSME in India's R&D Spend

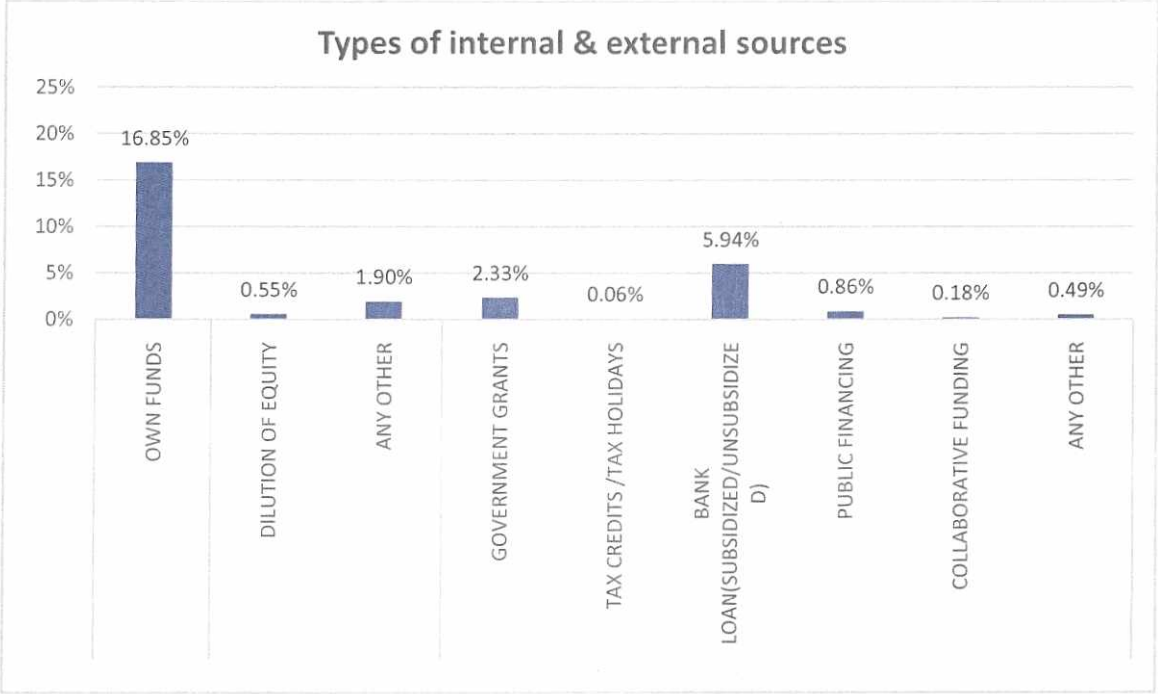
As per MIC estimates, MSME contributes to almost 21% of the national R&D spend, USD 12.86 billion by value. The major chunk of the spending is utilized in acquisition of machinery, equipment and software, accounting to 54% of the total R&D spend among MSMEs. Intramural R&D spend accounts to 29% whereas trainings and extramural account to 8% and 2% respectively.

5. To understand funding sources for R&D and innovation activities in Indian MSMEs

Among the MSMEs that are involved in innovation and R&D in India, the major source of funding has been their own internal sources. The management of firms spend their own funds to fuel the innovation and R&D needs. The use of external sources of R&D close to 8.3%, out of which approx. 6% are bank loans (secured/ unsecured).



The chart below provides a complete summary of the funding sources of R&D and Innovation among MSMEs in India:

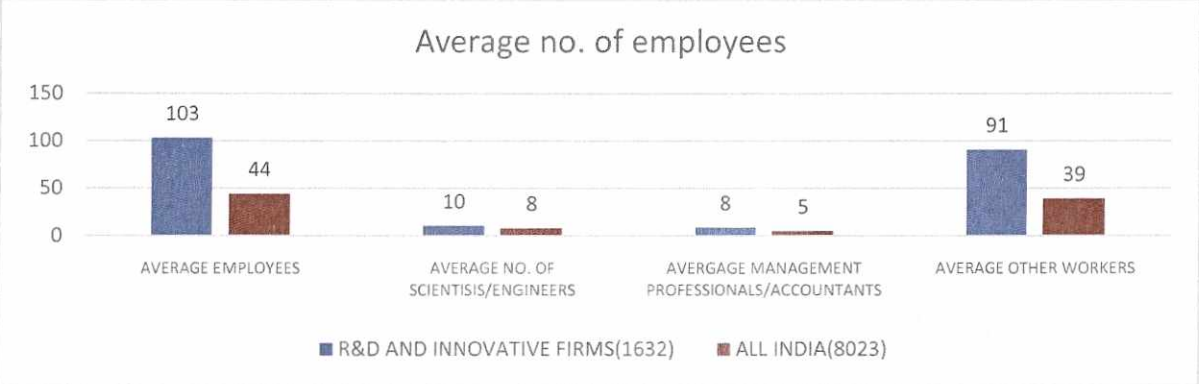


6. To understand the scenario of manpower deployment in R&D jobs in MSME sector in India

The total strength of manpower deployed in the 8023 firms surveyed in the study is 3.53 lakhs. Taking these figures it can be estimated that the total employment in the registered MSME sector is 683.8 Lakhs and a combined manpower of almost 969 Lakhs

As per the Fourth Census as well as data extracted from Economic Census 2005 the total employment in the sector increased to 805.24 lakh as compared to 249.33 lakh in the Third All India Census of Small Scale Industries.

