Chapter-6

CONCLUSIONS, RECOMMENDATIONS AND THE WAY FORWARD

The present research deals with measurement of technological development and establishes patterns of innovation in Indian Chemical Industry (ICI). The measurement parameters are developed based on (OSLO manual, 2007) with two broad objectives- (a) primary database through questionnaire having subjective and objective approach for firm level innovation assessment, and (b) patent statistics as classified parameter of technological development work in chemical industry (ICI).

The analysis results are derived through individual organizations and aims at setting benchmark for improving performance of Indian chemical industry (ICI) in general and specific segments are identified for emerging opportunities.

6.1 Conclusions

Indian Chemical Industry is estimated at US$ 60 million with the volume of production as third largest in Asia-Pacific. The Industry contributes to 7% of India’s GDP and 12.5% of Indian manufacturing segment. ICI has almost 4000 units widely spread in both large scale and small/medium scale industries and offers a wide range of over 7000 industrial products. The annualized growth of ICI is at around 10 per cent. (Lohokare, 2010). For a vision to accelerate the size of ICI to US$100 million with an enhanced global contribution of chemical industry to 3.9 per cent from current 1.9 per cent and Indian industry contribution from 7 per cent to 12.1 per cent sets of imperatives (KPMG Report, 2005) are derived through analysis. The analysis output aims for setting a guideline view for framework of industry/organization development and supporting policy framework for providing a conducive environment of growth. The Indian chemical industry is classified into nine segments- Petro-Chemicals, Plastics and Polymers; Organic Chemicals; Inorganic chemicals; Agro-chemicals and life science; Pharmaceuticals, drugs and Intermediates; Soaps and detergents; Fertilizers and Pesticides; Dyes, Paints,
Varnishes and Coatings; and Other chemicals like, Industrial Gases, metals etc.

These organizations based on sales turn over in Rs. Crores are classified as small, medium or large. Organizations having sales turn over (average of four years 2006-2009) less than or equal to Rs. 1 billion is classified as small, Medium is Rs. 1 billion to 5 billion and Large organization is classified as Rs. 5 billion and above. Similarly based on market exposure of the company the classification is carried as national or multinational markets and/or operations.

Research study on technological innovation and organization performance is compatible with Oslo Manual, Guidelines for collecting and interpreting Innovation data. (Oslo, 2005) This research study undertakes growth in financial performance (GFP) and growth in non-financial performance (GNFP) by formulating appropriate indices.

A two tailed analysis of Pearson correlation determines positive relation with R & D expenditure (RDE) and technological development and innovation (TDI) as combined factor. Innovative firms are sensitive to internal process improvements, rising to market requirements, sensitive to quality issues and compliant with statutory and regulatory legislations. The organizations arising to need of customer, meeting industry norms and enhancing performance through bridging gaps in performance are able to build confidence in organization and their stake holders.

To establish magnitude of expenditure on R & D (RDE) on Technological development and Innovation (TDI) on organization performance regression analysis finds 11.5% contribution. This signifies some role of R & D inputs in improvement technological innovation process. However organizations are able to improvise the innovation process without R & D through process & product development, utilization of plant and machinery as product of innovation, technological tie-up, know-how agreement etc.

Similarly regression analysis is carried for establishing magnitude of R & D Expenditure (RDE) and Technological development and innovation (TDI) combined on Growth in
financial performance (GFP) is 5.8% and a significant 42.2% on Growth of non financial performance (GNFP). Innovative organizations are able to establish image over competitors through their superior internal processes.

Test of null hypothesis ‘that the determinants for innovation and their outcomes are same across the entire industry segment’ is analyzed through ANCOVA. Total 172 organizations classified in two broader segments as basic chemicals and emerging chemicals is represented by 110 and 62 samples respectively. The analysis is carried with two variables wherein size of organization is represented as log transformed of sales turnover and firm type as bi-variant expression of national/multi-national. Eight variants of innovativeness namely, Process Innovativeness, Product Innovativeness, Overall Innovativeness, Process Patenting, Product Patenting, Expenditures on R & D, Drivers for Innovation, and Barriers for Innovation are different for both segments i.e. basic chemicals and emerging chemicals. Summary of the findings reveal that:

1. Process innovation in ICI is a common feature. Irrespective of size and type of organization organization’s very survival and competitiveness is dependent on their continued efforts on process improvements.

