SUPPLY CHAIN PERFORMANCE EVALUATION: STUDY OF SELECT PHARMACEUTICAL INDUSTRY

Project Completion Report

Sponsored

By:

National Science and Technology Management Information System (NSTMIS) Division

Department of Science and Technology

Government of India

Submitted by

Dr. Mukesh Kumar Barua

Principal Investigator

DEPARTMENT OF MANAGEMENT STUDIES

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

UTTRAKAND

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EXECUTIVE SUMMARY

- The study has been conducted in three major pharmaceutical clusters namely Haridwar, Hyderabad, and Mumbai of India.
- The study has been carried out in two phases. In first phase, an exploratory research and a brainstorming secession was carried out.
- In second phase, a conclusive study was done using a structured questionnaire, designed after taking inputs from phase one.
- The data were collected from 241 professionals working in small, medium and large Pharmaceutical enterprises.
- We have found major contribution from medium and large enterprises.
- More than half of the responses came from Mumbai and Pune region, this shows favourable sign for industrial growth in that region.
- The majority of the respondents (Approx. 80 %) are graduates and post graduates, which shows well qualified employees in the industry.
- Information collected through personal interviews with middle and high level management (CEOs, GM, Operations mangers) comprises 77% of the total respondents.
- Approximate 66% of the respondents having age between were 31-35.
- The age of the industry is approx. 11-15 years, which shows promising growth of the industry with increasing numbers of MSMEs in India in last decade.
- Approximately 81% of the units were medium sized.
- The quality management practices which are more prevalent in pharma industry are; TQM, continuous improvement tools, ware house safety, benchmarking, quality purchasing, inbound inspection and quality certification.
- Following modern supply chain practices like; supply chain, benchmarking, and vertical integration, relationship with suppliers, holding safety stock and use of external consultants were found least followed.
- On the basis of factor analysis, it has been found that quality management practices are widely being used.
- Following are the barriers which affect supply chain performance most; poor priories of top management / lack of top management, poor strategic planning, and inefficient information systems.
- Following are the barriers which affect supply chain performance least; corporate culture, and motivation for change.

- On the basis of factor analysis, it has been found that IT and communication barriers affect the performance of supply chain.
- The intervention of science and technology affect all the drivers. The most affected driver is "warehousing" and least one is "pricing".
- As per our study supply chain gets affected by scientifically designed systems in which decision support system, and RFID are ranked higher and CRM & APS get lower ranks.
- Operating profit margin, economic value added (EVA) & revenue growth rate, and net profit are found to be the most useful financial KPIs to access the financial performance.
- Customer profitability score, customer retention rate, and customer satisfaction index are found to be the most useful customer related KPIs to access the customer related performance.
- Process waste level, order fulfilment cycle time, and inventory shrinkage rate are found to be the most useful operational performance KPIs to access the operational performance.
- The integrated supply chain affects the "perceived quality of medicines" most and "packing" the least.
- Indian pharmaceutical producers are in great need of technological upgradation in distribution, packaging, and manufacturing process as we are in generics manufacturing. And warehousing and inventory show low response but they also require up gradations.
- The structure equation model has been found reliable and industry may assess the performance of pharmaceuticals industry. The pharma supply chain performance can be accessed through operational, financial, market, and customer related measures.
- It seems that in Northern region like Haridwar, there is a lack of infrastructural facilities as compared to other clusters.

ACKNOWLEDGEMENT

The study was under taken with the financial support on NSTMIS division of the department of science and technology, government of India .The successes of this assignment successfully, we take this opportunity to acknowledge the support *Dr. Parveen Arora, (Sc-G)* and head, *NSTMIS Division, Dr. A. N. Rai (Sc-F) NSTMIS* division for helping us in defining the board Objectives of the study, also the help and guidance of our eminent team of experts *Prof. T.T. Narendran, DoMS, IIT Madras, Prof. P. Vijayaraghavan, DoMS, IIT Madras Prof. S G Deshmukh, Director, ABV- IIITM Gwalior, Dr Rajesh Kumar Singh, Indian Institute of Foreign Trade and Dr Dilip Singh, NEET Business School* for their contribution in finalizing survey instruments and acknowledging subject of study. PI and his team would also like to thank Local DICs for giving valuable information supported our research. We also like to thank *Mr. Sanjay Gupta (DGM), Akums Drugs & Pharmaceuticals Ltd, Haridwar, (India),* for playing a key part brainstorming session organised to finalization of questionnaire. Entire team would to thank local project appraisal committee (LPAC) *Dr. Praveen Arora, Dr. A. N. Rai, Dr. A. Ramesh, Prof. M. Parida, Dr. Sudhakar Subudhi, Dr. A.K. Sharma, Dr. Usha Lenka, Dr. Durga Toshniwal, Prof. Renu Rastogi, Dr. Akshay Dvivedi and Dr. S. Rangnekar (HOD DoMS IITR)* for their support and investing time for keen observation to provide periodic suggestion for improvisation to move project in desired direction. Also the support received through various respondents working in the capacity of CEOs, general managers, heads of organisations and mangers is highly acknowledged as we know, without their support this project might not be at this successful stage.

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PROJECT TEAM

LOCAL PROJECT APPRAISAL COMMITTEE (LPAC) MEMBERS

Project Team

S.No.	Name	Organization/Institute
1	Dr. M.K. Barua (PI)	Associate professor , Department of Management Studies IIT Roorkee
2	Professor S. Rangnekar(Co-PI)	Professor , Department of Management Studies IIT Roorkee
3	Mr. Vinayak Vishwakarma	Research Scholar (MHRD), Department of Management Studies IIT Roorkee
4	Mr. Jamal Uddin	Project associate (MBA) Department of Management Studies IIT Roorkee
5	Mr. Rohit Saini	Project associate (MBA) Department of Management Studies IIT Roorkee

LPAC Members

Sr No	Name	Organization/Institute	Designation of LPAC
1	Dr. Praveen Arora	NSTMIS Division, Department of Science & Technology , New Delhi	Chairman
2	Dr. A. Ramesh	Department of Management Studies, IIT Roorkee	Co-Chairman
3	Prof.M. Parida,	Head, Centre for Transportation, IIT Roorkee	Member
4	Dr. A. N. Rai	NSTMIS Division, Department of Science & Technology , New Delhi	Member
5.	Dr. Sudhakar Subudhi,	Mechanical and Industrial Engineering Department, IIT Roorkee	Member
6	Dr. A.K. Sharma,	Mechanical and Industrial Engineering Department, IIT Roorkee	Member
7	Dr. Usha Lenka,	Department of Management Studies, IIT Roorkee	Member
8	Dr. Durga Toshniwal	Computer Science and Engineering, IIT Roorkee	Member
9	Prof. Renu Rastogi	Department of Humanities and Social Sciences, IIT Roorkee	Member
10	Dr. Akshay Dvivedi	Mechanical and Industrial Engineering Department, IIT Roorkee	Member
11	Dr. M.K. Barua (PI)	Associate professor , Department of Management Studies IIT Roorkee	PI
12	Dr. S. Rangnekar,	Head, Department of Management Studies IIT Roorkee	Co-PI

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LIST OF ABBREVIATIONS

3PL	-	Third Party Logistics
ANDA	-	Abbreviated New Drug Application
APS	-	Advance Planning System
CAGR	-	Compound Annual Growth Rate
CAPEX	-	Capital Expenditure
CCC	-	Cash Conversion Cycle
CE	-	Customer Engagement
CER	-	Customer Engagement Ratio
CII	-	Confederation of Indian Industries
CLV	-	Customer Lifetime Value
CMO	-	Contract Manufacturing Organisation
COPQ	-	Cost Of Poor Quality
CRAMS	-	Contract Research and Manufacturing Services
CRM	-	Customer Relationship Management
CRR	-	Customer Retention Rate
CSI	-	Customer Satisfaction Index
CTR	-	Customer Turnover Rate
CUR	-	Capacity Utilisation Rate
D/E	-	Debt-to-Equity
DIFOT	-	Delivery in Full, On Time
DMFs	-	Drug Master Files
DPMO	-	Defects per Million Opportunities
DST	-	Department of Science and Technology
EBITDA	-	Earnings before Interest Tax, Depreciation and Amortisation
EDI	-	Electronic Data Interchange
ERP	-	Enterprise Resource planning
EV	-	Earned Value
EVA	-	Economic Value Added
FCR	-	First Contact Resolution
FDA	-	Food and Drug Administration

FDI	-	Foreign Direct Investment
FPY	-	First Pass Yield
IPS	-	Innovation Pipeline Strength
ISR	-	Inventory Shrinkage Rate
IT	-	Information Technology
JIT	-	Just In Time
KPIs	-	Key Performance Indicators
MIS	-	Management Information System
MNCs	-	Multinational Companies
MRP	-	Material Resource Planning
MRP-II	-	Manufacturing Resource planning
MSME	-	Micro Small and Medium Enterprise
NPS	-	Net Promoter Score
NVA	-	Non Value Adding Activity
OEE	-	Overall Equipment Effectiveness
OER	-	Operating Expense Ratio
OFCT	-	Order Fulfilment Cycle Time
P/E	-	Price/ Earning
PCV	-	Project Cost Variance
PMS	-	Performance Management System
PPS	-	Percent Point Score
PSC	-	Pharmaceutical Supply Chain
PSV	-	Project Schedule Variance
R & D	-	Research and Development
RFID	-	Radio Frequency Identification
ROA	-	Return on Assets
ROCE	-	Return on Capital Employed
ROE)	-	Return on Equity
ROI	-	Return on Investment
ROI2	-	Return on Innovation Investment
S & T	-	Science and Technology
SC	-	Supply Chain
SCM	-	Supply Chain Management
SKUs	-	Stock Keeping Units

SME	-	Small and Medium Enterprise
SPSS	-	Statistical Package for Social Sciences
SRM	-	Supplier Relationship Management
SWOT	-	Strength, Weakness, Opportunity, Treats
TOC	-	Theory of Constraints
TOT	-	Transfer of Technology
TQM	-	Total Quality Management
TRIP	-	Trade-Related Aspects of Intellectual Property Rights
WHO	-	World Health Organisation
WMS	-	Ware House Management System

CHAPTER 1. INTRODUCTION

1.1 Introduction

This chapter elaborates the current status of pharmaceutical industry in India. India has achieved an eminent global position in pharma sector. The country also has a huge pool of scientists and engineers who have the potential to take the industry to high level. The Indian pharmaceutical industry is estimated to grow at 20 per cent compound annual growth rate (CAGR) over the next five years. Indian pharmaceutical manufacturing facilities registered with US Food and Drug Administration (FDA) as March 2014 was the highest at 523 for any country outside the US. The Indian pharma market size is expected to grow to US$ 85 billion by 2020.Considering the growth of Indian pharmaceutical industry major costs incur in production of drug /medicine, their logistics cost more than 60% of production, which came from Supply chain component of product life cycle. Investment in research and development is another major component which needs attention for development of future policies.

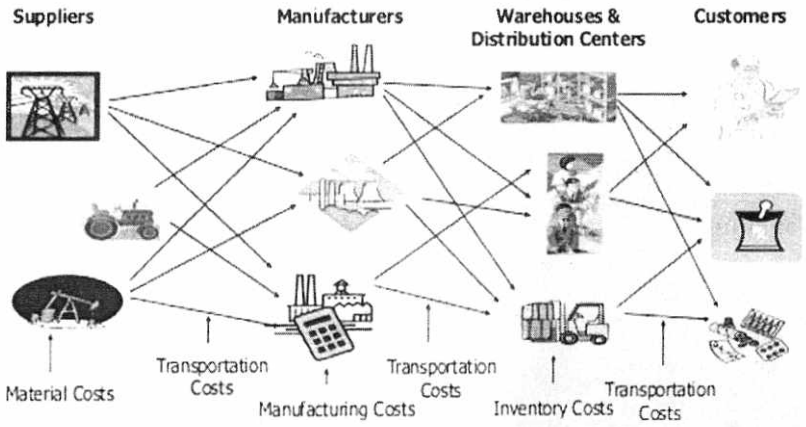


Figure 1-1 Typical pharmaceutical supply chain

1.2 Indian Pharmaceutical Supply Chain

Indian pharmaceutical industry was valued $12 billion in 2012 including domestic production of drugs, exports and imports. Technical and infrastructure capabilities of pharma companies, cost effective production process and reduced time to market drugs due to domestic regulations are the key factors driving the growth of Indian pharma segment. Indian API manufacturers produce close to 1000 Active Pharmaceutical Ingredients (APIs) for various therapeutic segments such as oncology, anti-infective etc. India has more than 120 FDA

approved sites and close to 90 MHRA approved plants. Efficient infrastructure facility coupled with relatively reduced labour cost enables the Indian pharma segment to attract foreign direct investments (FDI). The FDI flow is also reflected in the form of increased partnerships – either through mergers or acquisitions, including that of Abbott – Piramal (2010), Strides Arcolab – Aspen (2010), Solvay Pharma – Abbott Capital (2010), Hospira – Orchid Chemicals (2010), Sun pharma- Ranbaxy (2015) etc.

India is viewed as one of the most preferred and cost effective outsourcing partners for pharma MNCs. Outsourcing of bulk drugs by big pharma is slated to grow by $3 billion while the contract manufacturing organisation (CMO) market in India is expected to grow at a rate of 20 % till 2015. In terms of capacity, currently, the Indian pharma industry is operating at an average of 60-65 %. Henceforth, these major multinational companies (MNCs) are planning to utilise the remaining 15-20 % for their outsourcing activities.

1.3 National Status Review

This section explains Pharmaceutical companies in India which are coping up with ever increasing complexity of operations in the midst of strengthening regulatory and inflationary pressures. The current demand of industry is manufacturing, purchasing and planning need to work seamlessly for effective market- catering as well as to work for the overall company objective. The Indian Pharmaceutical industry today is in the midst of unprecedented growth with companies faced with multiple options varying from going for new molecule development, partnering with innovators for marketing rights to capture the new markets with their own, and existing formulations. A typical mid- sized pharmaceutical company in India today can aspire for turnovers ranging from INR 3000- 4000 Cr. In top line with a value growth, close to 30% y.o.y. With the West having widened in the post recessionary scenario, cost and productivity seems to be the key drivers worldwide , bringing new and enhanced focus on the Supply chain, forcing it to explore and deliver , consistent and never – before efficiencies.

1.4 International status review

Performance measurement is defined as the process of quantifying the effectiveness and efficiency of action (Neely et al., 1995). Performance measurement systems are described as the overall set of metrics used to quantify both the efficiency and effectiveness of action. Neely et al. (1995) identified a number of approaches to performance measurement, including:

- The balanced scorecard (Kaplan and Norton, 1992);
- The performance measurement matrix (Keegan et al., 1989);
- Performance measurement questionnaires (Dixon et al., 1990);
- Criteria for measurement system design (Globerson, 1985);

The excellent overview of performance measurement provided by Neely et al. (1995) has been widely cited in the recent research into supply chain performance measurement systems and metrics (Beamon, 1999; Beamon and Chen, 2001, Gunasekaran et al., 2001, 2004). These, and other studies, have highlighted, how the majority of the limitations cited by Neely and his collaborators remains salient in the case of performance measurement systems for supply chains.

Measuring performance means transferring the complex reality of performance into a sequence of limited symbols that can be communicated and reproduced under similar circumstances (Labas, 1995). There are many aspects of performance in evaluating a specific process or activity. There is a steady stream of performance measures and metrics being identified to support performance improvement and decision making. However, managers face another puzzle: how to select the suitable measures to supply. This case is more urgent, especially in performance measurement of SCM. Supply chain managers are often confused with the vast amount of measures and performance indicators that are often used to assess some specific aspects(s) of single organization, rather than the overall performance of the whole supply chain system. Chang (2003) proposed the concept of performance of activity and suggested a board of performance metrics, each of which represents one of the dimensions of activity performance.

1.5 Literature review based SWOT analysis

India's pharmaceutical companies can also operate at much lower profit margins then the Western counterparts. Today, India produces some of the cheapest drugs in the world, especially because labour costs are 50 to 55% cheaper than in the West. Industry experts indicate that infrastructure costs are 40 % lower and fixed cost is estimated to be 12% to 20% less that in the United States and Western Europe. Consequently, India can produce bulk drugs that cost 60% less that in the West and can open a production plant in India 40% cheaper than in developed countries.

1.5.1 Strengths

- Cost advantages (development, manufacturing, R&D, clinical trials, and labour).
- Well-developed infrastructure with strong manufacturing base
- Access to pool of highly trained scientists, both in India and abroad
- Strong marketing
- Large pool of highly trained manpower.
- TRIPS compliance.
- Lower operating margins.
- Drug cost a fraction of the cost in the West.
- Growing biotechnology industry.
- Reverse engineering skills.
- Largest number of DMFs.
- Bio-diversity.
- FDI up to 100%.
- Strong IT skills for research data management.
- Well established network of laboratories.

1.5.2 Weakness

- Corruption.
- Government price controls.
- High logistics costs.
- High tariffs and taxes.
- Highly fragmented industry.
- Industry concentrated at lower end of value chain.
- Lack of experience in drug discovery.
- Lack of strong linkages between industry and academia
- Low level of investment in R&D.
- Low levels of per capita medical expenditure.
- Low margins.
- Most Indian companies are small by world standards.
- Substandard drugs and counterfeiting.
- Unable to maintain global quality standards.
- Weak domestic market.

1.5.3 Opportunities

- Contract manufacturing arrangements with MNCs
- Marketing alliances to sell MNC products in domestic market
- Potential for developing India as a centre for international clinical trials
- Significant export potential
- Supply of generic drugs to developed markets

1.5.4 Threats

- Additional tax deductions for R&D expenses.
- Drug price control order puts unrealistic ceilings on product prices and profitability
- Indian government initiatives compliance and policy
- Lack of Government Support for R&D activities
- More competitive global players
- Product patent regime poses serious challenge
- Recognition of the pharmaceutical industry as a knowledge-based industry.
- Reduction in interest rates for export financing
- Reduction in the price control of pharmaceuticals.

1.6 Challenges to Overcome

- To manage operational excellence in terms of cost-effective development and faster lead-times (Pisano & Verganti, 2008).
- Expenditure of high cost and time in conducting clinical trials with low success rate in product discovery and clinical development,(Cogdill & Drennen, 2008).
- To improve Innovation rates in the industry (Talias, 2006)
- Drug prices rises as high as 650 percent than the acceptable international standard in under developed countries in addition to the low availability of cheap medicines in the market, (Who, 2012)
- Inability to forecast accurately, lack of incentives for maintaining stocks, inefficient distribution systems and pilferage of medicines for private resale (WHO, 2010).
- Majority of hospitals seem to have outdated information systems with inter-organizational connectivity (Carroll et al., 2011)
- Inventory costs in the health care sector are substantial and are estimated to be between 10% and 18% of net revenues (Jarett, 1998).

- Determining optimal inventory levels in the pharmaceutical supply chain is a complex problem due to the involvement of various stochastic variables (Shang et al., 2008)
- Quality standards are very stringent (Greene and O'Rourke, 2006).
- Optimal process planning and scheduling is crucial for the Development of New Product (Perez-Escobedo et al., 2012).
- Reverse Logistic for expired medicines (Breen & Xie, 2015)
- Risks and uncertainties related to the recovery of pharmaceutical drugs (Srinivasan et al., 2011).
- To control potential impact of pharmaceuticals that reaches lakes and rivers via sewage plants and other sources (Kathuria, 2007)
- Implementation of e-business practices in the healthcare supply chain such as lack of consistency and poor data quality and global nature of suppliers. (Bhakoo & Chan, 2011)

The supply chain is very critical as we see from SWOT analysis that its shows the complex structure of pharmaceuticals industry due to complicated network structure among supplier, manufacturer and distributors. Also above mentioned challenges and weakness require a special attention to reform the industry and to enhance performance of pharmaceutical supply chain which also serves our very first objective i.e. to understand the supply chain complicacy as well as the required areas of concerns, hence it also serves our first intermediated objective.

1.7 Motivation of Study:

The Scopus based statistical overview is given below on the basis of key words.

Subject Area	**No of articles**
Engineering	440
Business, Management and Accounting	424
Computer Science	221
Decision Sciences	221
Environmental Science	150

Subject Area	No of articles
Social Sciences	116
Energy	74
Economics, Econometrics and Finance	71

The list does not include studies on pharmaceutical supply chain. Apart from this, time is most important factor in pharmaceutical supply chain. The drugs should be transported & warehoused in a temperature controlled atmosphere. There are several players (raw martial suppliers, manufactures, dealers, retailers, transporters, warehousing facilities, and customers) in supply chain of pharmaceutical industry. This study has been undertaken only on manufactures, because they are the most important players. The other reasons for taking up this study are:

- Indian pharmaceutical industry is one of the fastest growing sectors in the Indian economy with an average annual growth rate of 11% during 2001-2006.
- The industry is ranked fourth in the world in terms of production volume and 13th in domestic consumption value.
- With more than 10,000 manufacturing units, the Indian pharmaceutical industry is a fragmented one.
- In course of time, the industry has given importance to logistics by focusing on supply chain and logistics level activities such as delivering the product to the end customer at the right
- With the growing competition among major pharmaceutical players in the industry, inventory control plays a significant role in the Pharma value chain as lots of inventory exists in the supply chain.

1.8 Objectives of study

The objectives of the study are:

1. To identify industry's profile throughout clusters by understanding demographical variations.
2. To study the current status of supply chain practices with in industry.
3. To study how research and development factors affect supply chain performance.
4. To identify critical barriers affecting supply chain performance.
5. To identify how supply chain drivers get affected due science and technology intervention.
6. To study how systems, science and technology affects supply chain performance.
7. To identify key performance indicators that could help in accessing the performance of pharmaceutical supply chain performance.
8. To access how the quality of medicine could be affected by level of supply chain integration.
9. To identify the need of technology transfer in pharmaceutical industry.

The privatization and globalisation policy of the government of India in the mid-1990s provided incentives to R&D in the pharma sphere. Innovative products were given exemption from price control, a number of financial schemes were made available to firms for undertaking R&D. Technology collaborations were brought under the automatic approval route, and patent rights were granted for a period of 20 years for products as well as processes.

This huge incentives created a seismic shift from the practice of only manufacturing to a practice of innovation. India was previously known as the generic capital of the world owing to the wide spread reverse engineering industry, this is now changing and companies in India have started to develop and innovate drugs.

More than 870 multinational companies have set up their R&D operations in India since 1985, the first one being Texas Instruments.

The prime reasons why R&D in India is viewed as beneficial are:

- **Biodiversity:** Some drugs aimed at the Indian market require certain gene specific R&D and clinical trials. India's rich genetic bio diversity offers a perfect destination for such R&D and clinical trials.
- **Cost effectiveness**: The cost of setting up world class R&D facilities in India cost a fraction of what they do in the west. The overall R&D costs are about one-eighth and clinical trial expenses around one-tenth of western levels.
- **Established R&D centres**: Pre-established state of the art R&D centers offer logistic convenience and cost effectiveness.
- **Governmental incentives**: Post the liberalisation era, the Indian government has offered numerous incentives to R&D in India.
- **Growing biotechnology industry**: Indian biotechnology industry has grown by leaps and bounds and has some world class players.
- **Market access**: India is one of the fastest growing markets in the world. R&D in India allows companies to gain a foothold in this new and growing market.
- **Rising household incomes**: The growing middle class in India is an attractive market for drugs. With increasing disposable incomes, the market for non-essential drugs, is set to grow rapidly.
- **Skill**: A large pool of English speaking technical skill power is available at a low cost with highly developed R&D oriented skill sets.

Pharma R&D in India is expected to witness exponential growth in the near future, and with the growth of the economy and pharma industry in India, innovation assumes new economic importance in the Indian pharma industry.

1.9 Chapter summary

This chapter summarizes the complex nature of pharmaceutical supply chain, as well as need of performance measurement of Indian pharmaceutical supply chain. This helped in forming our objectives related to evaluation of performance of pharmaceuticals. Further, we have discussed SWOT analysis of the industry. The next chapter deals with literature review for study.