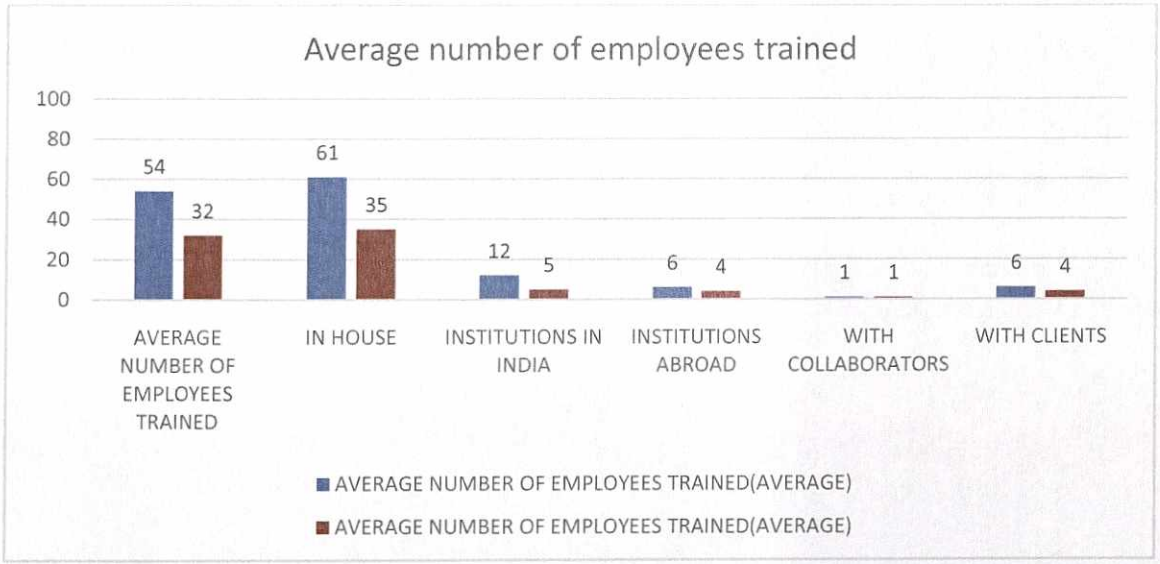
As per the research and analysis of the firms surveyed, the split status of manpower among MSME is as per the chart given below:



It's clearly visible that the firms involved in R&D and innovation have a better average of manpower capacity as compared to the overall India average of manpower deployment.

7. To understand the scenario of training of R&D personnel in Indian MSMEs

Trainings in the MSME sector is majorly concentrated in-house using resources available with the firm. The average of number of employees trained in Innovative firms are better as compared to overall MSME firms. The chart below presents the break-up of training types among MSMEs.



The orientation of training among innovative firms is more than the overall national average. The innovative firms provide 4 training sessions in a year to their employees.

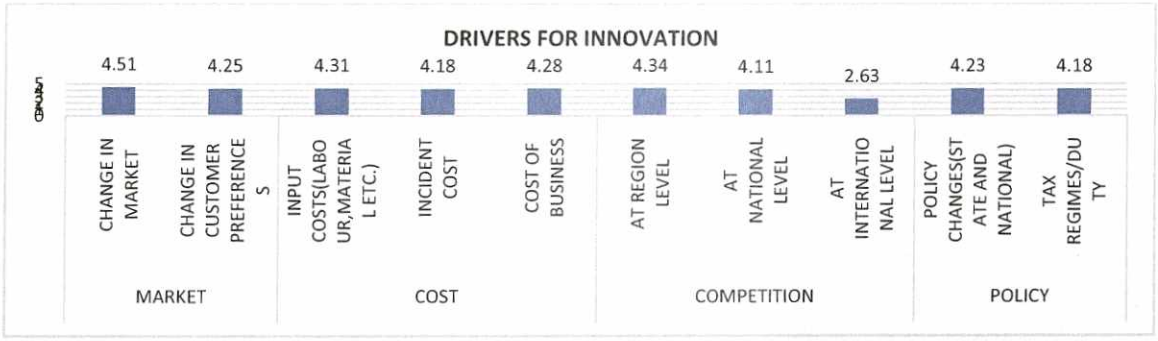
An average 53.40% of the firms provide technical skill training are found to be innovative i.e tech skill training providing firms have approx. three times more tendency to be innovative.

All the firms providing R&D project related training, are found to be innovative that shows the 100% tendency of a firms to become innovative that is providing R&D projects related training, as compared to the firms not providing R&D related training.

An average 58.33% of the firms providing new product/process related training are found to be innovative i.e. new product/process related training providing firms have approx. three times more tendency to be innovative.