2. Emerging chemicals segment has dominance over basic chemicals on all variants except barriers. This is evident from the fact that basic chemicals shall have more controlled expenses and strategic orientation for nurturing innovation. The basic chemicals in various segments like inorganic chemicals, organic chemicals, petro-chemicals, polymers, fertilizers, soaps and detergents are having low R & D needs due to their long positions in market and matured consumer segments. Whereas emerging market chemicals have need for laboratory trials, simulation/pilot scale studies on set-up/plant scale. Emerging chemicals are also addressing ‘gap’ in market and hence ‘new to organization/ new to market’ is identity of these chemicals. Both, product and process development through in-house efforts/patent or various other means is obtained by the emerging segment. Emerging segment is also vulnerable to market competition as well first mover’s advantage.
3. Product and new process development thus is dominant with emerging industry segment. The measure confirms 60% of organizations have patented one or more products and 56% organizations have patented one or more process patent. The organization builds an organization culture to address to continue to remain competitive and speedy to reach to market. Innovation thus has a significant strategy to diffusion process also.

4. Influence of firm size and firm type is analyzed by F-values. Firm size has significant relation to expenses on R & D, Innovation drivers and Innovation barriers. Firm type has significant relationship to patenting activities. This is obvious of the fact that emerging segment has to position in competitive market through well established technological support.

5. Industry segments (national/multi-national), size expressed as log transformed and type of industry (basic chemicals, emerging chemicals) indicate $R^2$ values of significance for product innovativeness (35.6% contribution), Process patenting (39.7% contribution and drivers for innovation (34.1% contribution).

6. Analysis is furthered to establish effect of five input variable (Size of firm, Type of firm, Expenditure on R & D, Drivers to innovation and Barriers to innovation) on outcome variables (process innovativeness, product innovativeness, process patenting and product patenting). First two outcome variables (process innovativeness, product innovativeness) are continuous in nature and hence linear multiple regression is applied. Other two outcome variables (process patenting and product patenting) are binary in nature and hence binary logistic regression is applied. For all the model testing two covariant, (Firm type and firm size) are introduced in first block followed by three determinants (Overall Indian Chemical Industry, Basic Chemicals and Emerging Chemicals) are introduced. The analysis outcome is summarized as per tabulation of result summary.
<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Output</th>
<th>Remark</th>
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<tbody>
<tr>
<td>Process Innovativeness</td>
<td>R2 values are widely varying. However across the segments firms remain innovative.</td>
<td></td>
</tr>
<tr>
<td>Product Innovativeness</td>
<td>Firm size has positive significance with basic chemicals</td>
<td></td>
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<tr>
<td>Process Patenting</td>
<td>Emerging chemicals R &amp; D expenditure and drivers have significance. No factors are effecting on process patenting</td>
<td></td>
</tr>
<tr>
<td>Product Patenting</td>
<td>Basic chemicals have significance for barriers. Emerging chemicals have significance for Type of firm and drivers.</td>
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</table>

[Table 6.1: Summary of Analysis for Firms Innovativeness]

7. Patents serve as technological activities indicator for firm’s efforts to remain competitive in market place. Total 8248 patents pertaining to chemical industry issued by Indian Patent Office (IPO) between 21st January 2005 till 02nd March, 2007 have been analyzed.

8. From the total population of patents filed during this period, 17 % (1365 Nos) were from Indian origin and balance 83% (6883 Nos) were filed from 44 different countries around globe. This may be also true that BRIC countries (Brazil, earst while Russia, India and China) are preferred destinations due to less stringent environmental norms, plenty of knowledge workmen availability, less competitive markets. Specific reference to Indian Patent approval, it is coupled with license for manufacturing activities. This aspect is continuing till this time for shift of concentration of chemical industry base towards Far East countries. Patents are also sometimes used as tool for trade barriers in competitive markets.
9. In order of number of filed patents in Indian Patent Office (IPO), other chemicals segment (2664 Nos.), Pharmaceuticals and drugs (2199 Nos.), Agrochemicals and life sciences (1802 Nos.) are the favored segments. In basic chemicals segment patenting is primarily active in petro-chemicals and polymers segment. However contribution from Indian Origin lacks far behind as compared to external patents.

10. Patent filing is dominated by Industry at IPO, however a significant contrast is observed that Indian patent are in maximum from Institution whereas foreign applications are dominantly from Industry (among this large populations of industry belongs to a global size).