CHAPTER 2. LITERATURE REVIEW

2.1 Introduction

This section explains the literature supported by various researchers across globe for the studied. Pharmaceutical supply chain aspects; supply chain practices, barriers, drivers and others support parameters influencing performance related to R and D, and technology transfer have been discussed.

2.2 Identification of PSC Practices

The following are the supply chain practices which are well found in response from primary survey (table 2-1).

Table 2-1 Literature support for identified PSC practices

S. No.	Supply chain Practices	Description	Supported Literature by Authors
1	Close partnership with suppliers	Close partnership with suppliers gives a strategic advantages with flexibility over market completions	(Srinivasan et al., 2011)
2	Close partnership with customers	Market demand and trends could be well captured in to new product development in R and D.	(Lostakova & Pecinova, 2014)
3	JIT supply	Just in time production would leads manufacturing efficiency and quality medicines.	(Diabat & Govindan, 2011)
4	e-Procurement	Use of network in e-procurement will reduce errors and discrepancies	(Chang et al., 2013)
5	EDI	Huge deduction in lead-time supports lean production	(Hill et al., 2009)
6	Outsourcing	Focusing on core strengths, outsourcing enhance performance of organisation.	(C. Enyinda et al., 2009)
7	Subcontracting	Subcontracting refers to the process of entering a contractual agreement with an outside person or company to perform a certain amount of work	(Ha & Tong, 2008; Seifert et al., 2012)
8	3PL	A third-party logistics provider (abbreviated 3PL,	(Kilby, 2009; Sahay &

S. No.	Supply chain Practices	Description	Supported Literature by Authors
		or sometimes TPL) is a firm that provides service to its customers of outsourced (or "Third Party") logistics services for part, or all of their supply chain management functions	Mohan, 2006; Shaharudin et al., 2014)
9	Plan strategically	Strategic planning is an organization's process of defining its strategy, or direction, and making decisions on allocating its resources to pursue this strategy.	(Susarla & Karimi, 2012; William J. Wales et al., 2013)
10	Supply Chain Benchmarking	Benchmarking is the process of comparing one's business processes and performance metrics to industry bests or best practices from other companies.	(Stewart, 1995; Soni & Kodali, 2010)
11	Vertical Integration	Vertical integration is an arrangement in which the supply chain of a company is owned by that company. Usually each member of the supply chain produces a different product or (market-specific) service, and the products combine to satisfy a common need.	(Guan & Rehme, 2012; Maleki & Cruz-Machado, 2013)
12	Few suppliers	Focus on a few supplier strategy can make enterprises to improve the purchase quantity to enjoy the preferential price, and at the same time, can keep buyers and sellers of the credit relations, makes the enterprise as a stable supplier of large quantities of business partners.	(Ghatari et al., 2013; Singh & Acharya, 2014)
13	Many suppliers	With the many supplier strategy, the supplier responds to the demands and specifications of a 'request for quotation,'	(C. I. Enyinda et al., 2010; Mehralian et al., 2012)
14	Holding safety stock	The amount of safety stock an organization chooses to keep on hand can dramatically affect their business.	(Kelle et al., 2012; Uthayakumar & Priyan, 2013)
15	Use of external consultants	Works with client organizations to enhance supply chain and logistics performance through strategic planning, process re-engineering, and/or	(Susarla & Karimi, 2012; Yu et al., 2010)

S. No.	Supply chain Practices	Description	Supported Literature by Authors
		information technology implementation.	
16	TQM	Total quality is a description of the culture, attitude and organization of a company that strives to provide customers with products and services that satisfy their needs.	(Powell, 1995; Prajogo & Sohal, 2001)
17	Quality Purchasing	The purchasing function of large firms has slowly evolved from the operational task of ordering products and services towards a strategic part of business.	(Castaldi et al., 2011; Sánchez-Rodríguez & Martínez-Lorente, 2004)
18	Inbound Inspection	For –Example a pre-inspection will ensure your raw hardwood flooring is suitable for pre-finishing. Contribute to quality production.	(Svensson, 2003; Crawford & Shum, 1998)
19	Quality Certification	Certification is a formal recognition by governing body that an individual has demonstrated a proficiency within, and comprehension of, a specific body of knowledge.	(Renard, 2005; Sun, 2000)
20	Ware House Safety	Safety in warehouses is regulated by a series of standards from the Occupational Safety and Health Administration contribute as important function within PSC.	(Breen, 2008; Harper, 2010; Wertheimer & Norris, 2009)
21	Product Benchmarking	Product benchmarking is a baseline assessment of environmental impacts across all relevant categories, from extraction of raw materials to its end-of-life disposition.	(Cooper, 1995)
22	Continuous Improvement Tools	Continuous improvement is an ongoing effort to improve the quality of products, services or processes.	(Prajogo & Sohal, 2001; Schindel & Rogers, 2000)
23	Lean Certification	Lean Certification is an industry-leading certification program that provides individuals, companies, and educators with a comprehensive and effective roadmap for professional and workforce development that aligns with industry-recognized standards.	(Goldsby et al., 2006)

S. No.	Supply chain Practices	Description	Supported Literature by Authors
24	Communication Standard	The fast-paced evolution of information technology continues to offer new tools for firms to apply in logistics Planning and operations.	(Bauhof, 2004; Roethlein & Ackerson, 2004)
25	Use of Operational manuals	An Operations Manual should contain procedures, instructions and guidance for use by operational personnel in the execution of their duties. Reduces error and risks.	(Baird et al., 2011)
26	Preventive Maintenance	The maintenance that is regularly performed on a piece of equipment to lessen the likelihood of it failing. Preventative maintenance is performed while the equipment is still working, so that it does not break down unexpectedly	(Prajogo & Sohal, 2001)
27	ERP Integration	ERP integration is the process of integrating separate, stove-pipe ERP (Enterprise Resource Planning) systems with each other or with other enterprise information resources, to meet various B2B demands.	(Puschmann & Alt, 2005)
28	Team Work	The industry performance depends up on collaborative approach with teamwork to enhance productivity and overall supply chain performance.	(Baird et al., 2011; Benita M. Beamon, 1999; Yu et al., 2010)

2.3 R&D, Outsourcing and Innovativeness

Less important sources of knowledge include licensing in/out of companies with the different parties. For companies in high R&D intensity sectors, collaboration agreements with other companies as an important way of knowledge sharing are followed by licensing in/out with other companies especially pharmaceuticals & biotechnology, and then collaboration agreements with higher education's institutions and other public research organisations. For companies in medium and low R&D intensity sectors, collaboration agreements with higher education institutions and other public research organisations are seen as more important than licensing. The generally higher relevance of collaboration agreements contrasts with the relatively lower relevance of more formal licensing, which could be a sign of the increasing

role of open innovation. Thus questions that could answer to these are drafted as found in text as shown in table -2-2.

Table 2-2 Literature Support for R&D Innovation factor

S. No.	R&D Innovation factor	Literature Supported by Authors
1	R&D within the company	(Morbey, 1985)
2	R&D outsourced to other companies:	(Narayana et al., 2014)
3	R&D outsourced to higher education institutions or public research organisations	(Becker & Lillemark, 2006)
4	Purchase or licensing of intellectual property rights (patents, copyrights and designs) as well as know-how	(Motohashi, 2008; Yang & Maskus, 2001)
5	Acquisition of new or highly improved machinery, equipment and software:	(Pedroso & Nakano, 2009; Schweizer, 2005)
6	Training to support innovative activities	(Sweeney, 2005)
7	Market research, launch advertising, and related marketing activities for new product introduction	(Becker & Lillemark, 2006)

2.4 Factors /Drivers of Pharmaceutical supply chain

The performance of a supply chain is determined by decisions in the areas of inventory, transportation, facilities, and information. Hence these areas are identified as drivers of supply chain performance.

Table 2-3 Literature Support for supply chain drivers

S. No.	PSC Drivers	Literature Supported by Authors
1	Inventory	(Kelle et al., 2012)
2	Information	(Narayana et al., 2014)
3	Transportation	(Meena & Sarmah, 2013)
4	Purchasing /Sourcing	(Castaldi et al., 2011)
5	Pricing	(Pedroso & Nakano, 2009; Schweizer, 2005)
6	Facilities /Warehousing	(A. Gunasekaran et al., 2004)
7	Flexibility	(C. Enyinda et al., 2009)

There are expanded seven prominent drivers of supply chain that are relevant for pharmaceutical supply chain well found in literature too, hence it fulfil our objective of identification of factors/ drivers affecting pharmaceutical supply chain, as we can see in table 2-4.

2.5 Systems, Science and Technology

To Improve supply chain agility, reduce cycle time, achieve higher efficiency, and deliver products to customers in a timely manner supply chain are full of developed system which are driven by latest technology support world in contribution to science and human society .the various technology and systems we identified in the literature supports our intermediate objective of identification of factors related to technology interference and transfer feasibility are listed below in table 2-5.

Table 2-4 Literature Support for System science and technology factors

S. No.	System science and technology factors	Supported Literature by Authors
1	E-commerce	(Harper, 2010; Narayana et al., 2014)
2	E-business	(Chang et al., 2013; l Kubitza, 2009a)
3	Decision support / expert system	(Rossetti et al., 2011a)
4	Radio Frequency Identification (RFID)	(Yue et al., 2008)
5	Electronic Data Interchange (EDI)	(Hill et al., 2009)
6	Bar coding	(ICH, 2009; Shah, 2004)
7	Material Requirements Planning (MRP)	(Susarla & Karimi, 2012, 2012)
8	Manufacturing Resources Planning (MRPII)	(Shah, 2004)(Lambert & Cooper, 2000)
9	Warehouse Management System (WMS)	(Harper, 2010; Tan et al., 2009)
10	Customer Relationships Management (CRM)	(Kros et al., 2007; Lostakova & Pecinova, 2014)
11	Supplier Relationships Management (SRM)	(Baird et al., 2011; Shah, 2004; Wu et al., 2010)
12	Advanced Planning System (APS)	(Bas, 2013; Paich et al., 2011)
13	Just In Time (JIT)	(Kannan, 2005; Wazana, 2000)
14	Theory of Constraints (TOC)	(Gupta & Boyd, 2008; Watson et al., 2007)

2.6 Barriers against the growth of pharma industry

We have also identified barriers hindering the pharmaceutical and drug supply chain performance. The final sorting is done by experts after identification through literature. The following barriers were finalised to get opinion through industry responses (as shown in table 2- 3). This supports our objective of identification of barriers which affects supply chain performance.

Table 2-5 Literature Support for supply chain barriers

S. No.	Supply Chain Barriers	Description	Supported Literature by Authors
1	Inefficient Information system	Any firm in the pharmaceutical industry requires efficient and effective management information systems (MIS) to support managerial functions.	(Pedroso & Nakano, 2009)
2	Disparity in trading partner's capability	Disparity in trading partners' capability is a major barrier in integration of agile supply chain because partnership fails due to poor capability at partner's end.	(Kim , 2006; Balachandran et al., 2013)
3	Lack of fund for Performance Measurement System (PMS) implementation	Indian industries often lack of funds for adopting performance management system provided by other agencies and unable to allocate funds for regular monitoring.	(Bulsara et al., 2014; Industries, 2015; Yu et al., 2010)
4	Lack of commitment by top management	Direct participation by the highest level executives in a specific and critically important aspect or program of an organization.	(a. K. S. Kumar et al., 2011; Narayan, 2011)
5	Unawareness about PMS in supply chain	Performance measurement and metrics have an important role to play in setting objectives, evaluating performance, and determining future courses of actions.	(B.M. Beamon, 1999; A. Gunasekaran et al., 2004)
6	Lack of strategic planning	Strategic planning looks at the long-term which is how organizations survive and how strategic planning outperform organizations that lack long-term planning.	(Balarajan et al., 2011)
7	Reluctance of support of dealers,	the reluctance of the support of the dealers, distributors, and retailers towards the logistics	(Srinivasan et al., 2011)

S. No.	Supply Chain Barriers	Description	Supported Literature by Authors
	distributors etc.	activities	
8	Lack of reach and service	Supply chain wide network gives flexibility and reach for robust supply of goods.	(Rossetti et al., 2011a)
9	Rising working capital constrains	A firm is required to maintain a balance between liquidity and profitability while conducting its day to day operations.	(Lind et al., 2012)
10	Rise in Bullwhip Effect	Distorted information from one end of a supply chain to the other can lead to tremendous inefficiencies	(Costantino et al., 2014)
11	Diversion of sales force focus	There is a lot of focus and emphasis today on how efficiently and effectively the Pharma Companies can market & sell their products globally.	(l Kubitza, 2009b)
12	Higher inventory caring cost	Catering to higher demands pharmaceutical companies needs to have special care and temperature condition for speciality drug and low self-life.	(Uthayakumar & Priyan, 2013)
13	Lack of motivation	Lack of acceptance and motivation from the employees affects the performance of a supply chain	(Talias, 2006)
14	Weakened Global trade	Due to Global market trading complexity small and medium enterprise has a strategic disadvantage towards growth.	(l Kubitza, 2009b; Sciences, 2010)
15	Stringent Supply Chain Collaboration	The nature of supply chain collaboration impacts on firm performance.	(Vachon, 2007)
16	Need of service as complementary to product	Products that are sold separately but that are used together, each creating a demand for the other with service.	(Y. S. Kim et al., 2011)
17	Guaranteed compliance	The pharmaceutical and life sciences industry is among the most heavily regulated in the world. Today, these companies face unprecedented compliance challenges, and the close regulatory scrutiny	(Shah, 2004)
18	Co-development of new substance/product	Co-development agreements refer to the mutual development of a drug. This approach is mostly used by companies which try to complement their	(Rossetti et al., 2011b)

S. No.	Supply Chain Barriers	Description	Supported Literature by Authors
		development competencies and marketing capabilities	
19	Poor operations planning	The manager needs to monitor the progress of the operational plan and where there is evidence that an element of the operational plan is not succeeding	(Sangshetti et al., 2014)
20	Inefficient supply network	Inefficient supply affect Pharmaceutical supply chain competition which takes into account product perishability, brand differentiation of the product, as well as discarding costs.	(Narayana et al., 2014)
21	Changing patient target group	Continually growing and rapidly ageing population ,rapidly changing healthcare requirement would be task for pharmaceutical to respond	(Drakulich & Van Arnum, 2009)
22	Expanding regulations	environmental legislation, client audits/standards, need of sustainable eco-friendly (production) processes, manufacturing standard has to abide by industry	(ICH, 2009)
23	No implementation of supply chain wide PMS	Performance has been measured for entire supply chain, industry lacking growth by only providing selective measurement system for a section or department.	(Stewart, 1995)
24	Dispersed IT infrastructure	Data driven system needs complete IT infrastructure, to enhance visibility, reduce counterfeit, leads to secure and quality medicine.	(Ha & Tong, 2008)
25	Non-availability of performance metrics	Various matric has been designed for manufacturing but given special focus on pharmaceutical and drug manufacturing which is one of unique in itself	(Hsu et al., 2009)
26	Improper training of employees	Employee training is essential for an organization's success. Despite the importance of training, a trainer can encounter resistance from both employees and managers.	(l Kubitza, 2009b)
27	Corporate Culture	Organisation traits create a vibrant community and a supportive culture that allows our people, regardless of where they work in the world, to feel valued, involved, supported and respected.	(Baird et al., 2011)

S. No.	Supply Chain Barriers	Description	Supported Literature by Authors
28	Motivation for change/Support for Measurement	The rapidly change business environment the industry should entertain change in terms of working condition to adoption of new systems and technology.	(Pisani & Arlington, 2009)

2.7 Key performance indicators for PSC

The literature and management text emphasis on performance measurement suggest following key performance indicators which could be helpful in measuring the performance of pharmaceutical supply chain.

Table 2-6 Literature Support for supply chain KPIs

S. No.	Key Performance Indicator	Definition /Description of the Term
Financial KPIs		
1	Net Profit	Net profit, also known as net income or net earnings is the amount of money left after paying all the expenses of the business. Unlike gross profit or operating profit, net profit looks at total revenue from all sources, not just sale of goods and services. This time, though, it also deducts total expenses including depreciation, interest, taxation and all other costs.
2	Net Profit Margin	The key performance question net profit margin helps to answer is: 'How much profit are we generating for each dollar in sales?' Net profit margin is calculated from data that appears on your income statement and it's usually measured once a month, or however often the income statement is prepared.
3	Gross Profit Margin	Gross profit margin deducts the cost of goods sold or cost of sales. These are the direct production and distribution costs your business incurs for the supply and delivery of your goods or services.
4	Operating Profit Margin	Also known as operating margin this KPI provides additional insight into your operating efficiency and pricing strategy, because it only includes revenue from normal business operations.

S. No.	Key Performance Indicator	Definition /Description of the Term
5	EBITDA- Earnings Before Interest Tax, Depreciation and Amortisation	The key performance question EBITDA seeks to answer is: 'To what extent are we operating our business efficiently to generate profits'? It is usually measured on a monthly or quarterly basis and is extracted from the income statement. As the name would suggest EBITDA is calculated when you take sales revenue or earnings and subtract all expenses before interest, tax, depreciation and amortisation. As such this KPI measures a company's operational profitability over time by removing expenses that can easily distort performance such as the cost of capital.
6	Revenue Growth Rate	The key performance question revenue provides an answer to is: 'How much money are we making from sales?' The data needed to calculate this metric are collected in your general ledger or the main accounting record of your business, and the revenue figure is usually calculated and reported monthly
7	Total Shareholder Return (TSR)	Ultimately investors want to know how much money is going to be returned to them either through in increase in share value or through dividends. The metric that they use to measure this is called total shareholder return (TSR), and it is useful to investors in analysing the best companies to invest in, or the ones they believe will deliver the best return on investment.
8	Economic Value Added (EVA)	The key performance question EVA helps to answer is: 'How well are we delivering value to our shareholders?' This metric is usually reported on a monthly basis. Use this formula: Economic Value Added (EVA) = Net Operating Profit After Tax (NOPAT) – (Weighted Average Costs of Capital (WACC) × Economic Capital Employed)
9	Return on Investment (ROI)	Return on investment (ROI), also referred to as rate of return (ROR) or rate of profit (ROP) is a financial KPI used to measure the efficiency of an investment. It can be calculated during or after making an investment or used in the decision-making process prior to a potential investment.
10	Return on Capital Employed (ROCE)	ROCE is usually measured on an annual basis and is an easy KPI to measure as the information needed is readily available in the

S. No.	Key Performance Indicator	Definition /Description of the Term
		accounting data. Again, you can calculate ROCE as a simple ratio number or as a percentage. This formula calculates the percentage: ROCE = EBIT/Total capital employed × 100
11	Return on Assets (ROA)	The key performance question ROA helps to answer is: 'To what extent are we able to generate profits from the assets we control?' The data needed to calculate ROA comes directly from the income statements of the business and it is usually calculated every year, but reported on a rolling quarterly basis (that is, calculated for the past four quarters, each quarter).ROA = (Net income for period in question/Total assets at end of period) × 100
12	Return on Equity (ROE)	The key performance question ROE helps to answer is: 'How efficiently are we using the investments that shareholders have made to generate profits?' The data needed for ROE comes directly from the income statements of the business.
13	Debt-to-Equity (D/E) Ratio	A debt ratio used to measure a company's financial leverage, calculated by dividing a company's total liabilities by its stockholders' equity. The D/E ratio indicates how much debt a company is using to finance its assets relative to the amount of value represented in shareholders' equity.
14	Cash Conversion Cycle (CCC)	The most common cause of business difficulties is liquidity. The business simply runs out of cash. This KPI helps to avoid this by helping you to answer the question: How well are we doing at maintaining a healthy cash position?
15	Working Capital Ratio	The key performance question working capital ratio helps to answer is: To what extent do we hold enough short-term assets to cover our short-term debt?' Working capital, also known as current position is a measure of current assets minus current liabilities. This metric therefore measures how much you have available in liquid assets to build and maintain ourr business.
16	Operating Expense Ratio (OER)	A measure of what it costs to operate a piece of property compared to the income that the property brings in. The operating expense ratio is calculated by dividing a property's operating expense by its gross operating income. Investors using the ratio can further compare each type of expense, such as utilities, insurance, taxes

S. No.	Key Performance Indicator	Definition /Description of the Term
		and maintenance, to the gross operating income, as well as the sum of all expenses to the gross operating income.
17	CAPEX (Capital Expenditure)to Sales Ratio	CAPEX to Sales Ratio measures the level of investments a company is making into its future. It compares the capital expenditure (CAPEX) to sales in a given period. CAPEX to Sales Ratio = (CAPEX in period t / Net Sales in period t) x 100
18	Price Earnings Ratio (P/E Ratio)	The key performance question P/E ratio helps answer is: 'To what extent is the current share price attractive to investors?' The data required to calculate P/E ratio is available from your company accounts and the current share price. This metric is usually measured on a quarterly or annual basis. P/E Ratio = Current price per share/Earnings per share
Customers KPIs (19-26)		
19	Net Promoter Score (NPS)	This KPI seeks to answer the question: To what extent are our customers satisfied and loyal? Instead of seeking the answer through customer surveys, which are notoriously expensive and subjective, NPS was developed as 'the one number you need to know'. On a scale of 0 to 10 (where 0 is very unlikely and 10 is very likely) our customers are asked one simple question: How likely is it that you would recommend (our company or our product or service) to a friend or colleague?
20	Customer Retention Rate	The key performance question Customer Retention Rate (CRR) helps to answer is: 'To what extent are we keeping the customers we have acquired? 'Customer Retention Rate (CRR) = No. of those customers that are still customers at the end of period/No. customers at start of period × 100
21	Customer Satisfaction Index	Customer Satisfaction Index (CSI). A CSI is simply an aggregation of all the attributes that you believe contribute to customer satisfaction. Again don't assume what creates customer satisfaction find out what actually does and then measure that.
22	Customer Profitability Score	The key performance question customer profitability helps to answer is: 'To what extent are we generating profits from our

S. No.	Key Performance Indicator	Definition /Description of the Term
		customers? 'The formula for how you would work this out changes depending on the various perspectives above. The most basic formula would be: Customer Profitability = Revenue earned from the customer – Costs associated with the customer relationships.
23	Customer Lifetime Value	The key performance question Customer Lifetime Value (CLV) helps to answer is: 'How well do we understand the financial value from our customer relationships?' Calculating CLV can be as simple or as complex as you want. But initially, let's start with the simplest version to give you an idea of CLV. CLV = (Average Value of a Sale) × (Number of Repeat Transactions) × (Average Retention Time in Months or Years for a Typical Customer)
24	Customer Turnover Rate	The key performance question Customer Turnover Rate (CTR) helps to answer is: 'How many customers are we losing?' Customer Turnover, also known as customer churn, customer defection or customer attrition looks at the other side of the coin – how many customers are you losing, rather than keeping, over a given period? The data you will to calculate CTR should be easily accessible from our customer records. CTR = Lost customers over a period/Total number of customers at the end of a period × 100
25	Customer Engagement	The key performance question customer engagement helps to answer is: 'To what extent are our customers engaged with our organisation?' This metric is usually measured and reported annually and the data needed comes from a customer engagement survey. Customer Engagement Ratio (CER) = Number of engaged customers (percentage): Number of disengaged customers (percentage)
26	Customer Complaints	Customer complaints/ satisfaction level is often measured on a rolling basis and reported quarterly along with any specific insight gained from the qualitative information.
Market KPIs (27-37)		
27	Market Growth	Market growth rate is a key indicator of the health of our business