8. To assess drivers of innovation & R&D activity at a firm level

The chart below represents different drivers to innovation with their level of intensity:

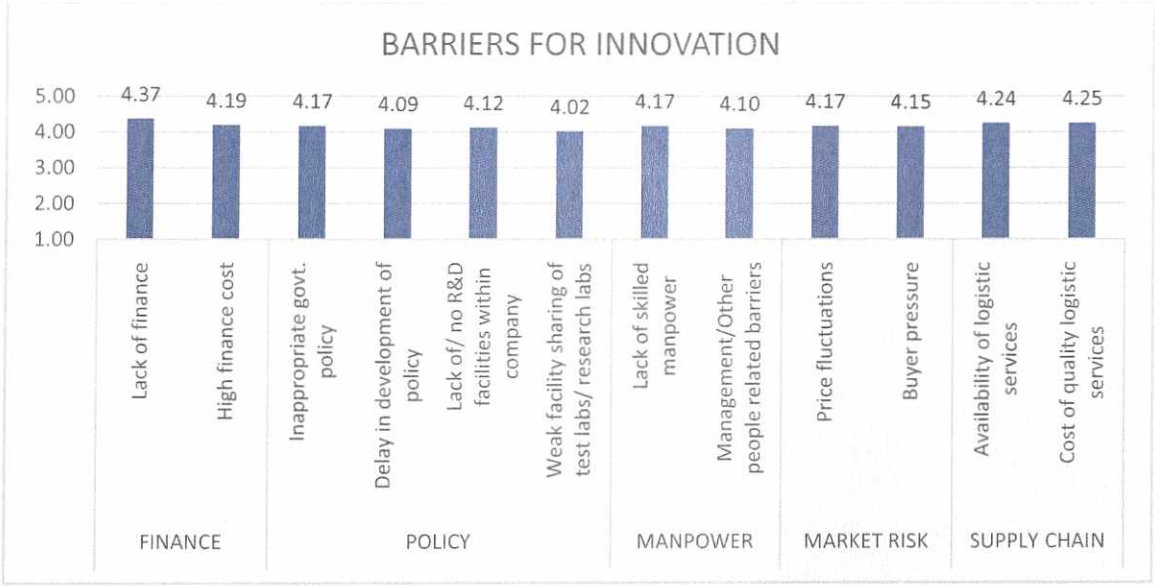


- The basic need behind every innovation is the survival in the market. Growth of organization and maximization of the profits parallelly with the optimization of the resources and minimization of the risks are secondary among MSMEs. Drivers are the forces behind the innovation done by firms, which states the factors driving the firms to get engaged in innovation activities.
- Market as a driver achieved the highest rating of 4.51 in "change in market" which signifies **"survival of the firm in the market"** is the major driver forcing the firms to do innovation and bring out new and improved products/ process.
- "Competition at regional level" is the second highest rated driver with the average rating of 4.34, i.e. highly competitive market being one of the major driving force for firms to get engaged in innovation activities and to bring out new and best innovations to achieve an edge over their competitors in the local market.

- "Input costs (labour, material) achieves the third position in major driving forces, that signifies cost cutting and to manufacture products in low prices as compared to market prices is also a challenge facing by the firms which is acting as a driver.
- "Change in customer preferences" and "policy changes (state and national)" are at fourth and fifth slot respectively.

9. To assess barriers to innovation & R&D at a firm level

The chart below represents different barriers to innovation with their level of intensity:

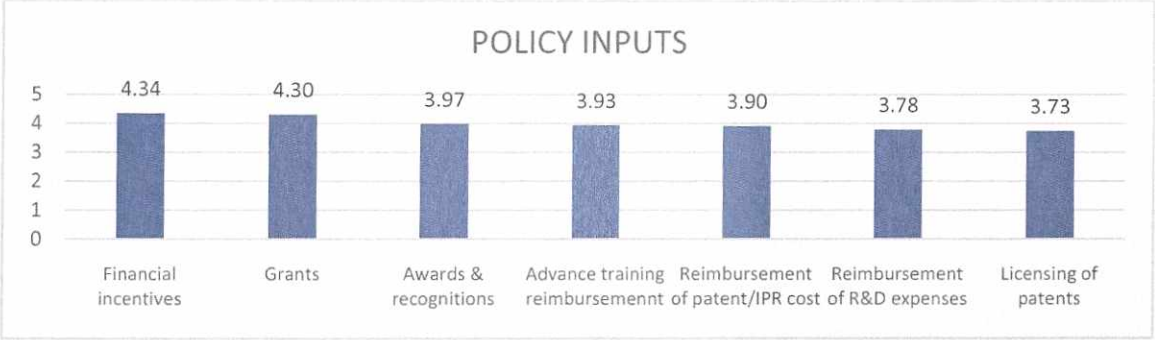


- Highest rated factor is "lack of finance" i.e finance is acting as the major barrier towards innovation, that needs to be taken into account while policy structuring.
- "lack of quality supply chain facilities" is also one of the major factor and is the second highest rated by firms. Exploring newer markets and expanding the sales and distribution base is acting as a strong barrier.
- "policies" includes inappropriate government policies rated 4.12 is also a major barrier for performing innovation activities. It has been observed that the MSMEs feel the right kind of policy is lacking to promote innovation and R&D in India.
- Lack of skilled manpower is also a concern.

- "market risks" that include price fluctuations and buyer pressure are also proved to be important barriers.