11. Patterns of patent approving efficiency is analyzed using ANOVA with inputs as log transformed value of lead time to decide for patent approval (LGLTD). A Foreign application has less time to decide. This is effect is understood as influence of another approving patent office. Once a patent in any WIPO country is granted, the patent approval process enables the IPO to accelerate internal patent processing. With post hoc Turkey test significance is found to have long time between application and grant of patent filed by Indian Institutions. Such patents are requiring more professional approach in filing of patents and follow-up with subsequent processes.

12. The post hoc Turkey test describes that patents in Agro chemicals and life science is processed faster than in other prominent segments.

13. The analysis further signifies that organic chemicals have been faster to obtain grant of patents followed by Agrochemicals and life science, pharmaceuticals drugs and intermediate and dyes, paints varnishes and coatings. These firms are renowned multinationals with use of accumulated experience over years in global offices for patent application and a sound back up from their parent companies.
6.2 Recommendations

Based on analysis of data gathered through questionnaire and patents, the following suggestions are proposed.

- Process improvement for Indian Chemical Industry (ICI) is an integral part of survival. Improvement in process efficiency, enhanced quality control, modernization of process control systems, cost control through raw materials and utility optimization, improvement in SHE performance (Safety, Health and Environment), optimization of energy and maximize use of low cost and non-conventional energy sources, follow up with ‘Responsible care’ guidelines are few areas of continual improvements.

- Indian Chemical Industry (ICI) to take lead in creating knowledge hub and promote innovation centre to compete with global environment. CSIR (Central Scientific and Industrial Research) laboratories employ world’s second largest knowledge workmen. A focused objectivity and speed of converting innovation solution is a key to competitiveness.

- Contribution of R&D specific to industry has large potential to increase resources.

- Indian Chemical Industry (ICI) for an accelerated growth strategy should look for technological tie ups, merger and acquisition, create long term alliances with global companies having brand image, creation of increased sales networks.

- Improvise internal process and systems for cost control consolidation of business processes.

- Indian Patent Office (IPO) to accelerate patent processing system at par with advanced countries and their system adoption.
• Rise in level of Intellectual Capital being generated through training and study reforms and as consequence increase in number of patents.

• Development of core skills in chemistry, chemical engineering and general management with specific focus on specialty chemicals and knowledge chemicals.

Based on industry experience few more recommendations may help in consolidating the findings,

• Indian Chemical Industry (ICI) to have closer look at inefficient plant operations, cost disadvantages and obsolete process technology in operation.

• Organization to take appropriate decision for closure of inefficient units, consider relocation based on cost advantages, process technology up gradation and optimization on knowledge based workmen.

• Improve Safety, Health, and Environment (SHE).

• Enhance usage of IT interface with chemical process and other business processes.

• Organization to develop appropriate system for monitoring operation and financial cost and device suitable measures to keep the cost under control.

• Organizations to develop cluster of industries, common utilities, common affluent disposal system, waste disposal system and institutional interaction & support.

• Create infrastructure suitable for chemical plant equipments, fabrication, automation services, training institution for workmen.

• Create large size trading houses, venture capitalist and financial institution supports to build global size manufacturing units providing value to end users
and market advantage to manufacturing unit.

- Conducive regulatory and statutory framework to boost industrial activity provides suitable changes in value added tax structure.

6.3 Limitations and the Way Forward
The present study is based on public limited organizations having consistent positive performance. The study has helped to understand and measure technological innovativeness. The following paragraphs may lead the future researches to a wider and more applicable scope of the work.

- Support process of fragmented and unorganized chemical units need closure look at the product and process performance and sustainable profits.

- Study on structure institution/NGOs working towards consolidation of various chemical units and their R&D support.

- Study of special purpose economic zone and establish their relevance for Indian business.

- Case Study of successful chemical units to understand overall business process and establish how an organization has successfully been able to convert macro business objectives by utilization of effective business tools.

- Case Study of State and Central Legislation and compare with advance economies and their infrastructure support for industry.

- Study patent application process of measure institutions involved in Industrial Research and suggest improvement towards patenting process and knowledge diffusion.

- Study of industrial collaboration models/clusters having trade development
schools, common utilities, common infrastructure support and engineering support. This study should primarily focused on cluster of small scale units.