S. No.	Key Performance Indicator	Definition /Description of the Term
	Rate	because it helps you to understand how robust our market is. In other words, is our market expanding or contracting? Market Growth Rate (%) = Total sales in the market for this year/Total sales in the market for last year
28	Market Share	The key performance question relative market share helps to answer is: 'How well are we growing market share in comparison to our competitors?' Relative Market Share A (%) = Our Market Size/Overall Market Size × 100
29	Brand Equity	Brand equity is the positive or negative value that a brand adds to our products and services. In other words if you have a strong positive brand customers will often view our product as being of a higher quality even when there is no measurable difference in quality. As a result they are often happy to pay more than our competitor's products to secure the branded product
30	Cost per Lead	One of the most popular ways of finding out is through the KPI called cost per lead. As the name would suggest, cost per lead works out how much it costs to attract each potential customer to our product offering, and it is a powerful leading indicator of likely future revenue. The theory assumes that if you can attract potential customers cost effectively, then sales in the future will be strong.
31	Conversion Rate	There is no point having thousands of leads if our business can't convert them to paying customers. The customer conversion rate works out how successful our business is at turning opportunities or potential customers into actual customers.
32	Search Engine Rankings	The Keyword Ranking metric measures our search engine rankings for targeted keywords and analyses changes in that ranking over time. When it comes to search engine marketing, this is the quintessential KPI as it demonstrates the effectiveness at our website at getting ranked on Google and attracting organic traffic.
33	Page Views and Bounce Rate	Bounce Rate is an Internet marketing term used in web traffic analysis. It represents the percentage of visitors who enter the site and then leave ("bounce") rather than continuing on to view other pages within the same site. Bounce rate is a measure of the

S. No.	Key Performance Indicator	Definition /Description of the Term
		effectiveness of a website in encouraging visitors to continue with their visit. It is expressed as a percentage and represents the proportion of visits that end on the first page of the website that the visitor sees
34	Customer Online Engagement Level	Customer engagement (CE) is the engagement of customers with one another, with a company or a brand. The initiative for engagement can be either consumer- or company-led or the medium of engagement can be on or offline.
35	Online Share of Voice	Share of Voice in Online Advertising is an ad revenue model that focuses on weight or percentage among other advertisers.
36	Social Networking	Pharmaceutical are coming up with their own health portal which is social networking platforms where they have to compete
37	Klout Score	The Klout Score is a number between "1-100", that represent our influence. The more influential you are, the higher our Klout Score.
Operational KPIs (38-55)		
38	Six Sigma Level	The key performance question Six Sigma level helps to answer is: 'How capable are our processes in delivering error-free work?' First you need to calculate the Defects Per Million Opportunities (DPMO).DPMO = (Number of defects × 1,000,000)/(Number of units × Number of opportunities)
39	Capacity Utilisation Rate (CUR)	The key performance question Capacity Utilisation Rate helps to answer is: To what extent are we leveraging our full production/work potential? This metric is often measured daily or weekly, depending on what is being assessed. For example, you could calculate the CUR for a single Machine hourly while for an entire factory or company you could calculate the CUR weekly or monthly. CUR = Actual Capacity over specified time period × 100/Possible Capacity over specified time period
40	Process Waste Level	The key performance question Process Level Waste helps to answer is: To what extent are our processes lean and effective? All businesses should aim to have effective and lean operational processes that seek to minimise or eliminate waste. Under the principles of Lean waste is considered any activity that does not

S. No.	Key Performance Indicator	Definition /Description of the Term
		add value to the end customer.
41	Order Fulfilment Cycle Time	The key performance question Order Fulfilment Cycle Time (OFCT) helps to answer is: 'How efficient are our processes?' The formula for OFCT is: OFCT = Average actual cycle time consistency achieved to fulfil customer orders. This is calculated through an analysis of the end-to-end order fulfilment process over a specific period of time.
42	Delivery In Full, On Time (DIFOT) Rate	The key performance question Delivery in full, on time (DIFOT) rate helps to answer is: To what extent are our customers getting what they want at the time they want? The data you will need to calculate the DIFOT rate is contained in our order tracking system. If you use a third party in our supply chain then you will need to gain information from them too in order to calculate this metric. DIFOT = Units or orders delivered in full, on time/Total units or orders shipped × 100
43	Inventory Shrinkage Rate (ISR)	The key performance question Inventory Shrinkage Rate (ISR) helps to answer is: To what extent are we losing inventory along our internal processes? The data needed to calculate ISR is collected from the inventory management system, manufacturing data, purchasing data, stock taking information as well as sales and shipping data. Ideally this metric should be measured every 6 months or more frequently is it is considered high. Inventory can either be measured in actual stock-keeping unit (SKU) or in financial terms using average selling prices. ISR = (Inventory you should have – Inventory you do have)/Inventory you should have × 100
44	Project Schedule Variance (PSV)	The key performance question project schedule variance helps to answer is: 'To what extent are our projects delivered on schedule?' The data for this KPI usually comes from a project management software application or via manual records. PSV is usually measured monthly but can be monitored more often for important short-term projects. Project Schedule Variance (PSV) = Scheduled Completion Time (SCT) – Actual Completion

S. No.	Key Performance Indicator	Definition /Description of the Term
		Time (ACT)
45	Project Cost Variance (PCV)	The key performance question project cost variance helps to answer is: 'To what extent are our projects delivered on budget?' The data for this KPI will also usually come from a project management software application, financial planning applications or manual records. PCV is usually measured monthly but should be measured more frequently for important projects. Project Cost Variance (PCV) = Scheduled Project Cost (SPC) – Actual Project Cost (APC)
46	Earned Value (EV) Metric	The key performance question earned value helps to answer is: 'To what extent are our projects delivering the intended value?' Again the data you need to calculate EV will usually come from a project management software application or any manual project records.
47	Innovation Pipeline Strength (IPS)	The key performance question Innovation Pipeline Strength (IPS) helps to answer is: To what extent have we got a strong innovation pipeline? In order to calculate this metric you will need to look at the key innovation projects and estimate the potential future revenue they will generate. IPS is usually measured on a quarterly basis. Formula: IPS = Sum (Innovation project x Future revenue potential)
48	Return on Innovation Investment (ROI2)	The key performance question Return on Innovation Investment (ROI2) helps to answer is: To what extent are our investments in innovation generating a return? Innovation is important but it's also important to measure the effectiveness of that innovation to ensure that it's justified and delivers a return. The data needed to calculate this metric is available through the accounting data and project data and ROI2 is usually measured at the end of an innovation project or as a percentage return over a specific periods of time. ROI2= Net Profit from new product or service/ Innovation costs for the products and services.
49	Time to Market	Time to Market: This metric measures the time it takes from the initial idea for a new product to the point where that new product is ready for distribution. As an indicator it reflects how well our

S. No.	Key Performance Indicator	Definition /Description of the Term
		research, design, manufacturing and managing processes are integrated, and how quickly you can translate a great idea into a winning product. Wasted time in this process may cost our business money through the loss of our first mover advantage (benefit for being the first significant player in any market) and can allow competitors to pull ahead.
50	First Pass Yield (FPY)	First Past Yield (FPY): This metric measures the waste in the system caused by defects. Defects decrease operational effectiveness, increase costs through rework costs and reduce profit. It is essential that you know what defects are costing you and where they are happening. FPY helps you measure the yields of every step along the process, detect defects and rework requirements early so they can be fixed instead of remaining hidden until the customer complains!
51	Rework Level	The key performance question Rework Level helps to answer is: How effectively are we driving waste out of our processes? How often you measure rework will depend on our industry or sector. Manufacturers would be wise to measure rework levels weekly whereas service companies may only need to measure rework on a monthly basis. The formula is Number of defective products requiring rework over a specific period/ Total number of products produced over a specific period × 100
52	Quality Index	The key performance question our Quality Index helps to answer is: 'How is the organisation ensuring that it is delivering products/services that are fit for purpose?'
53	Overall Equipment Effectiveness (OEE)	Overall Equipment Effectiveness (OEE): This metric is a composite KPI that measures wasted capacity which takes process availability, efficiency and quality into account. It rolls up a number of output wastes into a single index which reduces complex production problems into a useful and intuitive information source for overall production effectiveness.
54	Process or Machine Downtime Level	Process or Machine Downtime Level: This metric looks at the waste caused by non-productive time. If machines or people are not able to do their job because of hold-ups, breakdowns or poor

S. No.	Key Performance Indicator	Definition /Description of the Term
		management or organisation skills then our business is losing money. You will never reach 100% capacity for all machinery, plant or people but you should know it's happening so you can minimise it as much as possible.
55	First Contact Resolution (FCR)	First contact resolution (FCR) is the percent of contacts that are resolved by the service desk on the first interaction with the customer.

2.8 Quality Dimensions

There are some new practices that are recently applied to the pharmaceutical industry, though they are widely applied in non-pharmaceutical industries, such as: the lean manufacturing; the Six Sigma; the total quality management. They do enhance the quality of medicines. We are focusing on objective of integration of such technologies, and affect of integration on quality of medicine. The quality is being measured thorough following dimensions.

Table 2-7 Literature support for Integration in supply chain across Quality Dimensions

S No.	Need of Integration in supply chain across Quality Dimensions	Supported Literature by Authors
1	Drug performance	(Cogdill & Drennen, 2008; Yu et al., 2010)
2	Features of drug/ medicine	(Newton et al., 2010; Schweizer, 2005)
3	Reliability of drug/ medicine	(Sangshetti et al., 2014; Schweizer, 2005)
4	Conformance to action requirement	(l Kubitza, 2009b)(Görög, 2008)
5	Self-life/usability	(Narayan, 2011; Pisani & Arlington, 2009)
6	Post sales services	(DelVecchio et al., 2006; Kurata & Nam, 2010)
7	Packaging	(l Kubitza, 2009b; Narayana et al., 2014)
8	Perceived quality	(Sánchez-Rodríguez & Martínez-Lorente, 2004)

2.9 Need of technology transfer from foreign organisation

Technology transfer, also called transfer of technology (TOT), is the process of transferring skills, knowledge, technologies, methods of manufacturing, samples of manufacturing and facilities from one institution to another in order to enhance the quality and productivity of system by replacing current technology and practices. Here we have tried to capture the intentions and trends of the industry towards readiness to transform and upgrade themselves to world class technology and practices adoption.

Table 2-8 Literature support for where technology transfer needed

S. No.	Supply Chain Elements	Supported Literature by Authors
1	R and D	(Han & Chuang, 2011; Schweizer, 2005; Sciences, 2010)
2	Clinical trails	(Cooksey et al., 2002)
3	Manufacturing	(A. Gunasekaran et al., 2004; Narayana et al., 2014; Shah, 2004)
4	Packaging	(l Kubitza, 2009b; Vachon, 2007)
5	Distribution	(Drakulich & Van Arnum, 2009; Rossetti et al., 2011a)
6	Warehousing	(Harper, 2010; Xu et al., 2013)
7	Inventory Management	(Kelle et al., 2012; Uthayakumar & Priyan, 2013)
8	Reverse Logistics	(Amaro & Barbosa-Póvoa, 2008; S. Kumar et al., 2009; Prakash & Barua, 2015)
9	CRM	(Kros et al., 2007)

2.10 Chapter summary

This chapter summarises literature on supply chain; practices, R & D factors, drivers, various system, science and technology, barriers, KPIs, quality dimensions and need of technology transfer.

CHAPTER 3. RESEARCH METHODOLOGY

3.1 Introduction

This chapter discusses the problem definition, design of questionnaire, data collection, sample selection and details of research methodology adopted for the analysis of data.

This chapter provides details with respect to the problem definition and research methodology. After conducting the detailed literature review, by going through the work done in the pharmaceutical supply chain and operations, we found that this supply chain comprise of several players (which are not there in other supply chains). The supply chain wide performance has been observed in major giants of pharma industry like Dr Reddys Labs, Cipla, Lupin Aurobindo and Ranbaxy. But considering the majority of MSME in India, it's hard to find world class performance management system within these small scale firms, which are either work as out licensed contact manufacturer for some bigger firms or batch manufacturer for generics.

The drastic transformations are desired and same has been observed in pharmaceutical MSMEs in India. Because of the nationwide presence and focused initiatives of Government of India, MSMEs are becoming the strength of the industry with quality manufacturing competing to worldwide price sensitive market.

This study attempts to evaluate various aspects of supply chain affecting overall pharmaceutical industry by understanding dynamics and investigating factors affecting firm's performance. This study could be a contribution to positioned Indian MSMEs in competent market. To make this possible we have identified major clusters of Indian pharmaceutical producers get the sufficient exposure of the current status of industry. We have identified three major clusters like; Haridwar (Uttrakand), Hyderabad (Telangana) and Pune (Maharashtra) for study. Our aim was to get the maximum response from the industry, so we have planned to visits personally and very few through others modes like email, online questionnaire and postal service.

3.2 Problem Definition

The concept of performance evaluation within supply chain is new to Indian MSMEs. Even though, the lean certification and quality management practices show prominent presence in Indian industry. Still they have to benchmark their performances with top MNCs.

Pharmaceutical industry is highly competitive and faces problems of infrastructure. It also suffers lack of standardises practices. Operating in Indian continent itself is a great challenge. Being highly profitable margins in pharmaceutical goods and medicine, it is still a lucrative option for investors. The industry also holds a societal impact.

3.3 Industry Population

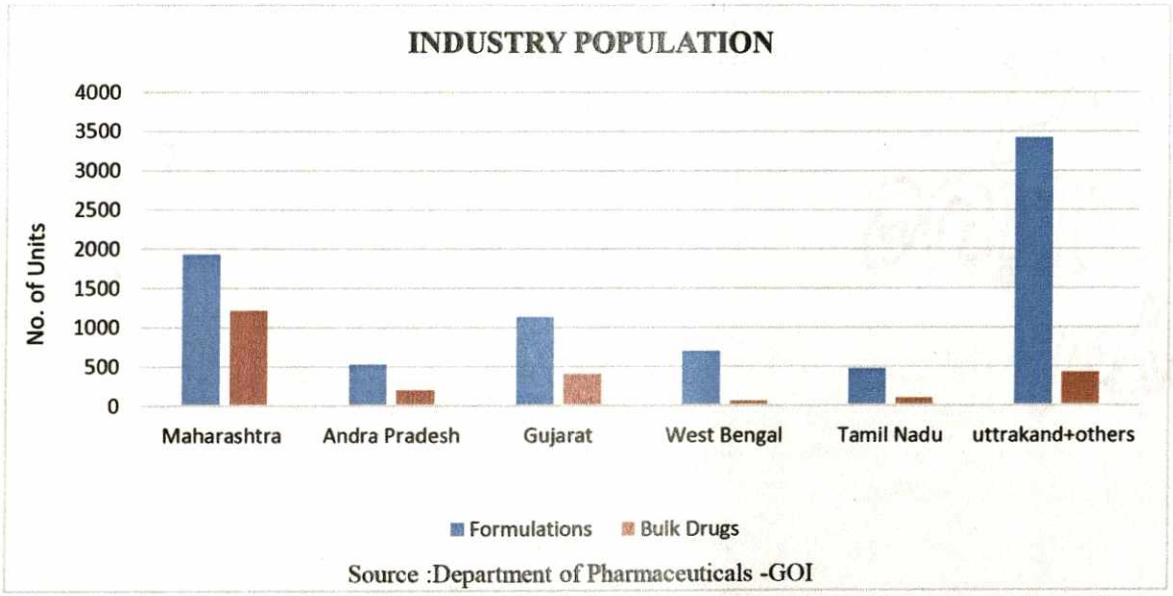


Figure 3-1 Pharma Industry population –Major States

3.4 Research Methodology

The study has been carried out in two phases. In first phase, an exploratory research was carried out. In this phase an extensive literature review has been done and inputs were received from brainstorming session conducted with experts. In second phase, a conclusive study was done using a structured questionnaire, designed after taking inputs from phase one.

3.4.1 Design of questionnaire and data collection

The survey instrument was designed to measure and evaluate supply chain performance of select Pharmaceutical industries. Due to this consideration, a questionnaire was designed in simple and straight forward language to enable respondents understands each question clearly and easily. Further, the questionnaire was designed in tabular format, so that, the respondents can easily tick their responses in appropriate box. The questionnaire was divided into four sections. Section I deals with Demographics profile, section II identifies external aspects, section III discusses about performances indicators and finally section IV deals about quality production and technology integration.

3.4.2 Pre-testing and validation of questionnaire

After framing the questionnaire, the same was sent to eminent experts in this field, so that the different sections pertaining to study could be critically examined. The contents of the questionnaire were reviewed by LPAC and external experts. With the inclusion of R&D related objectives and the suggestions provided by them were suitably incorporated in the questionnaire. Pilot testing of questionnaire was performed by personal visits to organizations; about twenty respondents were approached to evaluate the validity of the questionnaire.

3.5 Scope of data collection

According to the Confederation of Indian Industries (CII), there are around 8,000 small and medium enterprises (SME) units, accounting for about 70% of the total number of the pharma units in India. Indian SMEs are also opening up for emerging opportunities in the pharmaceutical industry in the field of CRAMS (Contract Research and Manufacturing Services), clinical research etc. These would drive them to play a definitive role in the transitional global pharmaceutical environment, where a sizeable number of drugs are expected to go off patent in the coming years. The Indian government has been making every attempt to support SMEs through several incentives. One such effort is the development of SME clusters in various parts of the country.

The following clusters are identified as we find the large no of SMEs in states of Maharashtra, Andhra Pradesh and Uttrakand (See Table 3-1). Haridwar, the area near to IIT Roorkee, also comprises a major chunk of pharmaceuticals manufacturer.

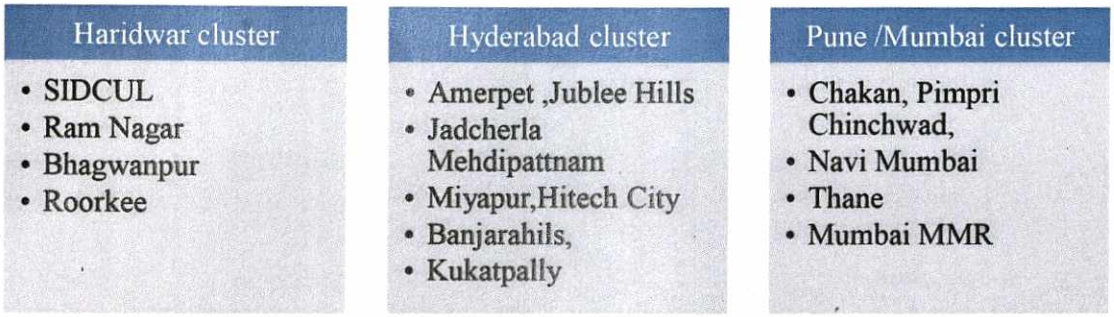


Figure 3-2 Selected Industry Clusters

- Methods of data collection: Postal mail, E-mail, and personal interviews by visiting various industries.
- The data collection period: Approximately one year.
- Sampling method: Stratifies random sampling. The strata were chosen on the basis of number of employees.

3.6 Data analysis tools

3.6.1 Charts

A chart, also called a graph, is a graphical representation of data, in which "the data is represented by symbols, such as bars in a bar chart, lines in a line chart, or slices in a pie chart". A chart can represent tabular numeric data, functions or some kinds of qualitative structure and provides different info.

3.6.2 PPS –Percent point score

Data pertaining to various sections in the questionnaire was collected and percent point score (PPS) is calculated, according to formula given in table below:

Table 3-1 Procedure to determine PPS score

No of Responses (N_i) for an item	**No. of unit scoring**					**Total point score (TPS)** **Total point score = $\sum w_I * N_i$**	**Percent point score (PPS)** **= TPS *100/(5*N)**
	1 (w_1)	2 (w_2)	3 (w_3)	4 (w_4)	5 (w_5)		

3.6.3 Factor analysis

Factor analysis is a statistical method used to describe variability among observed, correlated variables in terms of a potentially lower number of unobserved variables called factors. For example, it is possible that variations in say six observed variables mainly reflect the variations in two unobserved (underlying) variables. Factor analysis searches for such joint variations in response to unobserved latent variables. The observed variables are modelled as linear combinations of the potential factors, plus "error" terms. The information gained about the interdependencies between observed variables can be used later to reduce the set of variables in a dataset.

3.6.3.1 Exploratory factor analysis

Multivariate statistics, exploratory factor analysis (EFA) is a statistical method used to uncover the underlying structure of a relatively large set of variables. EFA is a technique within factor analysis whose overarching goal is to identify the underlying relationships between measured variables. It is commonly used by researchers when developing a scale (a scale is a collection of questions used to measure a particular research topic) and serves to identify a set of latent constructs underlying a battery of measured variables.

3.6.3.2 Confirmatory factor analysis

Confirmatory factor analysis (CFA) is a multivariate statistical procedure that is used to test how well the measured variables represent the number of constructs. Confirmatory factor analysis (CFA) and exploratory factor analysis (EFA) are similar techniques, but in exploratory factor analysis (EFA), data is simply explored and provides information about the numbers of factors required to represent the data. In exploratory factor analysis, all measured variables are related to every latent variable. But in confirmatory factor analysis (CFA), researchers can specify the number of factors required in the data and which measured variable is related to which latent variable. Confirmatory factor analysis (CFA) is a tool that is used to confirm or reject the measurement theory.

3.6.4 Structured Equation Modelling using of IBM-SPSS AMOS 21

SEM is an extension of the general linear model (GLM) that enables a researcher to test a set of regression equations simultaneously. SEM software can test traditional models, but it also permits examination of more complex relationships and models, such as confirmatory factor analysis and time series analyses. The basic approach to performing a SEM analysis is as shown in figure 3-2

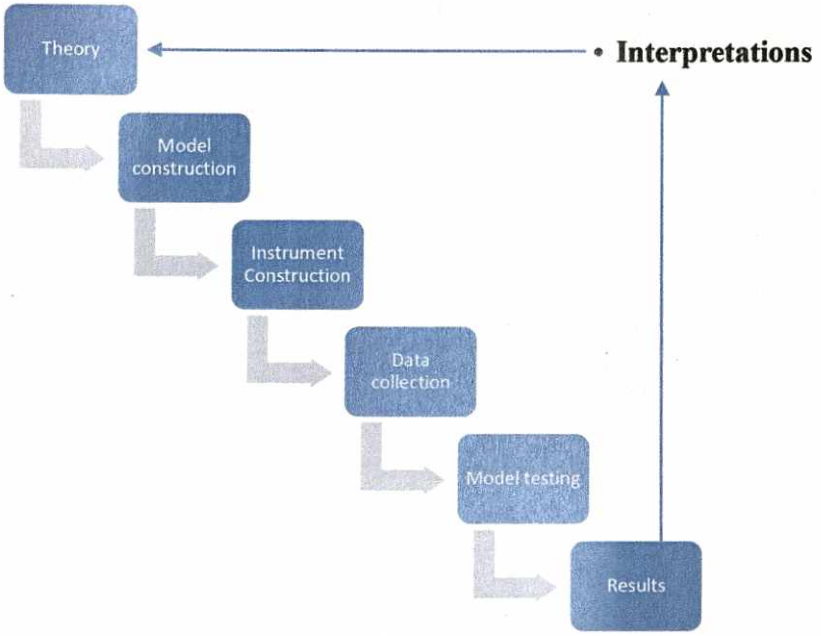


Figure 3-3 SEM analysis

The researcher first specifies a model based on theory, and then determines how to measure constructs, collects data, and then inputs the data into the SEM software package. The package fits the data to the specified model and produces the results, which include overall model fit statistics and parameter estimates.

The input to the analysis is usually a covariance matrix of measured variables such as survey item scores, though sometimes matrices of correlations or matrices of covariance and means are used. In practice, the data analyst usually supplies SEM programs like AMOS with raw data, and the programs convert these data into covariance and means for its own use. The model consists of a set of relationships among the measured variables. These relationships are then expressed as restrictions on the total set of possible relationships. Chapter summary

3.7 Chapter summary

This chapter described in details the problem definition, population, and sample size and research methodology along with the questionnaire administered for survey. The next chapter will discusses analysis on the data collected.

CHAPTER 4. DATA ANALYSIS

4.1 Introduction

The chapter presents opinions of respondents to the questionnaire used for data collection. It consists of response rate, percentage of responses, industry profiles, status of current scenario of MSME in Indian pharmaceutical industry.