10. To provide policy inputs for development of appropriate eco system at a national level to boost R&D and innovation in Indian MSME sector of India

The chart below represents the factors to be considered for policy inputs based on the responses gathered from the survey. Since financial crunch is one of the leading factor that is restricting growth of R&D and innovation among MSMEs, firms seek financial incentives & grants in top priority. A robust policy which motivates the firms and recognizes the efforts put in by MSMEs through Awards etc. will be appreciated by the firms.



Despite the numerous challenges, the MSME sector in India has performed well. There are distinct barriers to innovation, the most important of which seems to be government policy. This leads to the adage that enterprises grow not due to the government support in India, but despite the government. However, a deeper analysis leads one to conclude that the government is trying to facilitate the growth of MSMEs by promoting various schemes and programs to facilitate innovation in the sector through its distinct institutions. The Science, Technology and Innovation Policy 2013 has had an impact but the institutional functioning of the government, Council of Scientific and Industrial Research labs, and individual firms often does not match. The scale of operations in both the public labs and the private research institutions need to be ramped up for greater reach and support to MSMEs. Another major finding is that some programs, like the Cluster Development Program, can be expanded to provide greater access to more individual firms within the cluster. Modernization and technology upgrading along with innovative methods of capacity building and marketing of products are necessary. A holistic and separate innovation

policy for the MSME sector can also be made to promote innovation. The policy, institutions, and supporting framework have to be improved to remove MSMEs' perception that government is limiting their success. Over time, this can be done with the proactive participation of experts and policy makers to benefit India's MSMEs.

11. To assess industry wise and state wise scenario of R&D and Innovation in MSMEs on defined parameters

Among the states, Delhi, Haryana and Punjab are the top ranking states followed by Rajasthan, U.P and Tamil Nadu and Madhya Pradesh. States that are just below the nation average are Bihar, Uttarakhand, J&K, Karnataka and Andhra Pradesh. The Eastern States of Jharkhand, West Bengal, Orrisa along with Chattisgarh show an average of below 16% and some are at the bottom of the table.

Among the sectors machinery and equipment, electrical and electronics, engineering units, and wood holds the top slot in innovation activities.

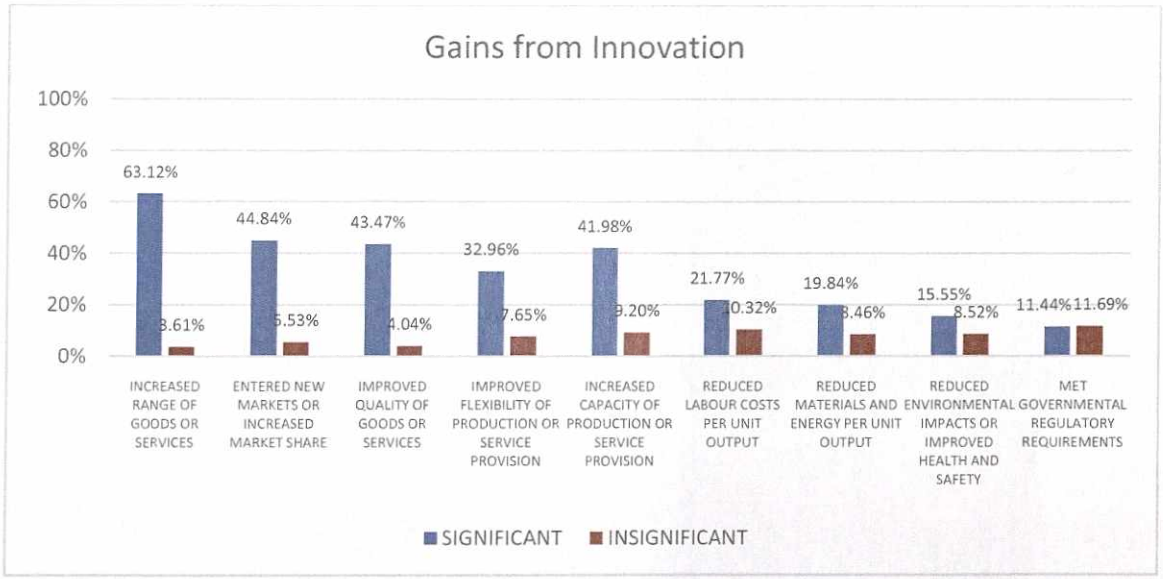
Metal products, rubber, non-metallic mineral based & chemical based, have shown above average innovation. Sectors such as plastering materials, cement, fabricated metal, textile and leather have shown innovation intensity just below the national average. Agro based, paper based and food processing lie at the bottom of the grid.

12. To assess the scenario w.r.t adoption of quality standards (BIS, ISO etc.) by Indian MSMEs

MSMEs in India have a low rate of adoption of quality standards. Among the various quality standards, ISO is the highest rated standard both in terms of the awareness and adoption. Although the awareness levels are high among the enterprises, there is still a long way to go as one third of the MSMEs still are not aware. Benefits received from the standards are perceived to be negligible. The chart below explains the scenario in detail.

13. To assess the gains from innovation & R&D from MSME perspective

MSMEs engaged in Innovation and R&D activities see a high significant gain in most of the parameters. The chart below depicts the various gains of innovation according to the significance levels.