4.2 Data collection

Based on the sample size and through discussions with industry experts, government officials and LPAC members, we finalized three major clusters of pharmaceutical MSMEs i. e. Haridwar, Hyderabad and Pune. The survey covered 600 MSME units in above mentioned clusters. Out of which 241 were found appropriate, thus yielding a response rate 40.1%, which is sufficient in number for further analysis. It was ensured that the questionnaire has to be completed by the respondents. The selected persons (middle and high level) who have filled responses were operations and supply chain executives within the organisation. They were mainly CEOs, MD or Top management representatives.

The data collection was done in following areas within respective time periods.

- Haridwar cluster **August -September 2014**
    - SIDCUL
    - Ram Nagar
    - Bhagwanpur
- Hyderabad cluster **November –December 2014**
    - Amerpet ,Jublee Hills
    - Jadcherla Mehdipattnam
    - Miyapur,Hitech City
    - Banjarahils,Kukatpally
- Pune /Mumbai cluster **January -April 2015**
    - Chakan, Pimpri Chinchwad,
    - Navi Mumbai
    - Thane
    - Mumbai MMR

4.3 Data Analysis

The questionnaire has been designed to capture the most of demographics to get additional dimensions for the analyses. The discussions of various responses gathered in form of charts are given below.

4.3.1 Section I-Demographics

It has been found that major contribution coming from medium type of enterprises, which shows that medium size enterprises have dominance within pharmaceutical industry. Here we can see in fig.4-1 that 81% response was from medium enterprises, where 13 % response from large enterprises and rest 6 % response belongs to small size pharmaceutical enterprises.

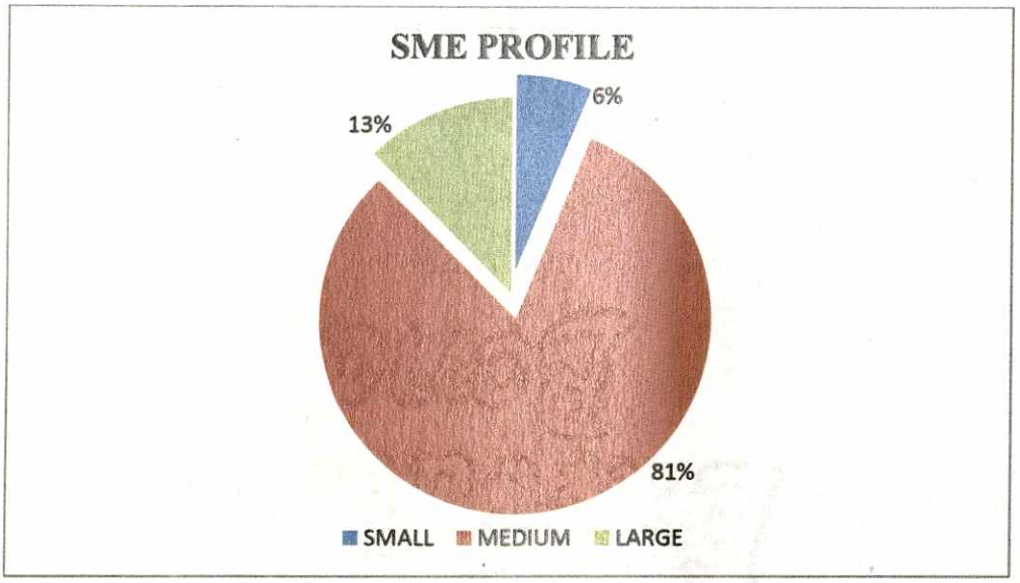


Figure 4-1 Classification of SMEs contacted

The questionnaires were sent to almost 600 organisations through various modes like; E-mail, shared spreadsheet, telephonic interviews and personal interviews. We found majorly of the filled in questionnaires were through personal interviews mode. We received 381 questionnaires initially and finally 241questionnaires were found satisfactory for further analysis. The responses summary is shown in table 4-1.

Table 4-1 Responses summary (cluster wise)

Clusters	Total population*	Target population	Filled in questionnaire received	Response rate
Hyderabad	1129	200	45	22.5%
Pune/Mumbai	1526	300	158	52.6%
Haridwar	513	100	38	38.0%
Total	2656	600	241	**40.1%**

Source: *NPPA, Directory of pharmaceutical producers of India 2007

4.3.1.1 *Education qualification*

The educational qualification of the respondent needed to be captured to ensure the authenticity and validity of information gathered through questionnaire and interview. Here in figure 4-2 we can see distribution says 58% were post graduate and 35% holds graduation and 4% were having PhD also.

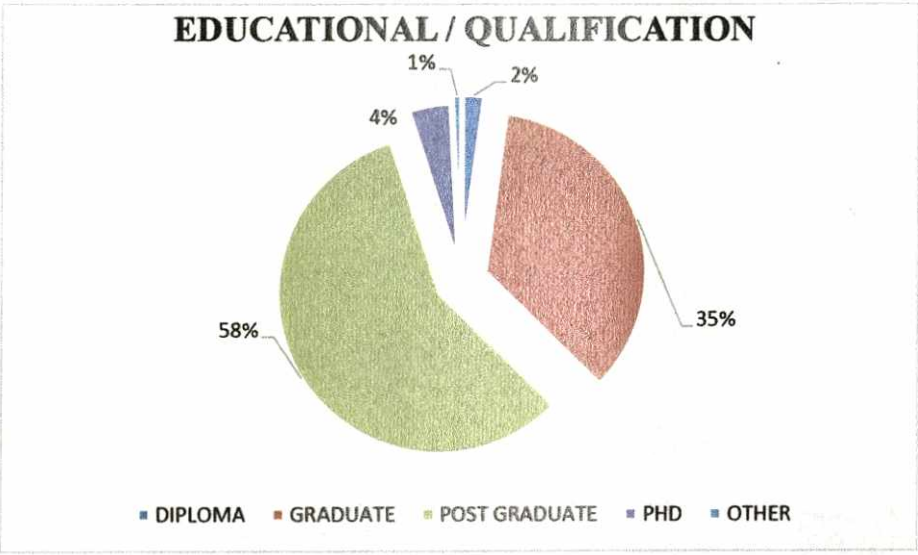


Figure 4-2 Education Qualification of respondents

4.3.1.2 *Position in organization*

The study seeks to obtain industry opinion about policy formulation, more over strategic dimensions. This could be achieved by incorporating opinions of top personnel from organizational hierarchy. Here our study holds major contribution from senior level management and middle level management in total 77% people belongs to desired key position holders like, CEOs, GM and operation managers, see figure 4-3.

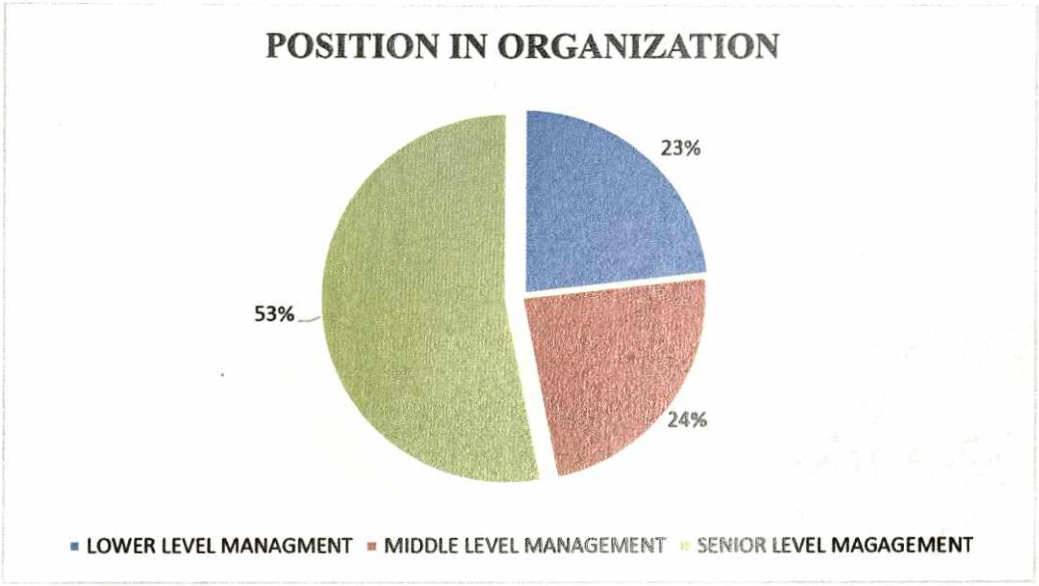


Figure 4-3 Position in organization

4.3.1.3 Age in Years

The respondents' age as shown in figure 4-4 clearly indicates that the growing population of young managers at higher levels in pharmaceutical industry. Majority of 66% found between age group of 31-35, followed by the senior group of 36-40 which is about 22%. Overall the responses have desired maturity within pharma and drug manufacturing.

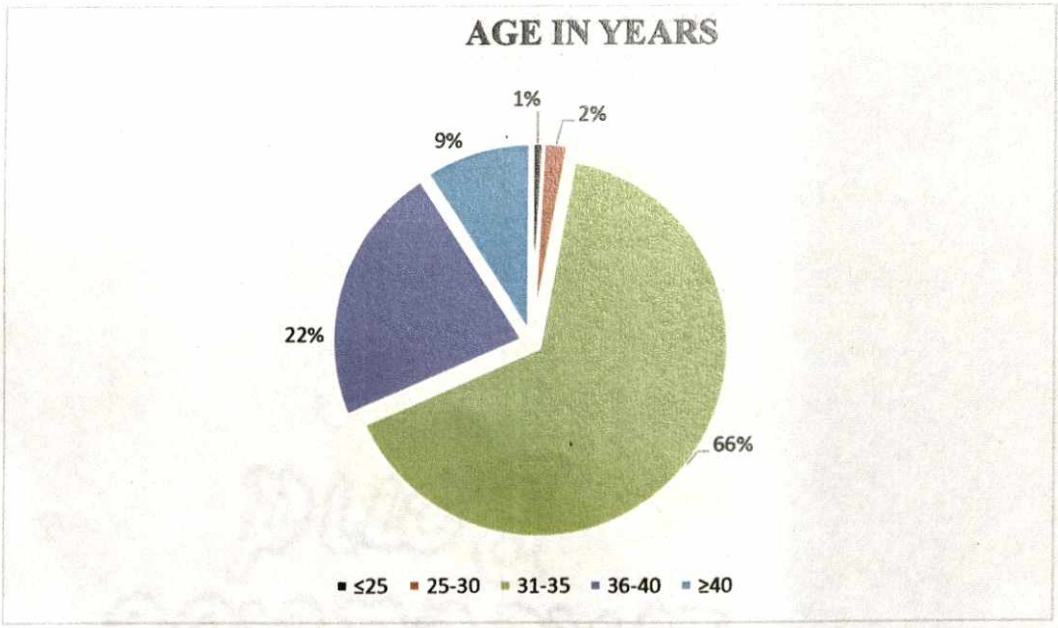


Figure 4-4 Age of Respondents in years

4.3.1.4 *Experience of respondents*

The Indian pharmaceutical industry is majorly contributed by small and medium enterprises and theses have grown especially in last decade. The figure 4-5 demonstrates that 62 % belongs to 11-15 years group of domain experience in pharmaceutical manufacturing, although mixed group of experienced people are also seen, which shows that the strategic reforms towards human resource management promoting young talent and diversification.

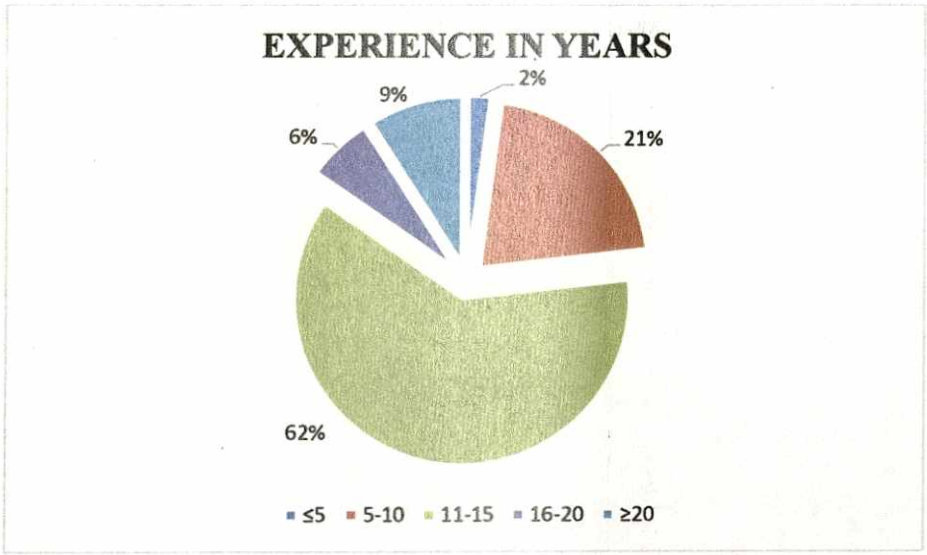


Figure 4-5 Experience in years of respondents

4.3.1.5 *Organisation Age*

The organisations' age profile as shown in figure 4-6 indicates that 66 % were around 10 years of establishment followed by the 27% of industry group operating from last 10-15 years.

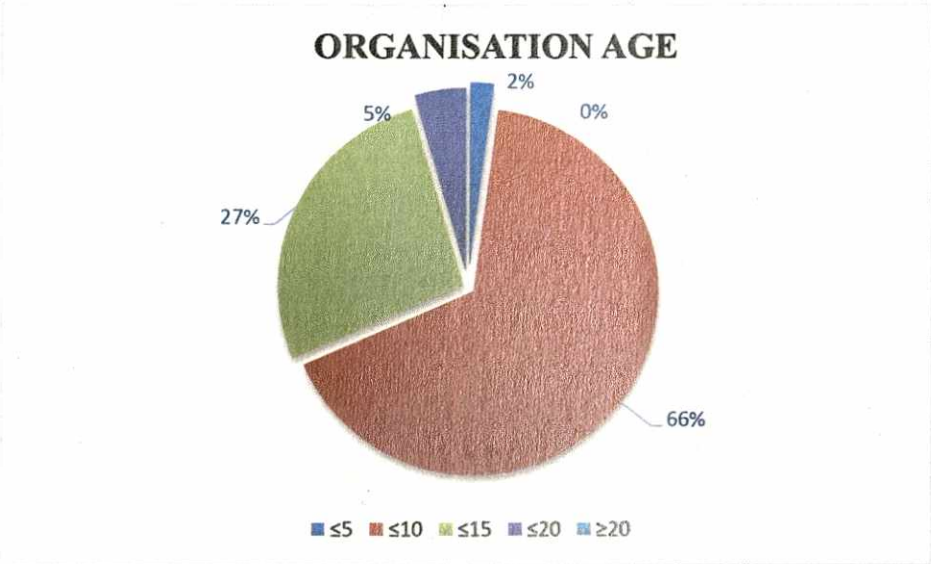


Figure 4-6 Organization Age in years

4.3.1.6 Number of Employee

The profile of employees in the samples can be seen in figure 4-7. We can see that majority belongs to 200-500, we can see that employee strength is 82% (54%+28%), which demonstrates the dominance of medium size enterprises.

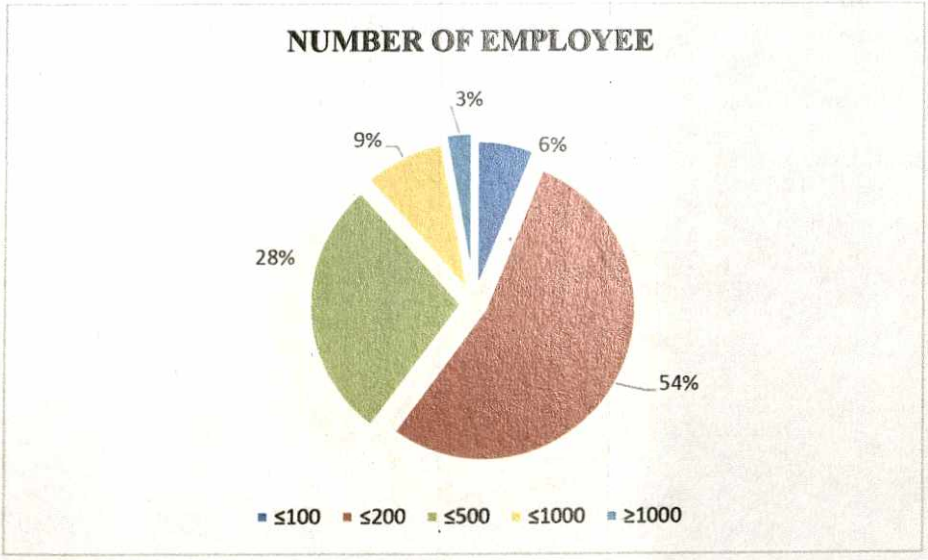


Figure 4-7 Number of Employees

4.3.1.7 R&D Investment

The questionnaire designed to ask R &D investment in past years, but we did not get proper answers, as the respondents were not aware of R&D investments. So the desired objective to access the investment could only be fulfilled by using secondary data sources like CMIE-

Prowess. As per the availability of data for pharmaceutical industry further analysis has been done. A cross comparison of R&D, the data from 1989 to 2005 were available, data could not be found before 1989 and after 2005, (see fig 4-8) spending by the Indian pharmaceutical sector with respect to other industry groups also indicates a rise in the share of R&D expenditure by the drugs and pharmaceutical sector of India (the data from 1989 to 2005 are available). The figure 4-8 which plots the contribution of R&D by the Indian pharmaceutical sector in the total R&D pool of the manufacturing and the chemical sectors shows two noticeable trends: The pharmaceutical industry is one of the major contributors of R&D in the chemical and manufacturing sector and the share of pharmaceutical R&D in the total manufacturing and chemical sectors is rising over the years.

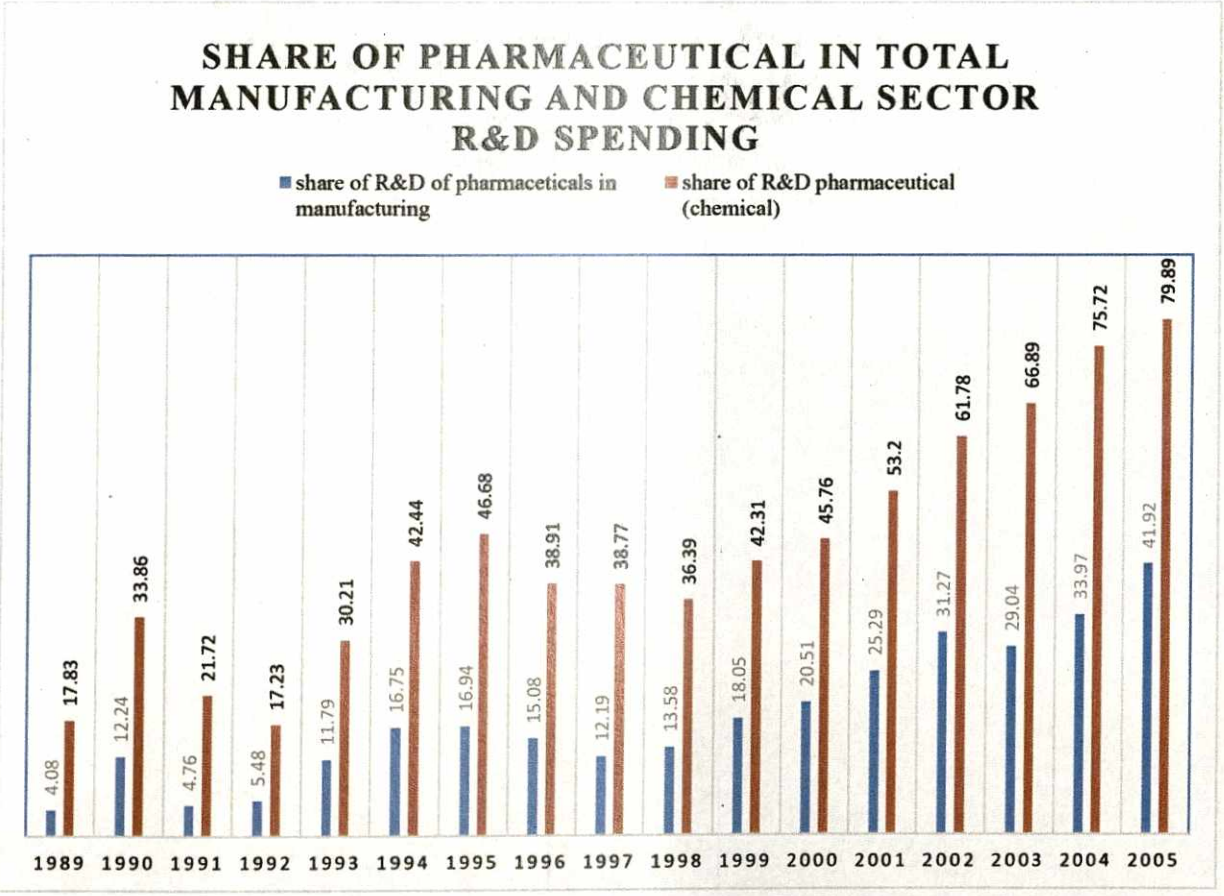
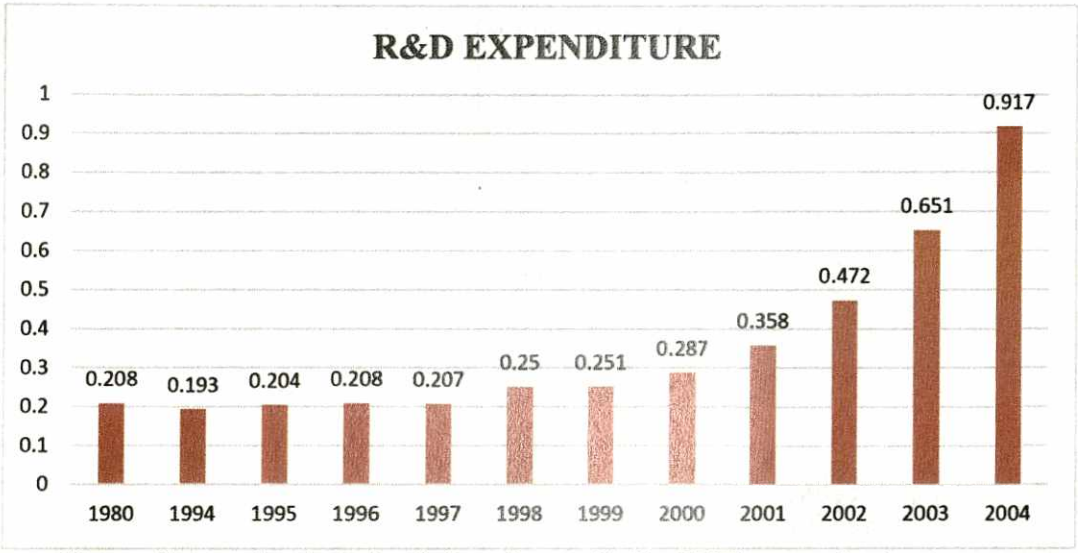


Figure 4-8 Share of Pharmaceutical in Total Manufacturing and Chemical Sector R&D spending



(Source: Computed on the basis of information provided by CMIE prowess data base)

Figure 4-9 R&D expenditure (Crores of dollars) in the Indian pharmaceutical sector

(Source: Computed from the Bulk Drug Association of India)

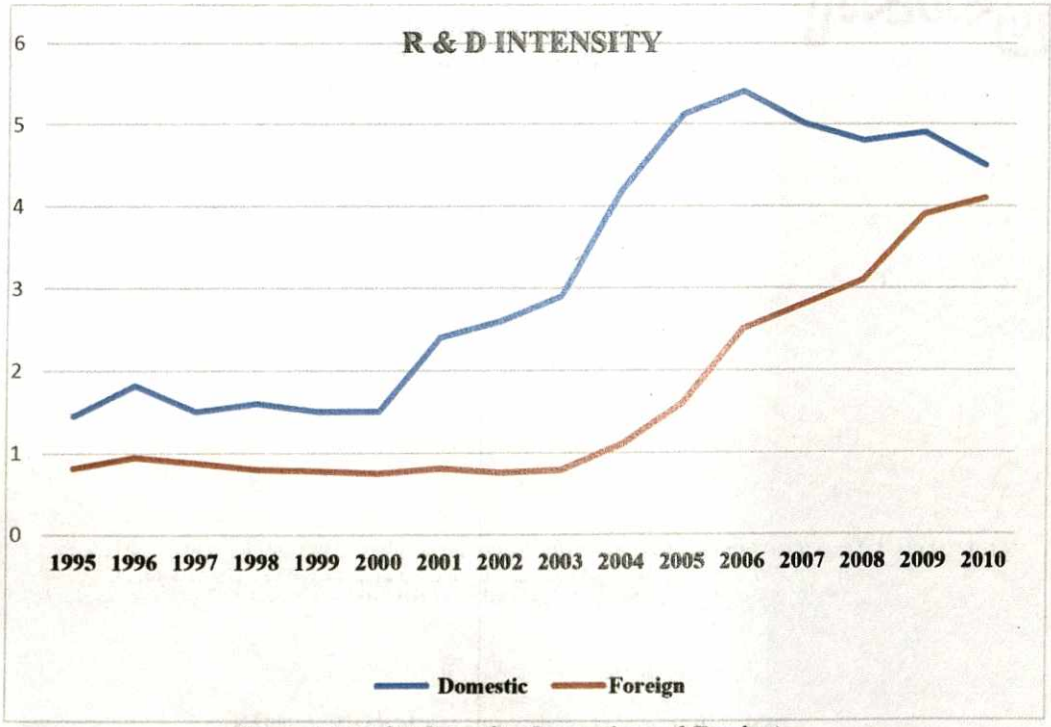


Figure 4-10 R&D Intensity (Domestics and Foreign)

(Source: Computed on the basis of information provided by CMIE prowess data base)

Figure 4.9 shows a constant investment in R&D expenditures during 1980 – 1997.The investment shows an increasing trend from 1998 to 2004. The data from 1980 to 2004 were available, the data could not be found before 1980 and after 2004. Figure 4-10 (the data were available from 1995 to 2010) indicates that from 1995 onwards, the total number of new generic products introduced in the Indian pharmaceutical market has increased substantially. This is an outcome of R&D initiatives by the Indian pharmaceutical firms and could be an important strategic move of firms to deter the entry of foreign firms into various product groups. However, in spite of its investment in R&D, the mean R&D-sales ratio of the Indian pharmaceutical companies is only 4% in 2005, which is far below the global figures of around 10–15%. R&D spending in India is low because most of the firms either fix process R&D or the thrust for R&D is targeted mainly for minor product improvement. The thrust of R&D activities of firms also differs according to the size of firms. Size-wise differences in the R&D intensity (R&D by sales ratio of firms (see Table 4.2) reveal that on an average, large sized firms spend more on R&D activities, followed by medium and small sized firms.

R&D intensity of the firm calculated as expenditure per sales generated for the unit of measure, here figure 4-10 shows that yearly the R&D Intensity is rising after year 2000 onwards. The figure 4-11 shows that average approvals based on cumulative applications has dropped from 61% in fiscal 2005 to 47% in fiscal 2012 and is now hovering at 28% only.

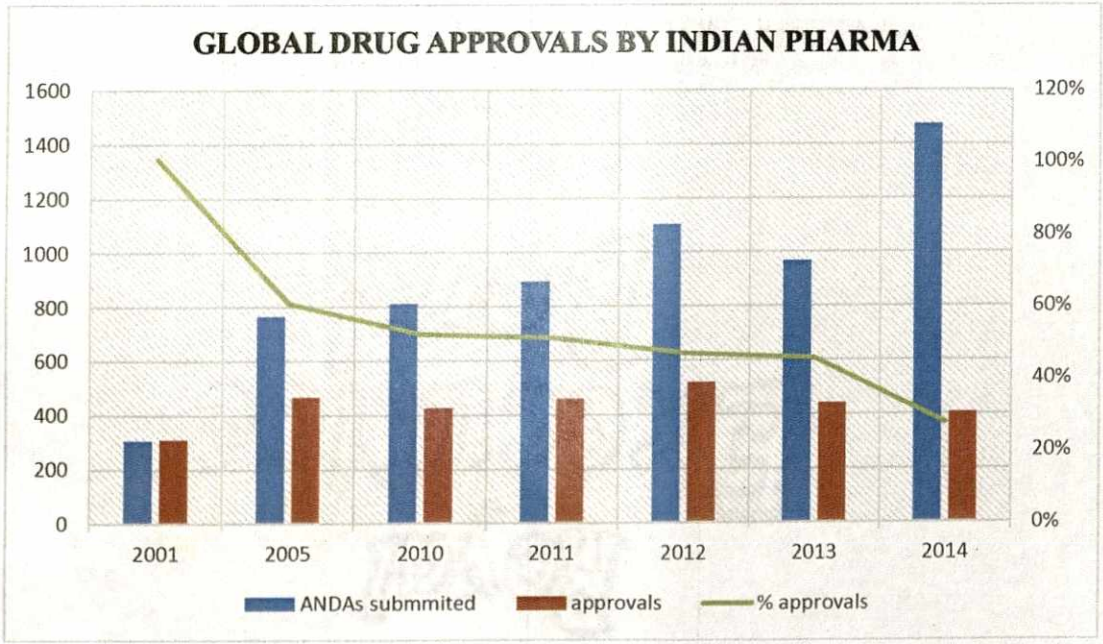


Figure 4-11 Global Drug Approval Submitted, Approved and Successes Rate

(Source: Computed from the Bulk Drug Association of India)

The trend in R&D also indicates that R&D intensity (see table 4-2) has also been steadily rising for all groups of firms though the rise is much higher for large and medium sized firms.

Table 4-2 R&D intensity for different sizes of firms

S. No.	Year	Large	Medium	Small
1	1995	2.224	0.988	0.663
2	1996	2.314	1.053	0.585
3	1997	3.309	2.993	0.617
4	1998	1.628	0.9	0.979
5	1999	2.191	0.953	0.639
6	2000	2.478	1.099	0.85
7	2001	3.065	1.374	0.877
8	2002	3.606	2.021	0.694
9	2003	3.879	2.02	0.608
10	2004	5.364	2.881	0.859
11	2005	7.776	4.157	1.718

(Source: Computed on the basis of information provided by CMIE prowess data base)

The data collected from secondary sources namely, CMIE- Prowess, reports of Government bodies, and pharmaceutical company annul reports which provides evidence for a strong positive association between the degree of investment and pharmaceutical supply chain performance (please refer Fig. 4-12 and Fig. 4-13) . It suggests that rising potential of R & D investments contributing to performance of firms. Hence it fulfilled our objective of study the effect of degree of investment in R&D in supply chain performance of the pharmaceutical industry.

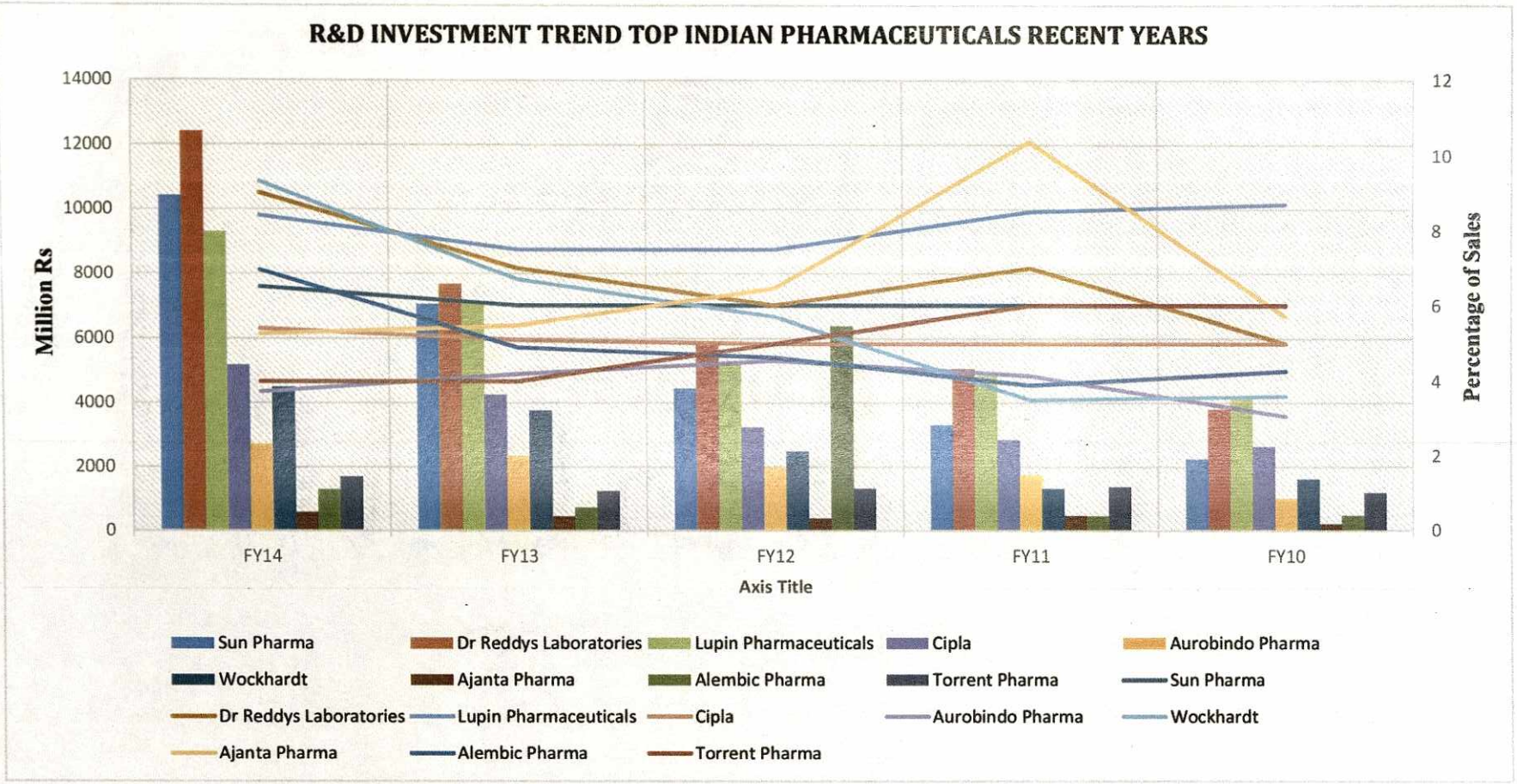


Figure 4-12 R&D Investment Trend Top Indian Pharmaceuticals Recent Years

Source: Companies' annual reports

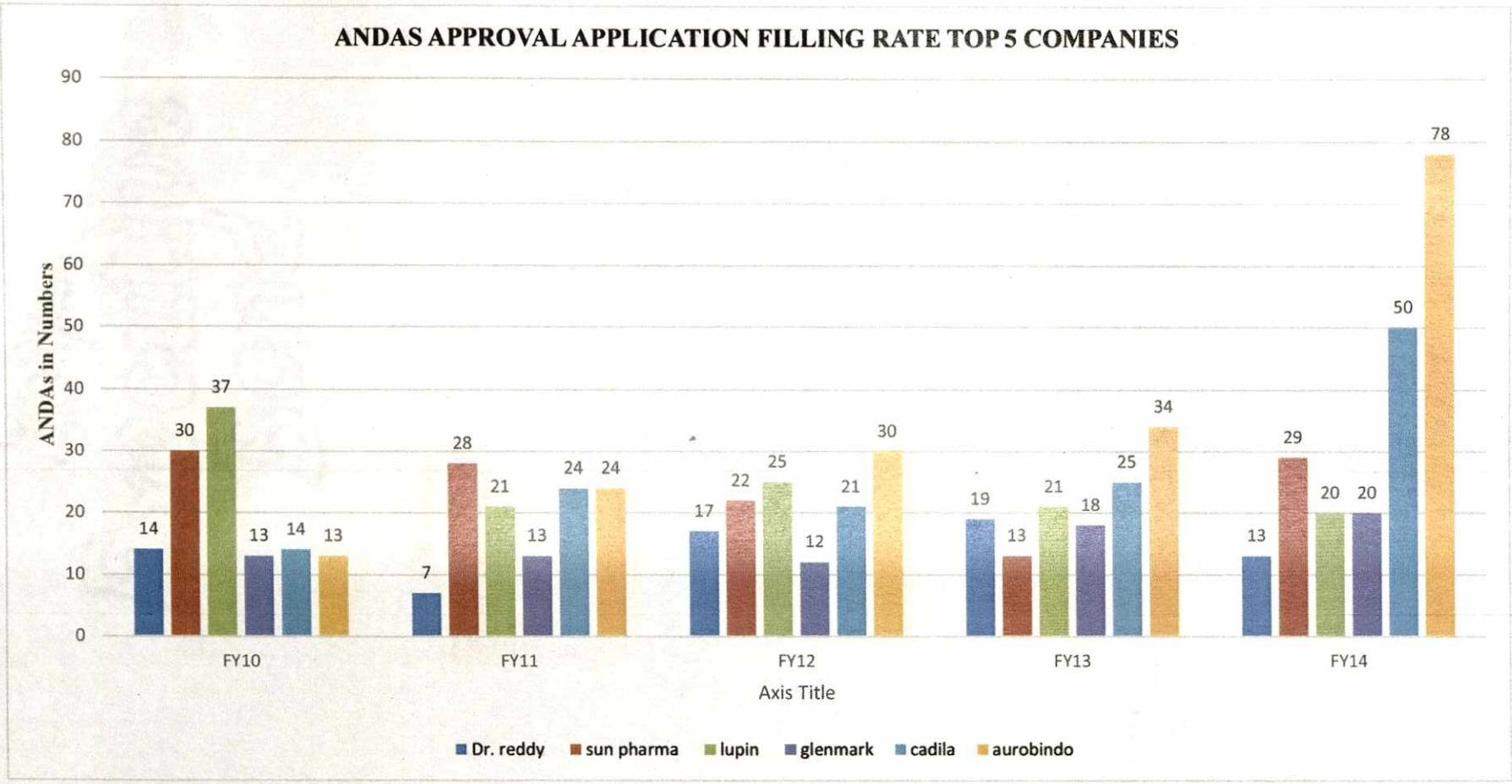


Figure 4-13 ANDAs approval application filling rate

Source: Companies' annual reports

4.3.2 Section –II External Aspects

The second section of questionnaire consists of understanding of current industrial scenario. It incorporates various prevailed practices, barriers against growth and drivers for pharmaceutical industry.

4.3.2.1 Supply chain practices

We have identified the prevalent world class supply chain practices of pharmaceutical industry through literature review and from experts' opinions. The identified world class practices under supply chain are listed in table 2-1. This serves our intermediate objective to identify and check feasibility of such practices. The supply chain practices were rated on scale of 1 to 5, from extremely unimportant to extremely important, responses in terms of percentage shown in summary table 4-2. Further the percentage point score (PPS) of each construct (practices) was calculated and ranked accordingly. We can see that most prevalent practices like TQM, Continuous Improvement Tools, Ware House Safety, Benchmarking, Quality Purchasing, Inbound Inspection and Quality Certification are holding high PPS and found the most important practices among supply chain practices in context to Indian pharmaceuticals (please see Fig. 4-15).

The figure 4-14 also clearly demonstrates the preferences of practices among various responses are majorly quality oriented. Modern supply chain practices like Supply Chain Benchmarking, Vertical Integration, relationship with suppliers, Holding safety stock and Use of external consultants were found least followed and it also justifies by holding low PPS scores. Strategic and policy wide management practices are still irrelevant in small and medium type industry.

The factor analysis has been performed to group these practices in to easily visualise sets. The table 4-4 and figure 4-16 show these practices like; TQM, Quality Certification, Quality Benchmarking, Quality Purchasing, Preventive Maintenance and Continuous Improvement Tools are grouped together with higher contribution to the factor. Further analyses have been done cluster wise (Hyderabad, Haridwar, and Pune) and size wise (large, medium, and small). The data have been collected from 241 respondents on 5 point Likert scale. The mean values have been used to find the results. Quality related practices are prevalent in all three clusters, most prevalent in Hyderabad (practice like Benchmarking 4.06) and least prevalent in Haridwar (practice like TQM 3.9). Benchmarking (4.06) is most and team work (2) is least prevalent in large industries, continues improvement (3.97) is most and having several

suppliers (2.27) is least prevalent in medium industries, TQM (3.93) is most and use of consultants (2.33) is least prevalent in small industries.

Inventory Practices also had major contribution in summarising variance of holding safety stock, Ware House Safety, Many suppliers, Inbound Inspection and Use of Operational manuals. At last we see Integration Practices hold to key practices, ERP Integration and Close partnership with customers. Strategic Practices comprises of Plan strategically, Use of external consultants, Team Work, and Vertical Integration. Similarly under Outsourcing Practices we found Outsourcing 3PL, Subcontracting, Supply Chain Benchmarking and EDI, Lean Certification. Supply Practices comprise of Close partnership with suppliers, few suppliers, e-Procurement and JIT supply. Hence this would investigate currently followed practices in Indian pharmaceutical supply chain and fulfils our intermediate objectives of identification of currently followed practices.

Table 4-3 Collected Responses for supply chain practices

No.	Supply chain practices	Extremely Unimportant	Unimportant	Somewhat Important	Important	Extremely important	PPS	Rank
1	Close partnership with suppliers	5%	32%	32%	27%	5%	58.84%	17
2	Close partnership with customers	6%	35%	34%	20%	5%	56.50%	19
3	JIT supply	4%	25%	34%	35%	2%	61.33%	15
4	e-Procurement	4%	28%	28%	34%	6%	62.58%	13
5	EDI	4%	29%	28%	35%	4%	61.58%	14
6	Outsourcing	5%	29%	34%	27%	4%	59.17%	16
7	Subcontracting	9%	39%	25%	25%	2%	54.58%	22
8	3PL	3%	20%	24%	46%	7%	66.80%	12
9	Plan strategically	10%	38%	26%	18%	8%	55.42%	21
10	Supply Chain Benchmarking	8%	40%	23%	25%	4%	55.67%	20
11	Vertical Integration	8%	55%	20%	14%	3%	49.75%	23
12	Few suppliers	15%	47%	18%	16%	4%	49.42%	24
13	Many suppliers	16%	56%	14%	12%	2%	45.56%	28
14	Holding safety stock	14%	55%	16%	12%	3%	47.33%	25
15	Use of external consultants	12%	57%	19%	8%	3%	46.72%	26
16	TQM*	0%	5%	17%	55%	23%	79.25%*	1
17	Quality Purchasing	0%	4%	18%	59%	19%	78.42%	5
18	Inbound Inspection	1%	3%	21%	55%	20%	78.17%	6

19	Quality Certification	1%	4%	22%	55%	18%	76.85%	7
20	Ware House Safety	0%	3%	19%	55%	22%	79.09%	3
21	Quality Benchmarking	2%	5%	14%	57%	23%	79.00%	4
22	Continuous Improvement Tools	1%	4%	19%	51%	25%	79.17%	2
23	Lean Certification	2%	16%	32%	38%	12%	68.30%	11
24	Communication Standard	2%	14%	30%	42%	12%	69.54%	10
25	Use of Operational manuals	3%	11%	29%	46%	11%	70.29%	9
26	Preventive Maintenance	2%	8%	22%	56%	11%	73.28%	8
27	ERP Integration	7%	39%	24%	22%	7%	56.60%	18
28	Team Work	12%	58%	16%	11%	3%	46.70%	27

4.3.2.2 Example on PPS calculation for TQM item*

Data pertaining to this section in the questionnaire was collected and percent point score (PPS) is calculated, using to formula given below:

S No.	Rating scale	Weight	No of scoring units for TQM	**Total point score = $\{\sum w_I * N_i/n$ x 5$\}$x100**
1	Extremely Unimportant	$w_1 = 1$	$N_1 = 1$	1x1+2x11+3x40+4x133+ 5x56 = {955/241x5}x100 = **79.25%**
2	Unimportant	$w_2 = 2$	$N_2 = 11$	
3	Somewhat Important	$w_3 = 3$	$N_3 = 40$	
4	Important	$w_4 = 4$	$N_4 = 133$	
5	Extremely important	$w_5 = 5$	$N_5 = 56$	