It is commonly understood that higher R&D effort entailing rigid process control, highly qualified manpower etc. translates into better innovation outcomes, however, the study has shown that higher R&D effort does not necessarily translate into significant innovation outcomes.

R&D efforts are closely linked to Return on Investment (RoI), making the MSME organizations directing the R&D efforts necessarily to bring economic gains to the organizations in near or medium term and only such innovation outcomes are considered significant by the organization.

Interestingly there are also cases wherein organizations are doing high quality R&D leading to innovations that are something new to the country, however, which may not lead to business gains in immediate term. These are the innovation endeavours having a "novelty value" and shall accrue benefits to the organization in long term only.

Such instances call for conducive policy frameworks to enables such organizations to undertake novelty innovation driven R&D which is radical departure from normally held position of just aiming for process optimization and monetary benefits.

14. To present case studies in context of R&D & Innovative initiatives in MSME sector in India

The survey received an overwhelming response in the quantitative phase and in the subsequent phase where firms were keen to share anecdotal information regarding their company's achievements through innovation and R&D efforts, learning that can be shared and expectations from the authorities. Based on the information shared by companies a compiled case study report has been developed and shared in Volume 2 of the report.

Study on Impact of MNC's R&D Units in India

Brain Storming Session – CHORD-NSTMIS, DST Supported Innovation Projects

Presentation delivered by Dr. G K Moinudeen on "Study on Impact of MNC's R&D Units in India"

Project Title - Study on Impact of MNC's R&D Units in India

Principal Investigator/Co-Principal Investigator – Mr. Anjan Das, Executive Director, Confederation of Indian Industry (CII), Dr. G K Moinudeen, Co-PI, Confederation of Indian Industry (CII)

Year of completion of Study - 2017

Key questions / objectives / hypothesis of the Study –

- Focusing on understanding and suggesting ways to improve the ecosystem of research & development in India being performed by multinational companies.
- Capturing the current context of MNC R&D in India.
- Suggesting necessary policies that have the potential to effect positive spillovers on the economy for long-term sustainable economic growth.
- Organizational and policy recommendations to attain the objectives laid out in the "Make in India" initiative.

Methodological details of Study –

A sample of 196 multinational companies was chosen to be surveyed of which 101 responded. The sample was a national representation of our R&D Database having details of 600 Foreign MNC R&D centres. Respondents were selected based on three layers of stratification: *Geographic location of the R&D centre*; *Industry sector of the R&D Centre*; *Financial revenue of the parent company for the year 2014-15*.

The primary survey questionnaire had 51 open and close ended questions categorized into 5 sections - *General Information; Internal Organization; Collaboration and Linkages; Outcomes & Output; Constrains & Suggestions*.

Data Sources

Primary

Primary Survey conducted in 2015 with 101 MNC R&D Centres. To complement the primary survey responses, a series of roundtable discussions were also organized with participation from MNC representatives across four cities- Ahmedabad, Bangalore, Pune and Hyderabad

Secondary

Publicly available data: The secondary sources and the publicly available data were incorporated into the formulation of the survey questions.

Data Collection Period: 2 Years

Brief findings/observations

- The primary factors that make India a preferred destination for MNC R&D are the availability of R&D talent pool at a low cost, cost of operations, and the opportunity to address India and similar markets.

- The priority for MNC R&D centres is product development followed by software development and design.

- Majority of respondents indicated that 60% of their R&D personnel have at least a Bachelor's degree. The percentage of R&D personnel having a Master's degree is 40% or lower for a majority of the respondents, and no more than 20% of R&D personnel have a PhD degree.

- The Indian R&D centre contributes less than 10% of the total patents filed by the parent company. A majority of the respondents also indicated that less than one-fifth of the patents filed by the Indian R&D centre were commercialized in India.

- On MNC-University collaborations, the nature of collaboration is internships followed by information sessions, workshops and hackathons, and development of new technologies.

Conclusion / Policy Implications

Make in India" has the potential to create an innovative economy centred on manufacturing. In order to capitalize on the presence of these MNC R&D centres and to attract further investments in R&D, the following steps need to be taken -

- Tracking of MNC R&D activity
- Developing Human Capital for R&D work
- Improving Contract Enforcement
- Fostering Linkages between MNCs and local entities
- Improving Land and Infrastructure
- Providing incentives based on expectations of MNCs

Organisational Practices for Innovation in Indian Industries: A firm level case study on Human Resources and Work Culture

Brain Storming Session – CHORD-NSTMIS, DST Supported Innovation Projects

Presentation by Dr. Pradosh Nath on organisational Practices for Innovation in Indian Industries: A firm level case study Resources and Work Culture on Human

Project Title: Organisational Practices for Innovation in Indian Industries: A firm level case study on Human Resources and Work Culture

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Year of completion of Study: July 2016

Key questions / objectives / hypothesis of the Study

Later day economists further enriched Adam Smith's insight that division of labour is limited by the extent of the market. Gary Becker argued that increase in productivity of a firm and division of labour is actually limited by the firm's ability to access and apply new knowledge. As Becker would argue, having an endowment of human capital does not automatically lead to application of the embodied knowledge. There has to be carefully designed teams based on specialization, there has to be proper coordination for synergy among the teams. Human capital has to be adequately activated through incentives towards motivation of the employees. These are the best practices for organizing, nurturing and activating human capital in the production system based on application of new knowledge; the path of innovation.