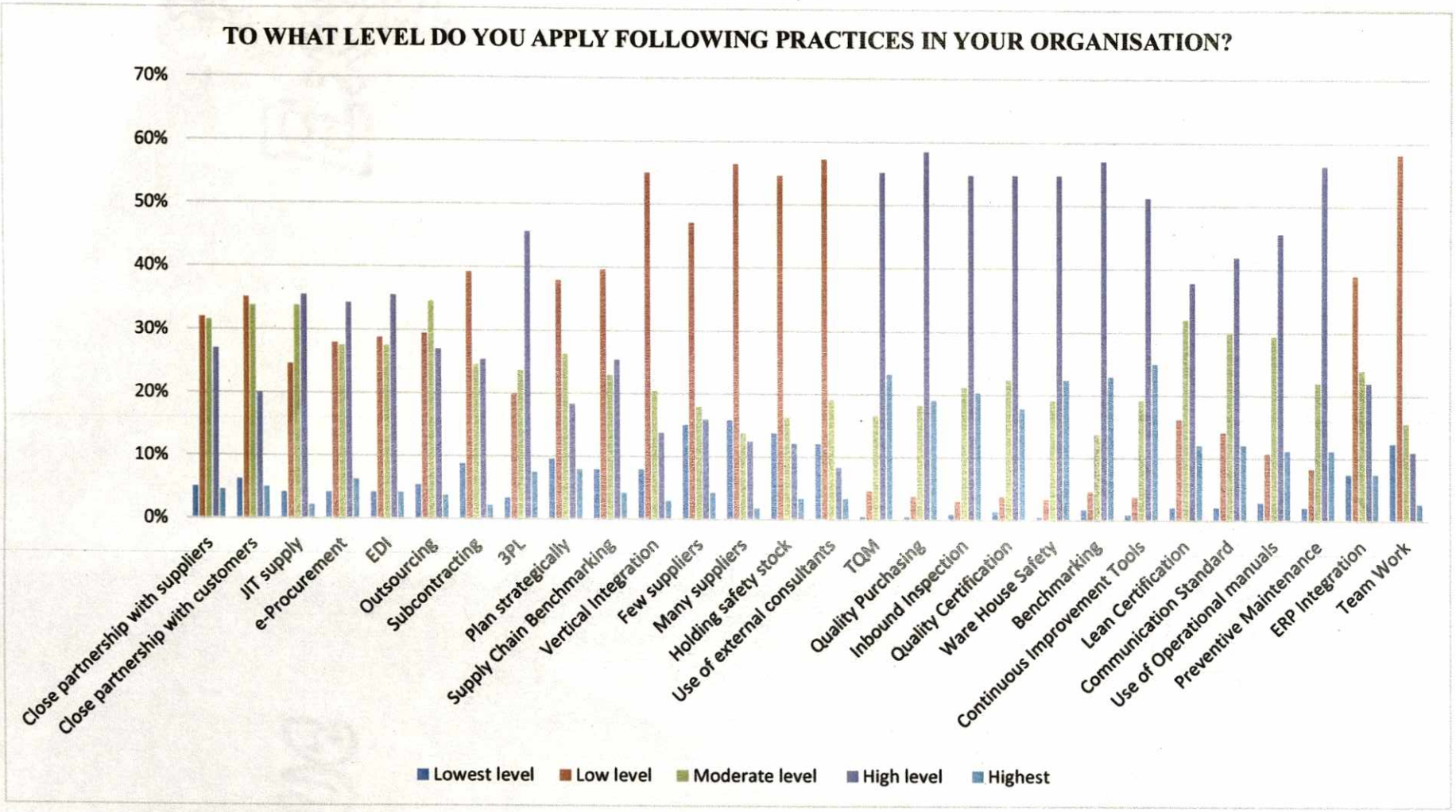


Figure 4-14 Responses summary of preferred supply chain practices

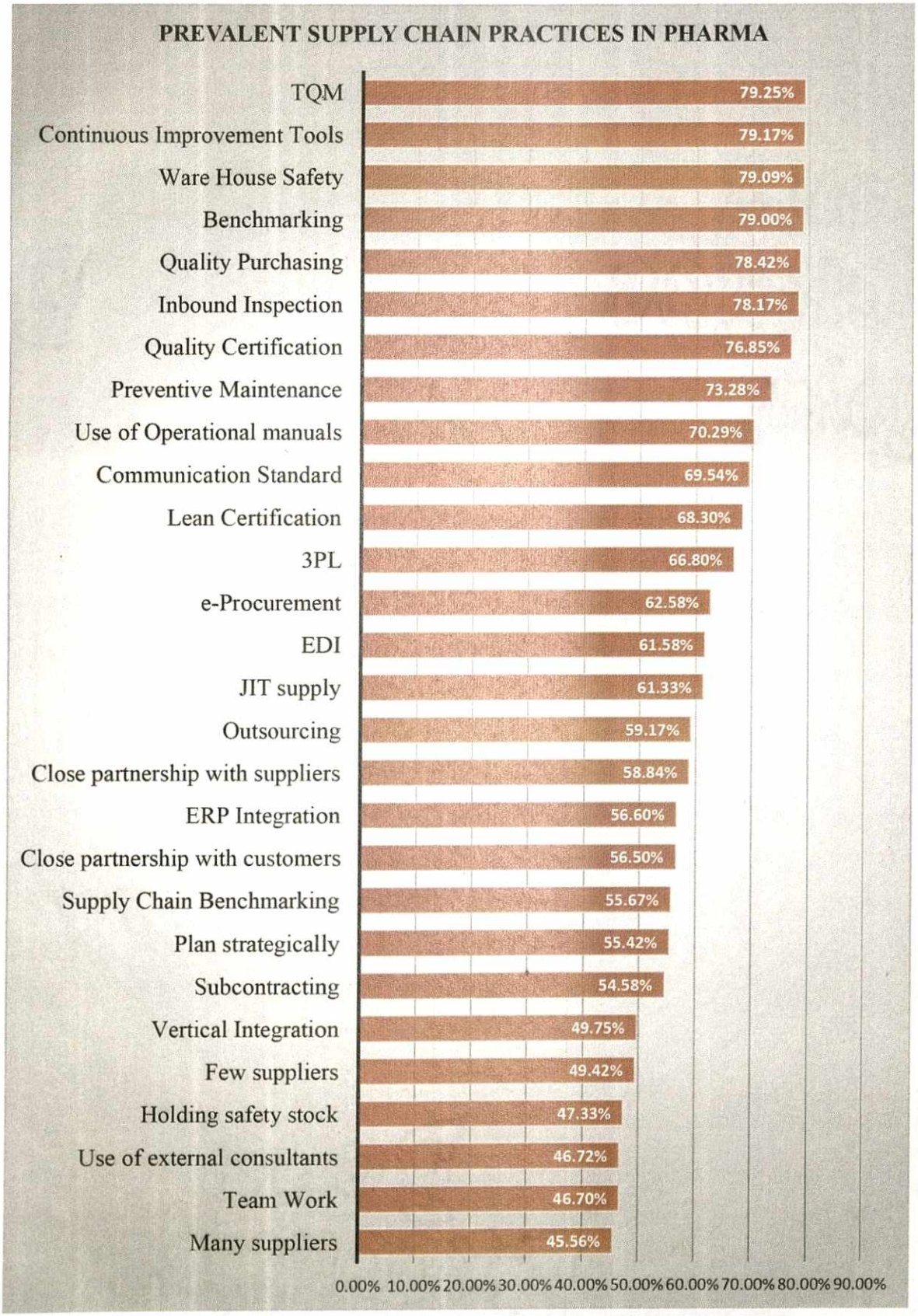


Figure 4-15 Prevalence of SC practices found in Pharmaceutical industry

Table 4-4 Factor analysis SPSS output: Rotated Component Matrix for practices

S. No.	PSC Practices	Factor Component (loading)					
		1	2	3	4	5	6
1	Outsourcing	.725					
2	ERP Integration						.780
3	e-Procurement				.811		
4	Few suppliers				.836		
5	EDI	.856					
6	Outsourcing	.846					
7	Subcontracting	.852					
8	3PL	.819					
9	Plan strategically					.755	
10	Supply Chain Benchmarking	.868					
11	Vertical Integration					.682	
12	Close partnership with suppliers				.698		
13	Many suppliers			.873			
14	Holding safety stock			.800			
15	Use of external consultants					.771	
16	TQM		.787				
16	Close partnership with customers						-.615
17	Quality Purchasing		.798				
18	Inbound Inspection			.844			
19	Quality Certification		.716				
20	Ware House Safety			.855			
21	Quality Benchmarking		.742				
22	Continuous Improvement Tools		.682				
23	Lean Certification	.817					
25	Use of Operational manuals			.883			
26	Preventive Maintenance		.843				
27	JIT supply				.824		
28	Team Work					.751	
		Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization. a. Rotation converged in 6 iterations.					

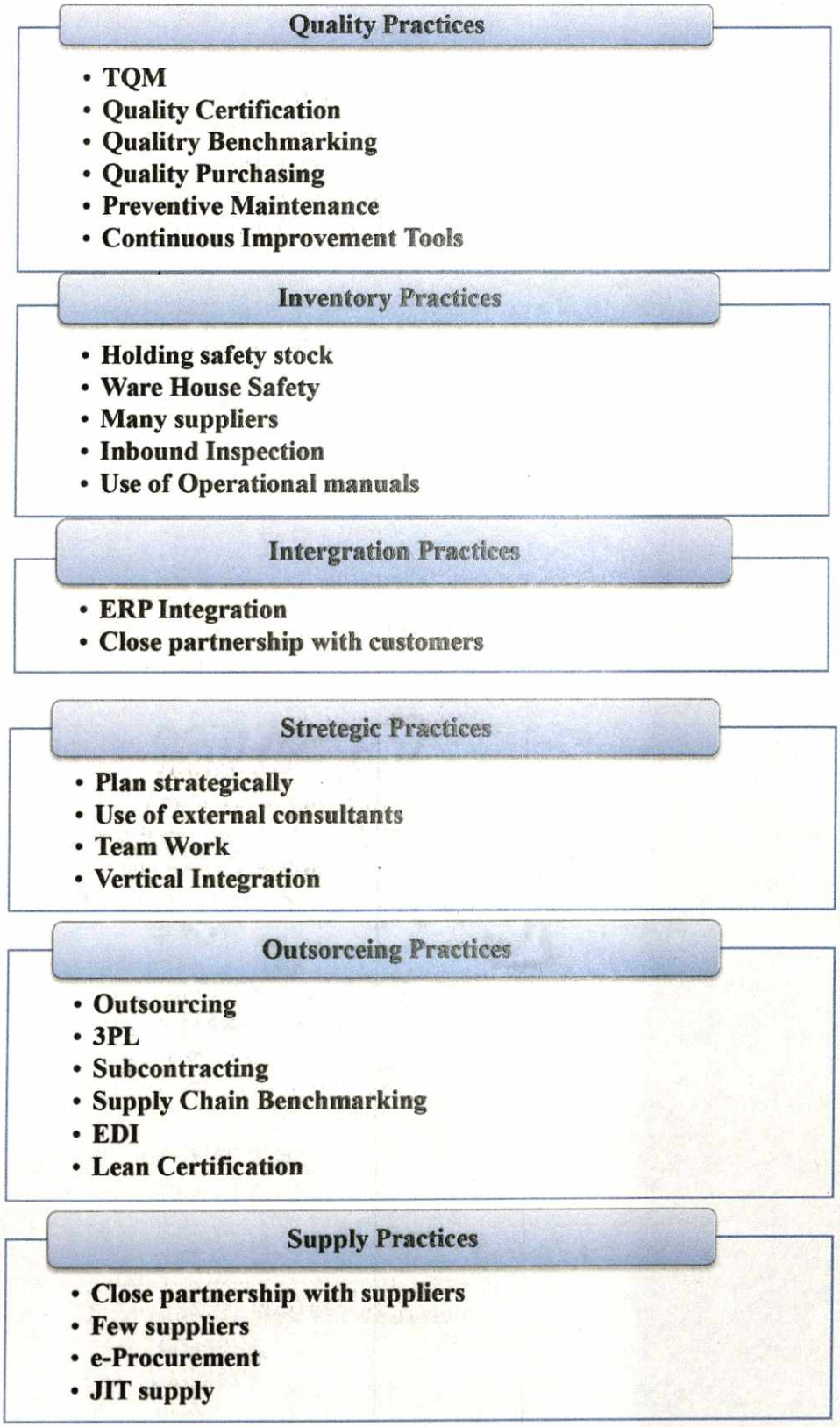


Figure 4-16 Classification of PSC Practices by factor analysis

4.3.2.3 Research and Development factors

The analysis of the data reveals that the pharmaceutical industry is one of the most profitable industries in India. The average profit earning (profit as a percentage of sales) of the pharmaceutical industry positions at around 8.8% in the year 1995 as against the 5.8% of the chemical industry, 4.8% of the food and the beverage industry, 5.5% of the machinery industry and 5.8 % of the transport and equipment industry. Further, there has been a rise in the profitability of firms from 8.8% to about 15.4 % in a short span of only 10 years from 1995 to 2005. In the pharmaceutical industry the extent of concentration is low. However, the co-existence of low levels of concentration and ever-increasing rise in profit earning stands against the conventional economic wisdom and a feature which is peculiar to this industry.

In the pharmaceutical industry, the benefits of higher profitability accrue to large sized firms not because of economies of scale in production but because of other factors like ability to undertake R&D or do more of marketing activity at large scale (Schweizer, 2005). Consider now the case of firms with R&D related outlays. On an average, firms with R&D units have earned higher profit compared to firms without any R&D unit. The productivity difference also reveals similar trends. This indicates that investment in R&D is an effective action for firms to perform better. Since most of the firms in India have embarked on R&D related activity quite recently, we also explain in brief the emerging R&D trends of the Indian pharmaceutical industry.

So research and development is most important aspect of study under which we have tried to capture the intentions of industry by asking them what strategies they would adopt by considering following factors affecting supply chain performance.

1. R&D facility within the company.
2. R&D facility outsourced to other companies.
3. R&D outsourced to higher education institutions or public research organisations.
4. Purchase or licensing of intellectual property rights (patents, copyrights and designs).
5. Acquisition of new or highly improved machinery, equipment and software.
6. Training to support innovative activities.
7. Market research, launch advertising, and related marketing activities for new product introduction.

Table 4-5 Collected responses on R and D Factors

R and D factors	Not at all	Somewhat	Moderate	High	Very High	PPS	Rank
RND01	4%	12%	29%	45%	9%	68.71%	2
RND02	4%	8%	21%	57%	10%	72.37%	1
RND03	3%	17%	33%	37%	11%	67.30%	3
RND04	5%	33%	31%	27%	5%	58.76%	6
RND05	6%	36%	34%	19%	5%	56.10%	7
RND06	5%	27%	32%	34%	2%	60.33%	5
RND07	4%	30%	28%	35%	3%	60.50%	4

The results show that R and D outsourced to other companies shows highest PPS 72.37 % where we can see that 57% rated high and 10% recommends full outsourcing (please see table 4-5) . With relatively low PPS of about 67.30% R and D outsourced to higher education institutes could be a suggestive strategy where 37 % rated highly preferred. Also the acquisition of new or highly improved machinery, equipment and software came out as least preferred one with low PPS of 56.10%.here we can see that how R&D related factors affect performance of pharmaceutical supply chain and fulfilled our desired objective (please see Fig 4-17).

Haridwar cluster shows R&D outsourced to higher education institutions (3.31) most and training to support innovative activities (2.71) least. While Hyderabad (3.88, 2.81) and Pune (3.67, 2.74) clusters show R&D facility outsourced to other companies most and acquisition of new or highly improved machinery, equipment and software least. Supply chains of large, medium, and small industries mostly (3.75, 3.6, 3.47) get affected when R&D is outsourced to other companies and least (2.97, 2.90, 2.57) affected when acquisition of new equipment and software.

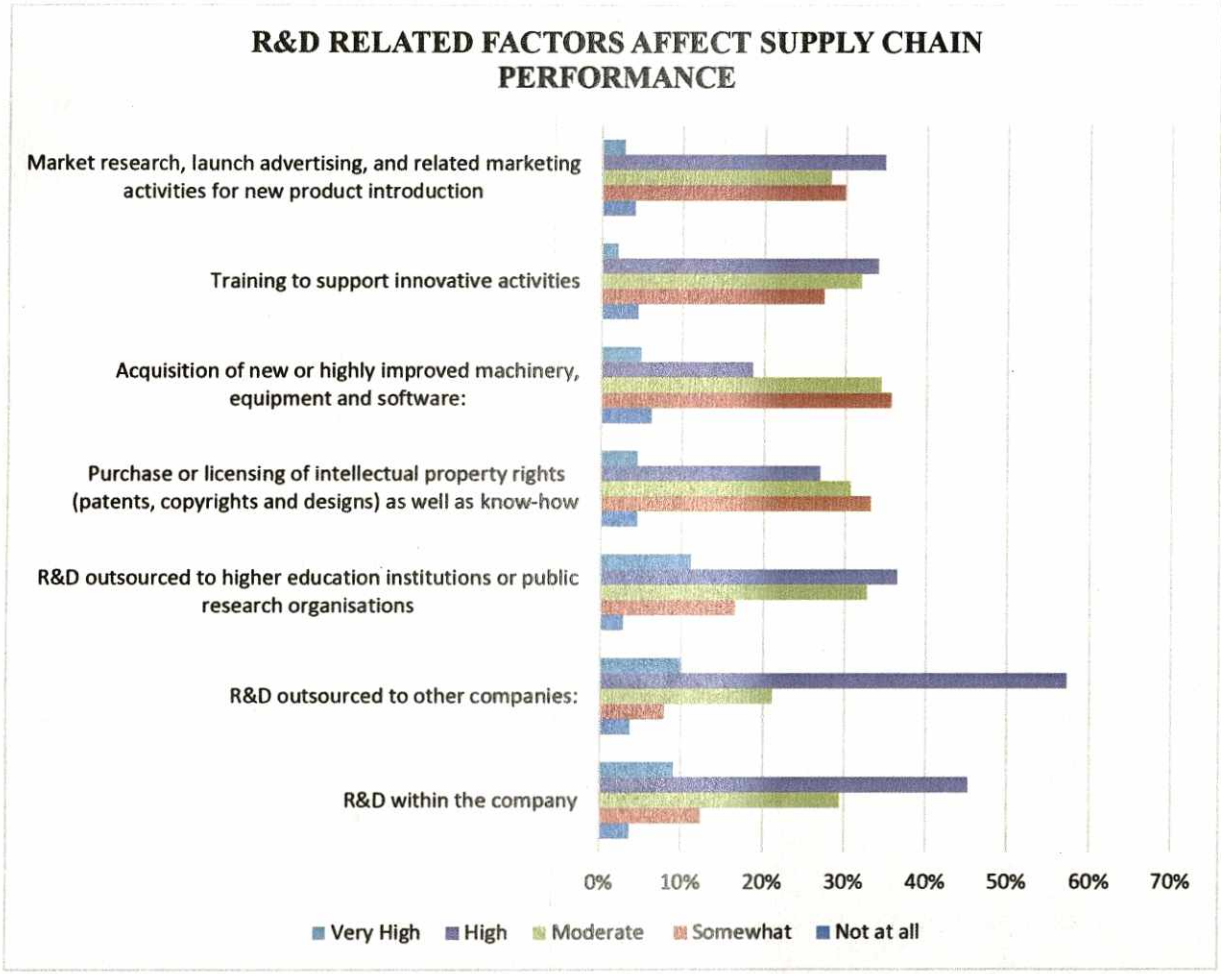


Figure 4-17 Responses to "How Research and development effects supply chain performance"

4.3.2.4 Barriers

Every supply chain has a challenge to overcome their barriers to sustain their growth in rapidly changing world. We have identified twenty eight barriers found relevant in context of pharmaceutical MSMEs in India. The response summary is being shown in table 4-6 and figure 4-18.

Here we can see that poor priority planning / lack of commitment by top management is observed as most critical barriers among identified barriers of supply chain performance with highest PPS of 78.34% .The other critical barriers ranked high in criticality as shown in table 4-6 are "Lack of strategic planning, Inefficient Information system, Unawareness about PMS in supply chain, Reluctance of support of dealers, Distributors and Lack of fund for Performance Measurement System (PMS) implementation" with higher PPS values (above 75 %). whereas Corporate Culture and Motivation for change/Support for Measurement are least critical barriers to pharma supply chain growth.

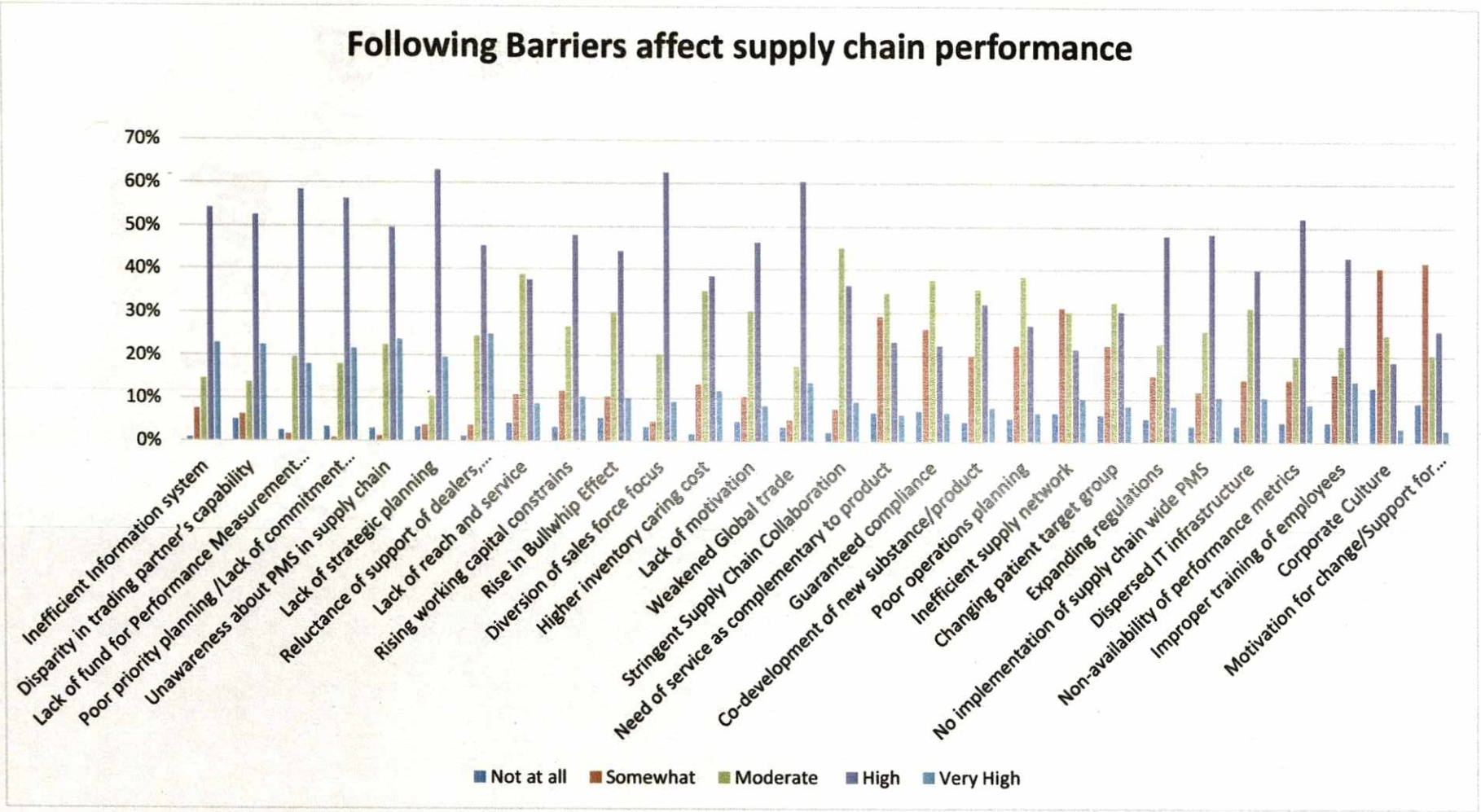


Figure 4-18 Responses to "How Barriers affect supply chain performance

Table 4-6 Identified Barriers against performance in PSC

No.	Barriers	Not at all	Some what	Moderate	High	Very High	PPS	Rank
1	Inefficient Information system	1%	7%	15%	54%	23%	78.17%	3
2	Disparity in trading partner's capability	5%	6%	14%	53%	22%	76.27%	7
3	Lack of fund for Performance Measurement System (PMS) implementation	2%	2%	20%	59%	18%	77.51%	6
4	Poor priority planning / Lack of commitment by top management	3%	1%	18%	56%	22%	78.34%	1
5	Unawareness about PMS in supply chain	3%	1%	23%	49%	24%	77.93%	4
6	Lack of strategic planning	3%	4%	11%	62%	20%	78.26%	2
7	Reluctance of support of dealers, distributors etc.	1%	4%	25%	45%	25%	77.76%	5
8	Lack of reach and service	4%	11%	39%	37%	9%	67.05%	20
9	Rising working capital constrains	3%	12%	27%	48%	10%	69.96%	11
10	Rise in Bullwhip Effect	5%	11%	30%	44%	10%	68.46%	17
11	Diversion of sales force focus	3%	5%	20%	62%	10%	74.02%	9
12	Higher inventory caring cost	2%	13%	35%	38%	12%	69.13%	14
13	Lack of motivation	5%	10%	30%	46%	9%	68.80%	15
14	Weakened Global trade	3%	5%	17%	60%	14%	75.35%	8
15	Stringent Supply Chain Collaboration	2%	7%	45%	37%	9%	68.63%	16
16	Need of service as complementary to product	7%	29%	34%	24%	6%	58.76%	26
17	Guaranteed compliance	7%	26%	37%	23%	7%	59.17%	25
18	Co-development of new substance/product	5%	20%	36%	32%	8%	63.73%	21
19	Poor operations planning	5%	22%	39%	27%	7%	61.41%	23
20	Inefficient supply network	7%	31%	31%	22%	10%	59.42%	24
21	Changing patient target group	6%	22%	33%	30%	8%	62.41%	22
22	Expanding regulations	5%	15%	23%	48%	8%	67.72%	19
23	No implementation of supply	4%	12%	26%	49%	10%	70.04%	10

	chain wide PMS							
24	Dispersed IT infrastructure	4%	15%	31%	40%	10%	67.80%	18
25	Non-availability of performance metrics	5%	15%	20%	52%	9%	69.21%	13
26	Improper training of employees	5%	16%	22%	43%	14%	69.29%	12
27	Corporate Culture	13%	40%	25%	19%	3%	51.82%	28
28	Motivation for change/Support for Measurement	9%	42%	20%	26%	3%	54.27%	27

The barrier identified are large in numbers so it's difficult for the organisation to sort, assign and target a barrier to overcome by implementing necessary actions within organisation. The least (2.54, 2.61, 2.55) affecting barrier in all three clusters is "corporate culture", while the most affecting barrier is "poor priority planning / lack of commitment by top management" in Haridwar (3.57), "inefficient information system" in Hyderabad (4.08) and "unawareness about PMS in supply chain" in Pune (4) cluster. In large enterprises, the supply chain is mostly (4.05) affected by inefficient information system and least (2.83) by corporate culture. In medium enterprises, the supply is mostly (3.97) affected by poor support from dealer & distribution and least (2.53) by corporate culture. In small enterprises, the supply is mostly (3.89) affected by poor priority planning and least (2.6) by motivation for change and support.