The present study is designed broadly following the above understanding. The contribution of the study therefore are four folds: It is more comprehensive, it reorients the study on firm level innovation from verification of determinants to activation of the determinants, and in that it brings in to focus three aspects: How the employees are organized, how are they motivated to give their best – incentivisation, and how the alienation is allayed through employees' participation in decision making. We develop a few proxies to capture the firm level practices accessing knowledge, skill development, incentives and motivation, and coordination.

Methodological details of the Study

The proposed study makes an effort to examine the internal system of innovation of a firm. One of the major lacunae of the NIS approach to innovation is that it still does not have a micro theory of innovation. We look at Firm level Innovation System, or Innovation System Internal to Firm, which essentially means to look at the innovation ability of a firm as the talent pull available to the firm. Or, in other words Human resource and work culture of a firm. We broadly ask two questions:

1. What do innovative firms do for creating enterprise specific human capital?

2. What are the characteristic differences (if any) among firms that can explain behaviour of firms, if those are distinctively different?

The questions were approached by examining the human capital related practices of the innovative firms. Innovative firms have been selected from the DST report on National Innovation Survey, 2013. DST Survey covered 36 states and Union Territories. DST Survey has ranked the states in terms of their innovation potentiality. We have chosen firms from seven states; two top innovation potentiality states (Karnataka and Maharashtra), two from middle level innovation potentiality (West Bengal and Delhi), and two from the bottom (Tripura and Bihar). We have chosen Gujarat as a special case, because, although the state is highly industrialised, it is not high in innovation potentiality ranking. Again, firms were chosen from top three sectors (NIC) in terms of innovation potentiality in the selected states identified in the DST study.

Data Sources

a. Primary: The study is based on primary data collected through questionnaire based survey of selected firms in different states . We proposed to choose 105 innovative firms (15 in each states, and 5 firms in each sector). However, in most of the sectors there were not many innovative firms to choose from. We, therefore, decided to cover all innovative firms in the sectors chosen in a state. Thus we covered 129 firms; 20 each from Maharashtra, Karnataka, West Bengal, Delhi, and Tripura, 15 in Bihar, and 14 in Gujarat.
b. Secondary: NA
c. Data collection period: September 2014 to May 2015

Brief findings/observations:

Brain Storming Session – CHORD-NSTMIS, DST Supported Innovation Projects

There is indication that firms involved in product and process innovation are more inclined to employ skilled manpower. Also demand for skill increases with higher size, and wider market reach of the firms. It is also indicative of the fact that adequate impetus to growth and availability of skilled manpower coupled with wider market reach can make SMEs more innovation oriented.

There is ICT enabled MIS for most of the firms, but decision making is centralised. Most of the firms claim the same extent and types of incentives; there is no industry leader as attractive employer. The industry in general does not provide career prospect, or skill development; most of them do not access the available training and skill development opportunities with external agencies.

Strengthening technological capability is recognized by firms as the most important requirement for wining competition. Firm size has some bearing on technology initiatives. Larger firms are more inclined to approach National Laboratories for technological inputs. Firms with wider market reach and firms with lesser competitive pressure are more technology oriented, seeking technology inputs from supporting agencies. Private agencies are more frequently approached for technology related support. Government agencies are approached mostly for finance and consultancies. Inadequate response from technology support system, and problem in dealing with government departments are seen as major constraints.

Conclusion / Policy Implications

Overall picture is that of sluggishness; a situation of status quo of a perfectly competitive market. Variations over the firms (different attributes taken into consideration), if any, is easier to overlook than take note of. There is not much initiative to create firm specific advantage to move ahead of competition; human resource being the most neglected aspect of firms' activities for gaining productivity and growth, so much so that firms are almost indistinguishable from each other in terms of their practices in organizing, nurturing and developing human resources.

The state of affairs of the innovation in the manufacturing sector (SMEs in particular) requires to be seen in terms of the future and emerging global scenario. In an increasingly globalised industrial activities, and fierce cost and technological competition from emerging economies like

China, the road ahead is to infuse new products, improved products, new technologies and new skill sets.

There is a need to create policy incentives for the firm to grow bigger; the most important impetus for innovation. At present the policies are biased towards remaining small. The fear is that the bigger units will eat up the smaller ones. The policy is short sighted. It presumes the present industrial activities, the basket of products manufactured as the universe and unchangeable. In reality the globalised industrial dynamics offer a potential product basket that is infinitely expandable with new products.

Issues to be addressed

The study indicates what the production sector suffers from. Indian manufacturing sector, particularly the SMEs are in an interesting and intriguing crossroad. We have tremendous technological achievements in the high tech areas along with a large pull of scientific and technological manpower that apparently is one of the major attractions for MNCs towards India, on the other side the production system suffers from practices that are archaic and far away from utilising the available scientific and technological knowledge pull. Becker in his seminal work 'Human Capital' argues that increasing reliance of industries on scientific and technological knowledge greatly enhances the value of education, technical schooling, on-the-job training, and other human capital. At the same time Becker writes, 'New technological advances clearly are of little value to countries that have very few skilled workers who know how to use them.'