The factor analysis has been performed to group these identified barriers into major sets for better understanding. The collected data for barriers is used to run analysis on SPSS using Extraction by Principal Component Analysis with Varimax rotation which converge to six iterations. Factor component loading values below 0.50 were suppressed. The output is shown in table 4-7 with classification in to six heads. On the basis of characteristics of the loaded components with in heads we had to assign them names often called factors ,here we are analysing barriers so we have to named them as below (also see Figure 4-19)

1. IT/Communication Barriers ,
2. Economical/Financial Barriers,
3. Strategic Barriers,
4. Market Barriers,
5. Supply and Supplier Barriers,
6. Human Resource Barriers.

The higher factor loading reflects higher degree of covariance among barriers. As per the priority of the organisation they could go for desired change in production policy and develop strategies (see table 4-7). Hence this also supports our objective of identification of barriers which affect the supply chain performance.

Table 4-7 Factor analysis SPSS output: Rotated Component Matrix for Barriers

	Pharmaceutical SC Barriers	**1**	**2**	**3**	**4**	**5**	**6**
1	Inefficient information system	0.797					
2	Disparity in trading partner's capability				0.826		
3	Lack of fund for Performance Measurement System (PMS) implementation		0.764				
4	Need of service as complementary to product			0.814			
5	Unawareness about PMS in supply chain						0.722
6	Co-development of new substance/product			0.861			
7	Reluctant of support of dealers and distributor					0.794	
8	Poor priority planning /Lack of commitment			0.795			
9	Rising working capital constrains		0.81				
10	No implementation of supply chain wide PMS	0.856					
11	Diversion of sales force focus						0.761
12	Non-availability of performance metrics					0.792	
13	Lack of motivation						0.725
14	Weakened Global trade		0.709				
15	Stringent Supply Chain Collaboration					0.814	
16	Lack of strategic planning			0.861			
17	Guaranteed compliance		0.766				
18	Poor operations planning					0.713	
19	Higher inventory caring cost					0.859	
20	Dispersed IT infrastructure	0.857					
21	Changing patient target group				0.695		
22	Expanding regulations				0.798		
23	Lack of reach and service	0.878					
24	Rise in Bullwhip Effect	0.888					
25	Inefficient supply network					0.826	
26	Improper training of employees						0.706
27	Corporate Culture						0.662
28	Motivation for change/Support for Measurement						0.695

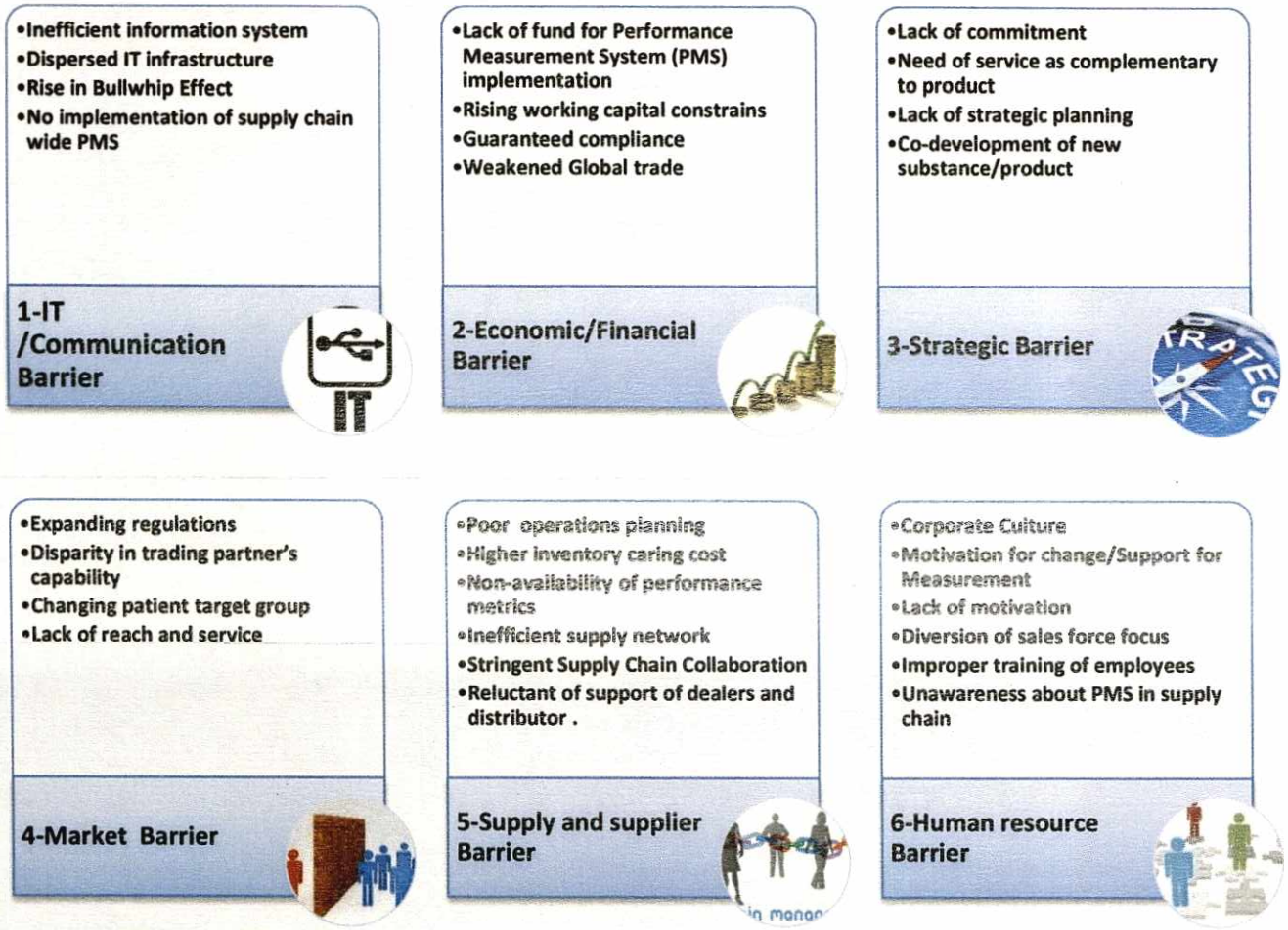


Figure 4-19 Classification of PSC Barriers by factor analysis

4.3.2.5 Science & Technology Intervention

The Indian pharmaceutical supply chain has medium level of technology adoption as per the world class standards, apart from basic infrastructural constrains. The technology intervention would have been a great impact if sourced proactively. Due to huge demands and production shortfall, Indian manufacture lags successful technology adoption to enhance their production facility. We have asked the industry that how the science and technology affects the drivers concerning to the performance of the supply chain. Here we can see in table 4-8 that Facilities /Warehousing driver would be highly affected by the science and technology intervention as it is ranked first with highly PPS of 63.97%, similarly inventory, flexibility and information ranked second with PPS 61.49%. Since all drivers are greatly affected by the science and technology intervention, however product design and process also got upgraded. Hence this analysis fulfilled our objective of finding the relationships with drivers and science and technology intervention. When analysis was done at cluster level, warehousing facilities mostly got affected by S&T intervention in Haridwar (3.62), Hyderabad (3.25), and Pune (2.98) clusters. Large, medium, and small industries need S&T intervention in warehousing facilities most (3.23, 3.13, and 3.36). While, least intervention is needed in flexibility in large (2.67) and small (2.73) industries. The least intervention in medium (2.73) industry is required in pricing.

Table 4-8 Effect of S & T intervention on PSC Drivers

PSC Drivers	Not at all	Somewhat	Moderate	High	Very High	PPS	Rank
Inventory	5%	24%	33%	34%	4%	61.49%	2
Information	5%	30%	28%	34%	3%	60.17%	4
Transportation	5%	30%	35%	28%	2%	58.34%	5
Purchasing /Sourcing	10%	30%	25%	31%	3%	57.14%	6
Pricing	7%	41%	24%	22%	5%	55.27%	7
Facilities /Warehousing	4%	27%	21%	42%	6%	63.97%	1
Flexibility	5%	29%	27%	35%	4%	60.75%	3

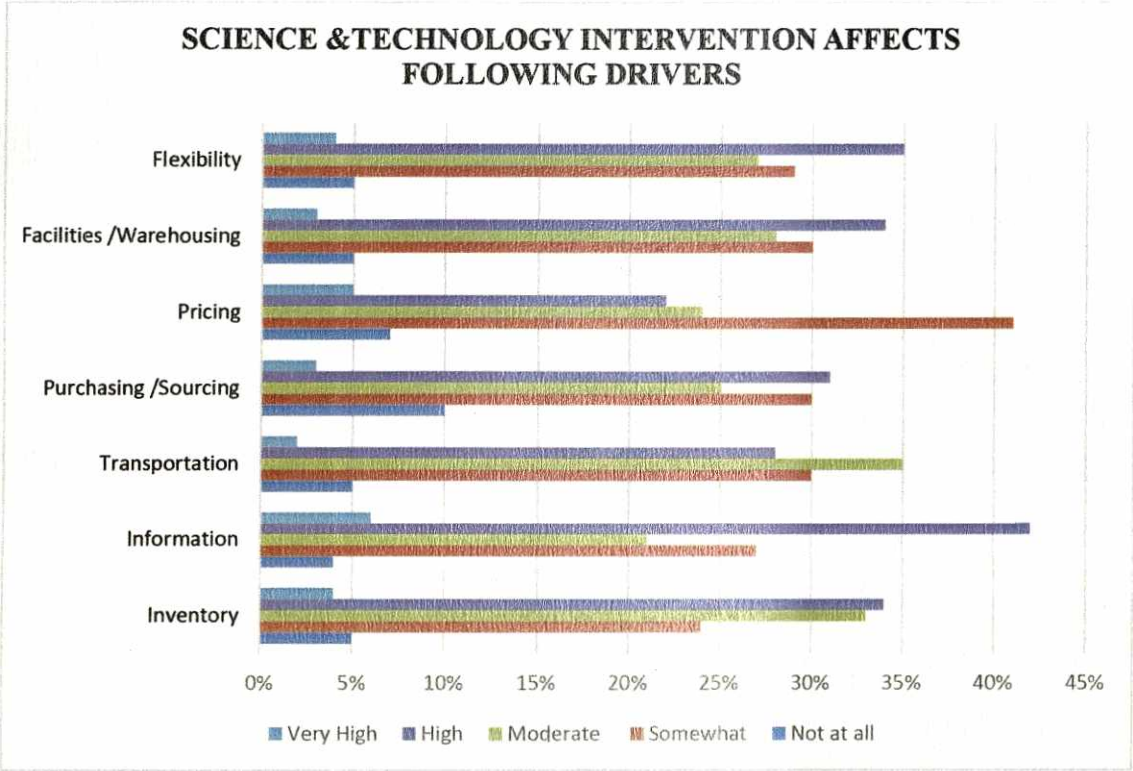


Figure 4-20 Response to "how Science &Technology intervention affects drivers".

4.3.2.6 Systems, Science and Technology

The scientific intervention and technology transfers capability of a firm affects the performance of the supply chain. When we have asked the industry personnel about how such supply chain get affected by the scientifically designed systems, we found decision support system, RFID are ranked higher with PPS score above 65% (please see table 4-9), which shows the industrial importance of such technologies which could affect the performance of the supply chain.

The traditional operational science comprises of the Material Requirements Planning (MRP) Supplier Relationships Management (SRM) and Just in Time (JIT) which shows critically higher understanding among the higher level of management. Here we can see that such systems are well initiated and adopted by large pharmaceutical producers also see figure 4-21.

Just-in-Time (JIT) system will mostly (3.57, 4.13, 3.95) affect PSC performance in all three clusters while APS will lest affect in Haridwar (2.71) and Hyderabad (2.2) clusters and CRM will least affect in Pune (2.13) cluster.

Considering size of the industry, we found that e-commerce as system affects all sizes firms most (4.05, 3.90, 3.94,) industry's performance. Whereas as CRM is the least (2.27) effected in large enterprises, APS is the least affected in medium (2.28) and small (2.42) enterprises.

Table 4-9 Systems, Science and Technology affect PSC performance

Science, System and Technology	Not at all	Some what	Moderate	High	Very High	PPS	Rank
E-commerce	4%	27%	30%	36%	3%	61.41%	5
E-business	4%	26%	28%	37%	5%	62.57%	4
Decision support / expert system	1%	5%	17%	56%	22%	78.59%	1
Radio Frequency Identification (RFID)	4%	5%	17%	56%	18%	75.77%	2
Electronic Data Interchange (EDI)	4%	20%	26%	45%	5%	65.23%	3
Bar coding	12%	37%	26%	19%	7%	54.36%	9
Material Requirements Planning (MRP)	8%	40%	22%	26%	5%	55.68%	7
Manufacturing Resources Planning (MRPII)	9%	54%	19%	15%	3%	49.63%	10
Warehouse Management System (WMS)	16%	46%	20%	13%	6%	49.38%	11
Customer Relationships Management (CRM)	14%	57%	15%	11%	2%	46.22%	13
Supplier Relationships Management (SRM)	9%	38%	23%	26%	4%	55.52%	8
Advanced Planning System (APS)	13%	56%	20%	10%	1%	46.14%	14
Just In Time (JIT)	5%	27%	36%	28%	4%	59.83%	6
Theory of Constraints (TOC)	15%	53%	15%	14%	4%	47.88%	12

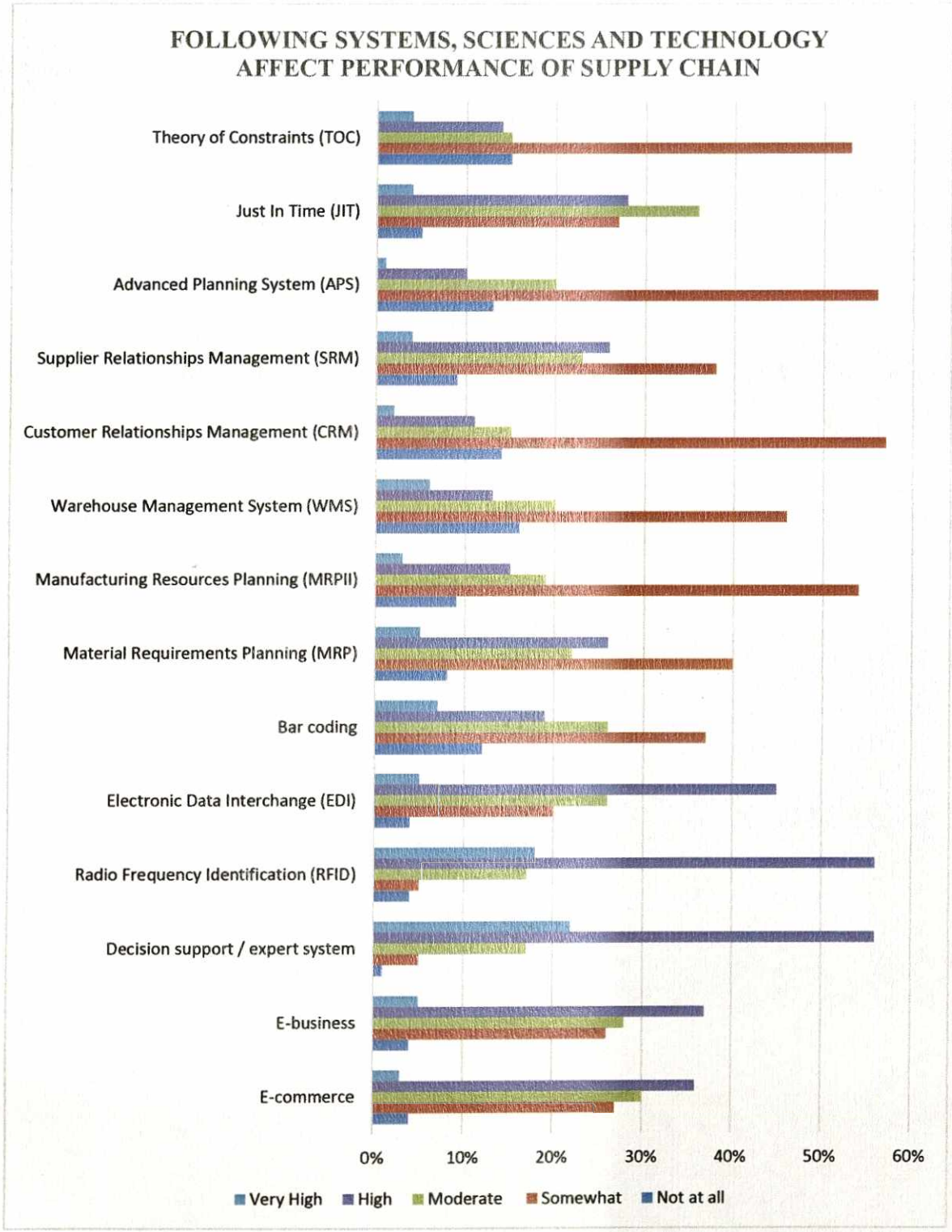


Figure 4-21 Response to "how Systems, Science and Technology affect performance of PSC".

4.3.3 Section III - Performances Indicators

This section deals with the objective of identification key performance indicator for measurement of pharmaceutical supply chain performance. The performance indicators as mentioned in literature review in previous chapters, we have classified in to following mentioned four performance sets.

4.3.3.1 Financial performance

The most common or familiar types of KPI are financial KPIs. By their nature they are quantitative, usually expressed as a number, ratio or percentage. Their quantitative nature often makes them easier to measure as compared to qualitative KPIs. Perhaps most importantly, they represent the Holy Grail of business KPIs because financial benchmarks are universally used as the yardstick of success. Financial KPIs are the heartbeat of any business because they tell owners and stakeholders whether that business is making money, how much the business is spending and how much of the revenue is profit. And considering that the primary purpose of business is usually to make money and grow year on year, then it's easy to see why financial KPIs are considered so important.

The table 4-10 shows the responses in a summaried way that among the profound KPIs in the literature and practices, the operationg profit margin , economic value added (EVA) and revenue groth rate, revenue growth rate and net profit are found most use ful to acceess the finanacial perfomance (please refer fig 4-22).

Table 4-10 Financial KPIs

Financial KPIs	Extremely Unimportant	Unimportant	Some what Important	Important	Extremely Important	PPS	Rank
Net Profit	1%	4%	22%	53%	20%	77.43%	3
Net Profit Margin	5%	34%	34%	21%	6%	57.84%	10
Gross Profit Margin	3%	23%	32%	38%	4%	63.40%	5
Operating Profit Margin	0%	6%	14%	57%	23%	79.50%	1
EBITDA	4%	26%	30%	36%	4%	62.16%	7
Revenue Growth Rate	3%	20%	24%	46%	7%	66.80%	4
Total Shareholder Return (TSR)	8%	37%	27%	25%	3%	55.60%	12
Economic Value Added (EVA)	1%	5%	19%	56%	20%	77.76%	2
Return on Investment (ROI)	11%	37%	25%	21%	7%	55.19%	13
Return on Capital Employed (ROCE)	7%	39%	22%	26%	6%	56.85%	11
Return on Assets (ROA)	7%	53%	18%	15%	6%	51.78%	14
Return on Equity (ROE)	13%	46%	20%	15%	6%	51.04%	15
Debt-to-Equity (D/E) Ratio	12%	58%	16%	11%	3%	47.05%	18
Cash Conversion Cycle (CCC)	14%	54%	16%	12%	4%	47.63%	16
Working Capital Ratio	12%	56%	20%	11%	2%	47.14%	17
Operating Expense Ratio (OER)	3%	28%	26%	37%	6%	62.74%	6
CAPEX to Sales Ratio	3%	32%	31%	29%	5%	59.92%	9
Price Earnings Ratio (P/E Ratio)	4%	28%	34%	29%	4%	60.17%	8

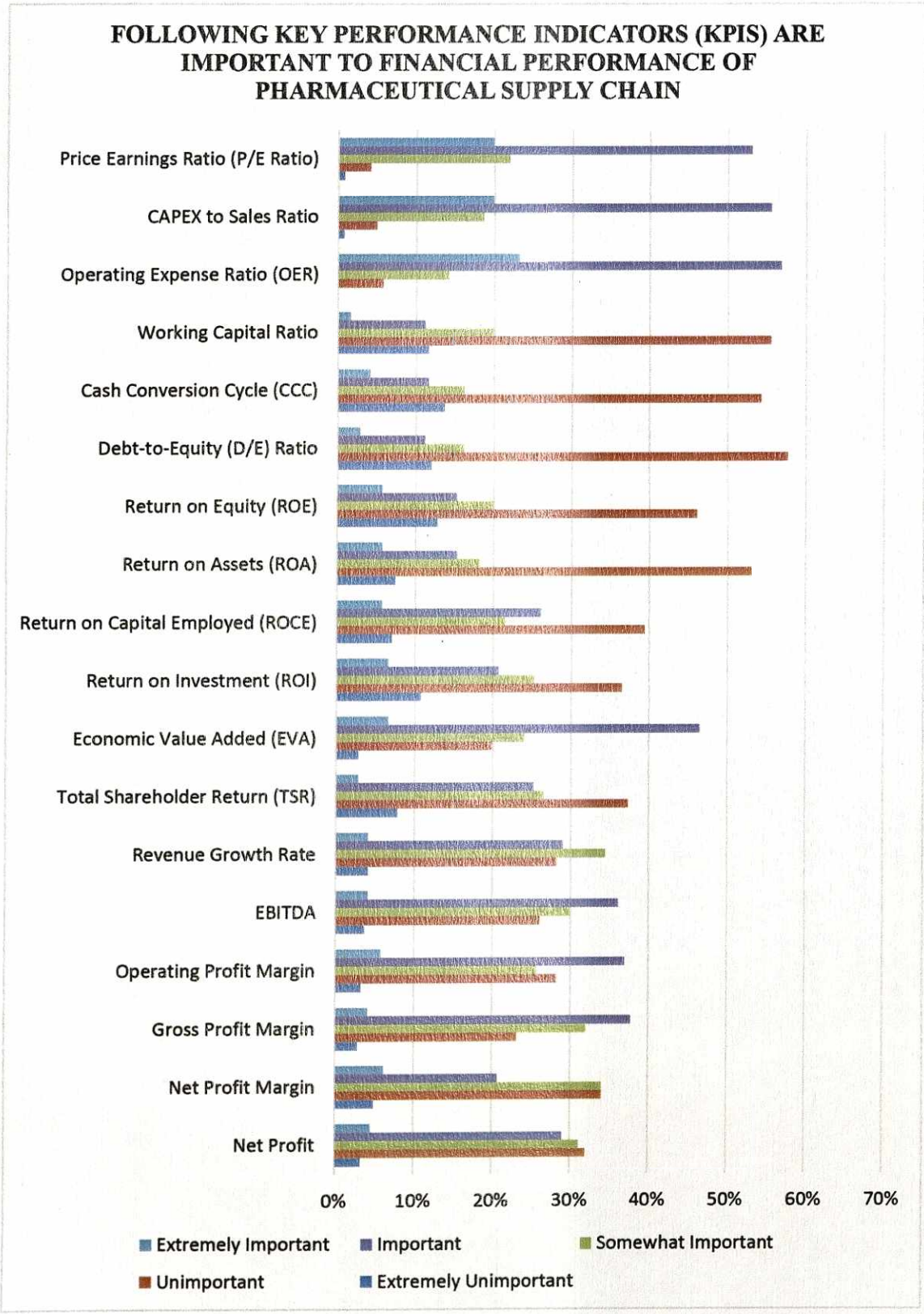


Figure 4-22 Response to "KPIs are important to financial performance of PSC".

4.3.3.2 *Customer related Performance*

There cannot be a business without customers. If we want to grow and prosper moving forward we need to know what our customers think about us and we need to know our market share? The supply chain performance is often customer driven based on perception over delivery of goods or products.