It is, therefore, imperative that the manufacturing sectors require help to gear up with new product ideas, new technologies and required skill sets, strong networking with technology generating system, harnessing human capital for creating innovation dynamics inside the firm.

DICs as Industry Commons

The new initiatives like 'Make in India', 'Skill India', and 'Start up India', have renewed the thrust towards strengthening innovation support system at the regions. The same, however, may fizzle out in the absence of a suitable organisational set up that can consolidate the need of new product ideas, new technologies and new skill sets for the generally defeatist manufacturing sector.

District Industry Centres (DICs) can be considered for revitalisation with a new mandate to undertake such tasks at regional/district level. DICs can be transformed to function as 'Industrial Commons', as hub of new product, technology, and skill. DICs can be seen in network with the technical institutions around it for accessing the available expertise. This would require a blue print for organisational transformation of DICs.

Way Forward

An intensive way forward session was held in the final session and the speakers and experts concurred on the following recommendations

Suggestions that emerged as a part of the Way Forward Session – BSS 18 Aug 2017

- **Strengthening the innovation support system at the local level:** Exploring the possibilities of activating District Industry Centres (DICs). Total revamp of DICs and facilitate move towards District Innovation Centres. Suitable integration of programmes like 'Make in India', 'Skill India', and 'Start-up India' with the process of revamping DICs.
- **Consolidating policy recommendations/findings of the BSS Studies:** Consolidation of all policy recommendations/findings of the BSS Studies together to identify synergy and value addition. Identification of value and understanding imparted by the studies for taking next round of NIS. Dissemination of the lessons thereof to the stakeholders
- **Initiation of next phase of National Innovation Survey (NIS):** New insights provided by the aforementioned studies to reaffirm key findings of NIS and act as inputs for improving the next NIS Survey dimensions. Relevant inputs from scholars, experts and other stakeholders for launching a more enriched and comprehensive NIS–2.
- **Consolidating the studies on Innovations in India to develop a comprehensive body of knowledge:** Consolidation of the studies on Innovations in India (both success and failure stories) to develop a comprehensive body of knowledge for concerted planning initiative for promotion and awareness of innovations with special reference to MSMEs.
- **Choice of the MSMEs:** Identification of MSMEs with radical innovations, having significant turnover and patents for further in-depth study of innovations, with particular focus on examining the factors stimulating innovations and the policy learning.
- **Emphasis on study in service sector:** Need for emphasis on studies in service sector and manufacturing in unorganized sector for the MSMEs.

- **Focus on 5 Cs critical for innovation** (i) Culture (competition) in cluster mode (ii) Communication/access across sectors (iii) Necessity for innovation, crowd funding, access to capital (iv) Collaboration & (v) Change radically
- **Support for innovation studies focused on public research, health, education and regulation:** Support by DST for innovation studies recognizing the key role of public research organizations and higher education research to foster innovation in the country. In addition, innovation studies to focus on public health and regulations.
- **Study on industrial product clusters:** Need for studies on industrial product clusters that are socially relevant with a clear focus on returns on R&D, outcomes of R&D and innovation

Brain Storming Session on 18th August, 2017 at Indian International Centre (IIC)

Brain Storming Session – CHORD-NSTMIS, DST Supported Innovation Projects

Annexure I: Schedule

9:30-10:00	**Registration**			
10:00-10:30	**Welcome Tea & Snacks**			
10:30- 11:00	**Inaugural Session**	**Welcome address by Dr. Parveen Arora,** Advisor & Head, CHORD(NSTMIS) Division, DST, Government of India		
	Session	**Time slot**	**Speaker(s)**	**Title of presentation**
11:00-12:30	**Session I:**Industrial Innovation– Within the purview of 'Make in India'	11:00-11:30	**Dr. Nirmalya Bagchi** Administrative Staff College of India	Innovation in Large Manufacturing Firms – In the Era of 'Make in India'
		11:30-12:00	**Mr. Anjan Das (PI) & Mr. G K Moinudeen (Co-PI)** Confederation of Indian Industry	Study on Impact of MNC's R&D Units in India
		12:00-12:30	**Prof. Pradosh Nath** Centre for Knowledge, Ideas and Development Studies, (KnIDS)	Organisational Practices for Innovation in Indian Industries: A firm level case study on Human Resources and Work Culture
12:30-13:30	**Lunch**			
	Session	**Time slot**	**Speaker(s)**	**Title of presentation**
13:30-15:00	**Session II:**Research & Development (R&D)& Innovation in Micro, Small & Medium Enterprises (MSMEs) in India	13:30-14:00	**Dr. Tamal Datta Chaudhuri** Calcutta Business School	Extent Of R & D And Innovation In MSMEs In West Bengal: Strategies, determinants and effects
		14:00-14:30	**Dr. J. S. Juneja** Global Projects & Services	Study on 'Status, Systems and Strategies of Innovation in SMEs in the Equipment and Machinery Sector
		14:30-15:00	**Mr. Sanjay Nagi** Market Insight Consultants	Assessment of Research & Development & Innovation Practices in Micro, Small & Medium Manufacturing Enterprises (MSMEs) in India
15:00 –15:30	**Tea**			
15:30 – 16:30	**Session III:**Innovation management & process: Policy framework perspective	15:30– 16:00	**Dr. K. Chitra** Sri Ramakrishna College of Arts and Science for Women	Innovation Management and Practices in SMEs': Antecedents & Challenges
		16:00– 16:30	**Mr. Mukesh Gulati (PI) & Ms. Sangeeta Agasty (Co-PI)** Foundation for MSME Clusters	Assessing Industrial Innovation Process and Suggesting Policy Support Framework in India
16:30-17: 30	**Brain storming session** and **way forward**			
17:30-18:00	**Tea & Snacks**			
18:00-19:00	**Road Map and Vote of Thanks**			
19:30 onwards	**Dinner**			

Annexure II: List of Participants

1	**Dr. A K Vasisht** Assistant Director General (PIM), Indian Council of Agricultural Research, New Delhi
2	**Mr. Amit Kumar** Research Associate, Research and Information System for Developing Countries (RIS)
3	**Prof. J .K. Mitra** Faculty of Management Studies University of Delhi,Delhi
4	**Mr. Janak Nabar** Centre for Technology, Innovation and Economic Research (CTIER), Pune
5	**Prof. M H Bala Subrahmanya** Professor and Chairman Department of Management Studies, Indian Institute of Sciences, Bangalore
6	**Ms. Megha Sunger** Asian and Pacific Centre for Transfer of Technology (APCTT), Qutab Institutional Area, New Delhi
7	**Dr. Mehak Malhotra** Centre for Technology, Innovation and Economic Research (CTIER), Pune
8	**Prof. Pranav N. Desai** Professor , Centre for Studies in Science Policy, School of Social Sciences-I, JNU, New Delhi
9	**Prof. R. Venkatesan** Senior Consultant, National Council of Applied Economic Research, New Delhi
10	**Dr. S. G. Deshmukh** Director, ABV Indian Institute of Information Technology and Management , Morena Link Road, Gwalior
11	**Dr. Parveen Arora** Advisor and Head, CHORD Division, NSTMIS, DST, New Delhi
12	**Dr. A N Rai** Scientist F, CHORD Division, Department of Science and Technology
13	**Dr. H. B. Singh** Scientist E, CHORD Division, Department of Science and Technology
14	**Mr. Praveen Rawat** KnIDS
15	**Dr. S. Saha,** RIS
16	**Mr. Anuj Munjal,** Co PI Market Insight Consultants
17	**Ms. Pratima Shaw, Research Assistant** RIS
18	**Ms. Pratikshya** FMC

19	**Mr. G K Moinudeen, Co-PI,** Director, Technology & IPR Division, Confederation of Indian Industry, Sector 18, Udyog Vihar, Gurgaon
20	**Prof. Pradosh Nath, PI** Ex Chief Scientist, NISTADS & Director, Centre for Knowledge, Idea and Development Studies (KnIDS), Sector- 4, Dwarka, New Delhi -110028
21	**Mr. Mukesh Gulati, PI** Executive Director USO House, 2nd Floor, USO Road, 6 Special Institutional Area, Off Shaheed Jeet Singh Marg, New Delhi – 110067
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23	**Dr. J. S. Juneja, (PI)** Global Projects & Services Pvt.Ltd. 707, Ansal Chamber -II, 6 - Bhikaji Cama Place New Delhi -110066 Phone: +91-11- 26170146, 26178443 (M) 9811099888 Email:globalprojects95@gmail.com
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25	**Dr. Nirmalya Bagchi (PI),** Dean of Research and Management Studies Administrative Staff College of India, Bella Vista, Raj Bhavan Road Hyderabad 500082
26	**Dr K Chitra (PI),** Innovation Management & Practices in MSE –Antecedents & Challenges Mobile : 9842648828 Email : principal@srcw.ac.in
27	**Mr. Sanjay Nagi, PI** Managing Director Market Insight Consultants B3, Sector 2 NOIDA- 201301 +91-98100- 81693; +91-120- 4322037
28	**Dr. Tamal Datta Chaudhuri, PI** Principal Calcutta Business School, Kolkata Mobile : 09831054204 Email: tamalc@calcuttabusinessschool.org

29	**Mr. Karnak Roy,** Academy for Science Policy and Implementation Research (ASPIRE) Administrative Staff College of India, Hyderabad
30	**Mr. Kohinoor Chatterjee,** Academy for Science Policy and Implementation Research (ASPIRE) Administrative Staff College of India, Hyderabad
31	**Mr. Arpan Roychowdhury,** Academy for Science Policy and Implementation Research (ASPIRE) Administrative Staff College of India, Hyderabad
32	**Ms. Katyayani P N S,** Academy for Science Policy and Implementation Research (ASPIRE) Administrative Staff College of India, Hyderabad

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About CHORD (NSTMIS)
The National Science and Technology Management Information System (NSTMIS), a division of Department of Science and Technology (DST) has been entrusted with the task of building the information base on a continuous basis on Resources devoted to scientific and technological activities for evidence based policy planning in the country. It is responsible for the assessment, monitoring and benchmarking of S&T potential of the country.

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