The customers related KPIs are shown in Table 4-11, where respondents ranked Customer profitability score as first with PPS 80.33 %, customer retention rate as second with PPS 79.09% and customer satisfaction index as third with 78.92%. Here we have seen least contribution of customer life time value as key indicator as per the tabulated responses whereas net promoter score and customer complaints are ranked moderately and settles in the middle (please referee fig 4-23).

Table 4-11 Customer related KPIs

	Extremely Unimportant	Unimportant	Somewhat Important	Important	Extremely Important	PPS	Rank
Net Promoter Score (NPS)	1%	2%	21%	56%	20%	78.17%	4
Customer Lifetime Value	2%	15%	32%	39%	12%	69.05%	8
Customer Satisfaction Index	1%	4%	17%	57%	22%	78.92%	3
Customer Profitability Score	0%	3%	18%	53%	26%	80.33%	1
Customer Complaints	2%	7%	20%	59%	13%	75.10%	5
Customer Turnover Rate	2%	14%	31%	41%	12%	69.13%	7
Customer Engagement	3%	11%	31%	45%	10%	69.71%	6
Customer Retention Rate	0%	4%	17%	57%	22%	79.09%	2

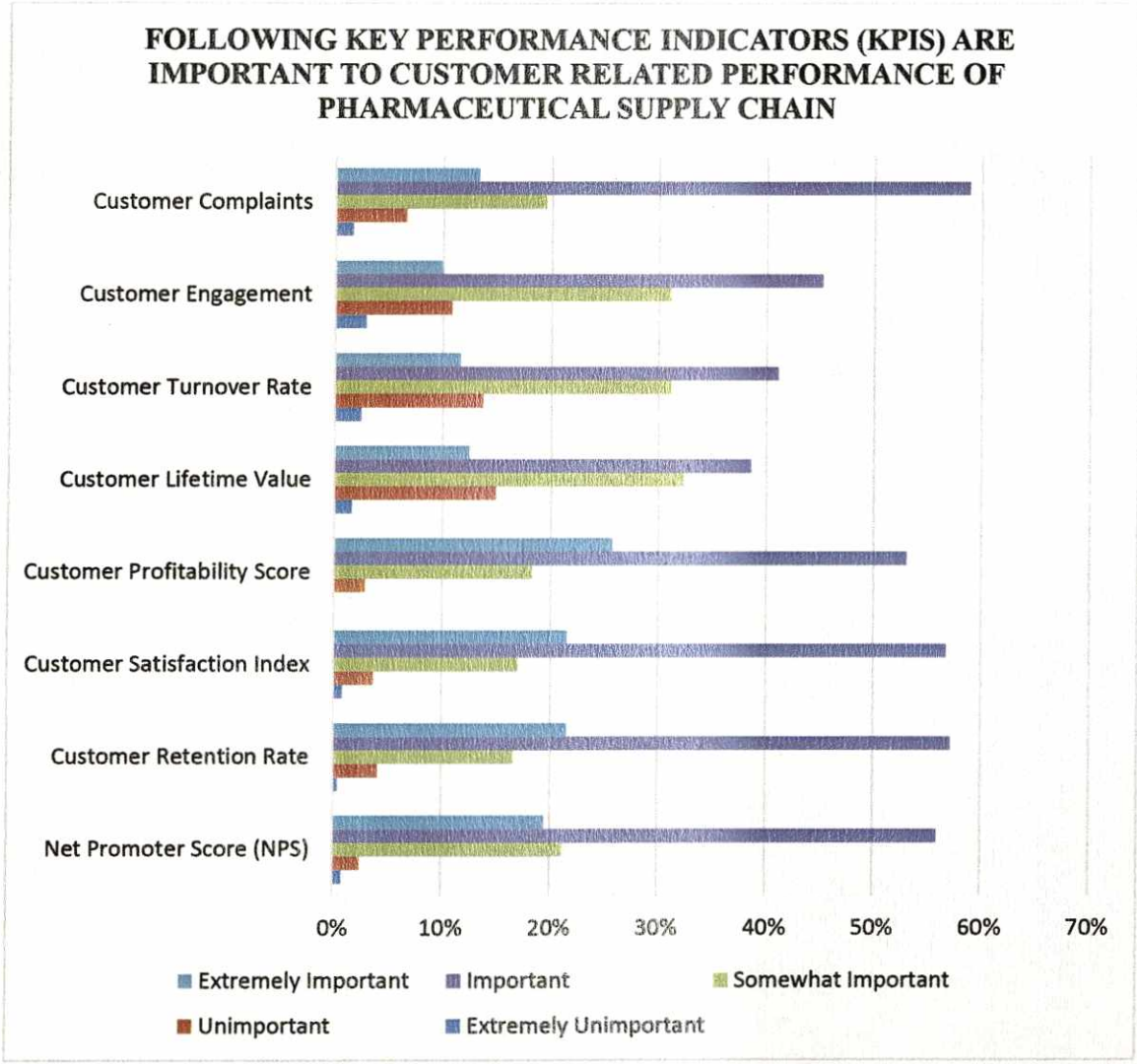


Figure 4-23 Response to "how KPIs are important to customer performance of PSC".

4.3.3.3 Market Performance

Market KPIs are crucial to our business. Financial KPIs are important because they allow you to measure our financial performance. Customer KPIs are important because they allow you to gauge the strength of our customer relationships and whether we are growing our customer base or whether it's remaining stagnant or contracting.

But our performance is also always relative to market. The KPIs detail in this chapter help you to measure market, so you can appreciate where you really stand relative to that market and competition. Table 4-12 shows that market share holds first position in market related KPIs, other details can be seen in table 4-12 and figure 4-24.

Table 4-12 Market Performance KPIs

Market Performance	Extremely Unimportant	Unimportant	Somewhat Important	Important	Extremely Important	PPS	Rank
Market Growth Rate	2%	6%	20%	61%	12%	75.10%	3
Market Share	1%	7%	9%	65%	18%	78.42%	1
Brand Equity	2%	5%	14%	63%	16%	77.26%	2
Cost per Lead	2%	15%	35%	38%	9%	67.14%	11
Conversion Rate	1%	7%	24%	56%	12%	74.19%	6
Search Engine Rankings	2%	8%	25%	47%	17%	73.44%	7
Page Views and Bounce Rate	2%	7%	29%	52%	9%	71.62%	10
Customer Online Engagement Level	1%	7%	25%	52%	15%	74.61%	4
Online Share of Voice	1%	7%	27%	55%	10%	72.86%	8
Social Networking	1%	7%	22%	58%	12%	74.44%	5
Klout Score	1%	11%	27%	51%	10%	71.95%	9

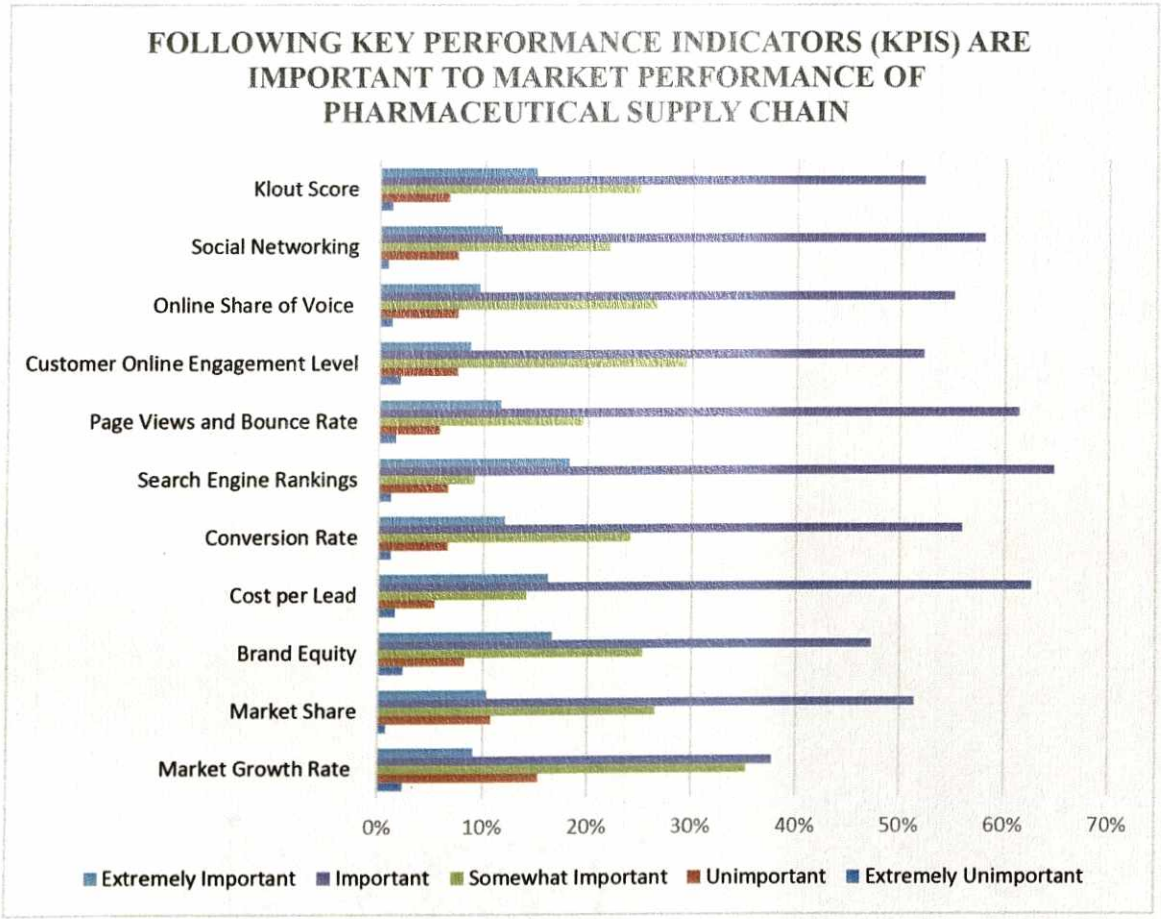


Figure 4-24 Response to "how KPIs are important to Market performance of PSC"

4.3.3.4 *Operational performance*

Operational KPIs seek to get closer and closer to 'real time' measurement, so you can assess what's actually happening in the business on an hourly, daily, weekly and monthly basis. These insights help you to do things better. They offer up important information about where systems, processes or people are falling behind or veering off course so that you can take corrective action quickly, solving the issue before it escalates into a full-blown problem. This real-time performance monitoring is not required for strategic measurement.

Here in table 4-13 we can see that Capacity Utilization Rate (CUR) Process Waste Level Order Fulfillment Cycle Time and inventory shrinkage rate came out as good measure of performance related to operations (please refer figure 4-25).

Table 4-13 Operational Performance KPIs

	Extremely Unimportant	Unimportant	Somewhat Important	Important	Extremely Important	PPS	Rank
Six Sigma Level	1%	10%	24%	54%	12%	73.36%	5
Capacity Utilisation Rate (CUR)	0%	8%	26%	57%	9%	73.42%	4
Process Waste Level	0%	7%	19%	53%	21%	77.34%	1
Order Fulfilment Cycle Time	0%	6%	27%	49%	18%	75.52%	2
Delivery In Full, On Time (DIFOT) Rate	2%	21%	37%	32%	9%	65.15%	7
Inventory Shrinkage Rate (ISR)	1%	8%	25%	54%	12%	73.53%	3
Project Schedule Variance (PSV)	3%	37%	36%	20%	4%	57.26%	13
Project Cost Variance (PCV)	4%	32%	34%	26%	4%	58.51%	12
Earned Value (EV) Metric	5%	37%	33%	19%	5%	56.51%	14
Innovation Pipeline Strength (IPS)	4%	25%	34%	35%	3%	61.66%	9
Return on Innovation Investment (ROI2)	4%	29%	25%	37%	5%	61.99%	8
Time to Market	6%	27%	26%	37%	4%	61.49%	10
First Pass Yield (FPY)	5%	29%	34%	30%	2%	59.25%	11
Rework Level	7%	39%	26%	26%	2%	55.19%	15

Quality Index	2%	21%	26%	45%	6%	66.14%	6
Overall Equipment Effectiveness (OEE)	10%	39%	27%	16%	8%	54.44%	17
Process or Machine Downtime Level	9%	41%	21%	26%	3%	54.77%	16
First Contact Resolution (FCR)	9%	56%	18%	12%	5%	49.46%	18

Hence above analysis identify key performance parameters and indicators to measure the supply chain performance which contributes in development of performance measurement framework as mention in our objective and work as a primary constructs to develop analytical model.

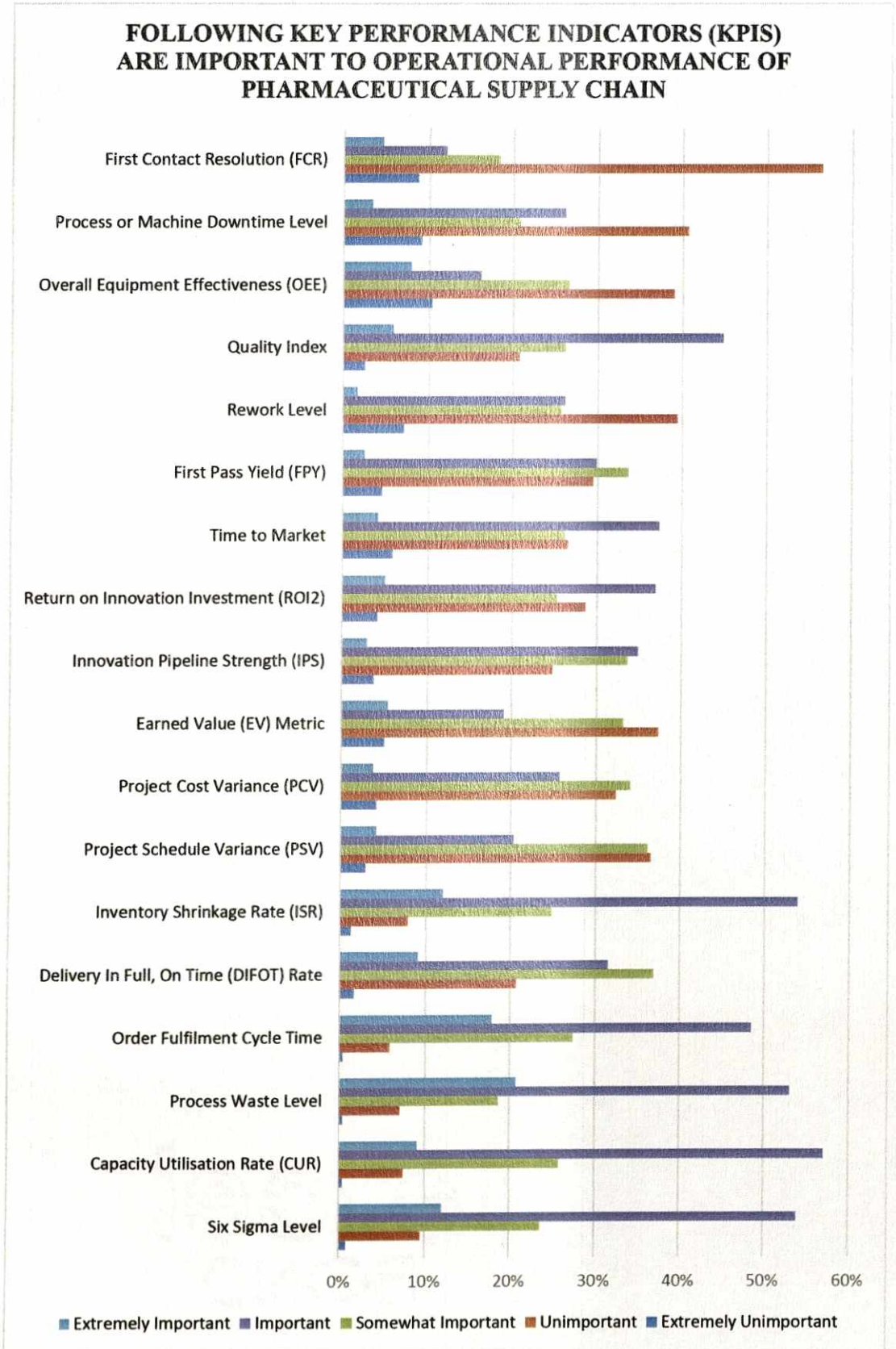


Figure 4-25 Response to "how KPIs are important to operational performance PSC"

4.3.4 Section IV-Quality Production and Technology Integration

This section incorporates the objectives pertaining to quality of medicinal production, supply chain wide integration and need of technology transfer. The responses to assigned questions data has been presented below in tables under this section to draw some inferences after data analysis.

4.3.4.1 Integration affects quality

This questionnaire section has been designed to investigate the quality dimensions affecting quality production of medicine. The amount of supply chain integration has direct affects on various dimensions of the quality of drugs. Here the respondents were asked to rate the integration level with respect to all quality dimensions (performance, features, reliability, conformance, self-life/usability, post sales services, packaging, and perceived quality.)

As we can see in table 4-14 the Perceived Quality got the first rank with the highest PPS 64.17% which draw attention towards Indian perception of medicines production with 49% responds to high level integration. Similarly the features of drugs/ medicine and drug performance also ranked second and third PPS of 62.38% and 62.21% respectively with high level of integration. Indian industry personnel belief post sales services, self-usability, and packaging least affected by the integration of supply chain. Hence it fulfil our intermediate objective of how supply chain integration affects quality of medicine (please refer fig 4-26).

When we analysed data cluster-wise, we found integration affects drug performance most (3.06) and packaging the least (2.55) in Pune. Integration affects perceived quality most (3.35) and post sales services least (2.76) in Hyderabad. Integration affects most (3.39) the features of drugs and packaging least (2.71) in Haridwar.

Similarly, in industry wise analysis, we found integration level affects perceived quality dimension most in all small (3.19), medium (3.26) and large (3.12) enterprises and packaging affect least in small (2.56), medium (2.65) and large (2.48) enterprises.

Table 4-14 Supply chain integration affects the Quality Dimensions

S No.	Integration level	Some	Moderate	Full	PPS	Rank
1	Drug performance	27%	37%	36%	62.21%	3
2	Features of drug/ medicine	31%	29%	41%	62.38%	2
3	Reliability of drug/ medicine	31%	28%	40%	61.87%	4
4	Conformance to action requirement	31%	37%	31%	59.40%	5

5	Self-life/usability	49%	23%	28%	54.81%	7
6	Post sales services	48%	23%	29%	55.23%	6
7	Packaging	41%	27%	23%	52.68%	8
8	Perceived quality	26%	25%	49%	64.17%	1

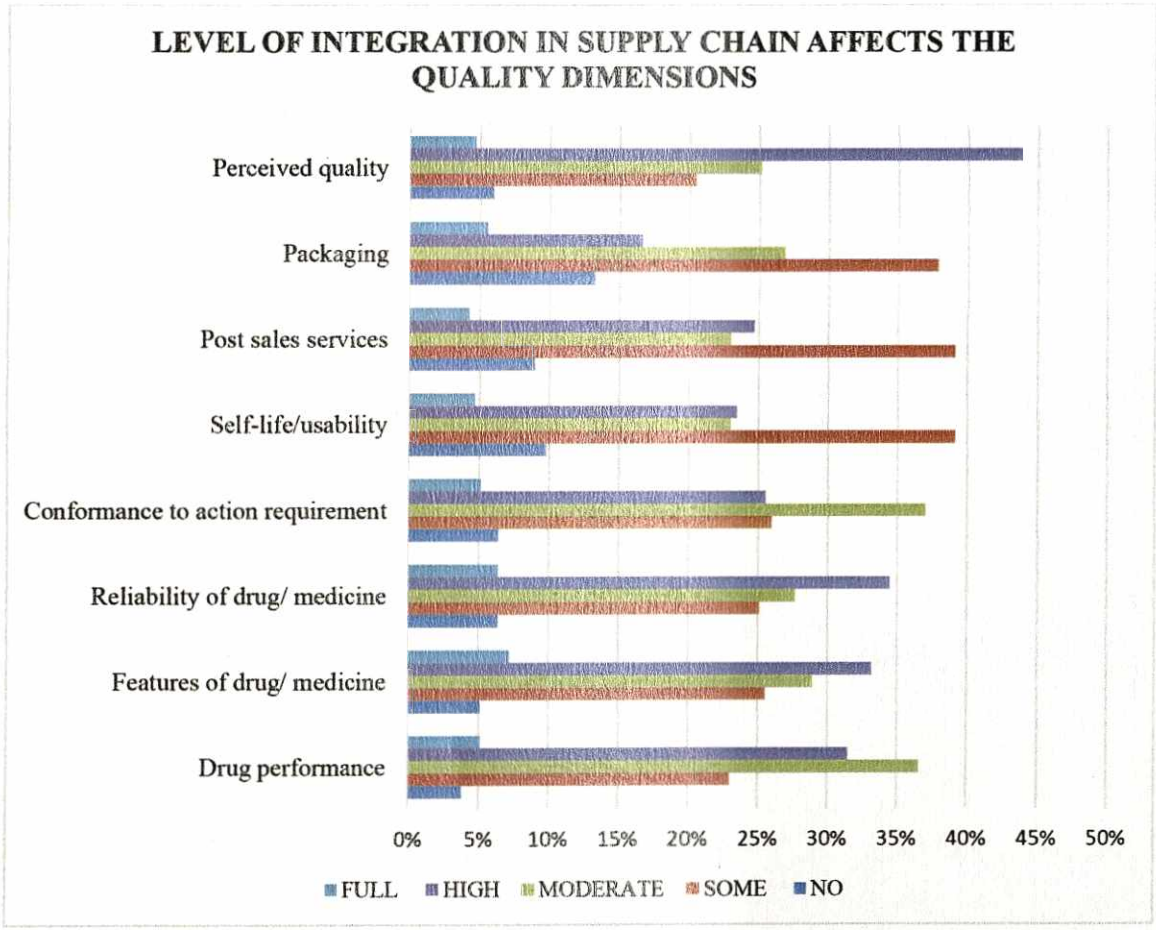


Figure 4-26 Response to "How supply chain affects the Quality Dimensions?"

4.3.4.2 Need of Technology transfer

There is a strong need of technology transfer in various value chain segments in pharma industry. The respondents were asked to rate the need of technology transfer from foreign organisation. The table 4-15 summarises that distribution dimension has got the highest preference with PPS (79.83%) among pharma value chain segments and followed by packaging and manufacturing with PPS 78.84% and 78.67% respectively. Indian pharmaceutical producers are in great need of technological up gradations in distribution, packaging, and manufacturing as we are in generics manufacturing. Although warehousing

and inventory show low responses, so these dimensions also require to be upgraded (please refer figure 4-27).

When we analysed data cluster-wise, we found that technology transfer is affecting R&D most (3.75) and inventory management least (3.15) in Haridwar. Distribution most (4.11) and inventory management least (3.51) in Hyderabad. Packaging most (4.08) and warehousing least (3.44) in Pune cluster. Large industries needed technology transfer most (3.97) in packaging and least (3.32) in inventory management. Medium industries needed technology transfer most (4.02) in distribution and least (3.42) in warehousing. Small industries needed technology transfer most (3.73) in clinical trial and least (3.26) in inventory management.

Table 4-15 Need of technology transfer from foreign organisation

Pharma value chain segments	Not needed	May be needed	Somewhat needed	Needed	Highly Needed	PPS	Rank
R and D	1%	3%	20%	56%	20%	78.34%	4
Clinical trails	1%	2%	19%	60%	17%	77.93%	5
Manufacturing	1%	4%	16%	58%	21%	78.67%	3
Packaging	3%	3%	13%	57%	23%	78.84%	2
Distribution	1%	3%	17%	53%	26%	79.83%	1
Warehousing	3%	15%	31%	41%	11%	68.55%	9
Inventory Management	3%	12%	32%	43%	10%	68.63%	8
Reverse Logistics	3%	10%	29%	46%	11%	70.21%	7
CRM	3%	7%	22%	57%	11%	73.44%	6

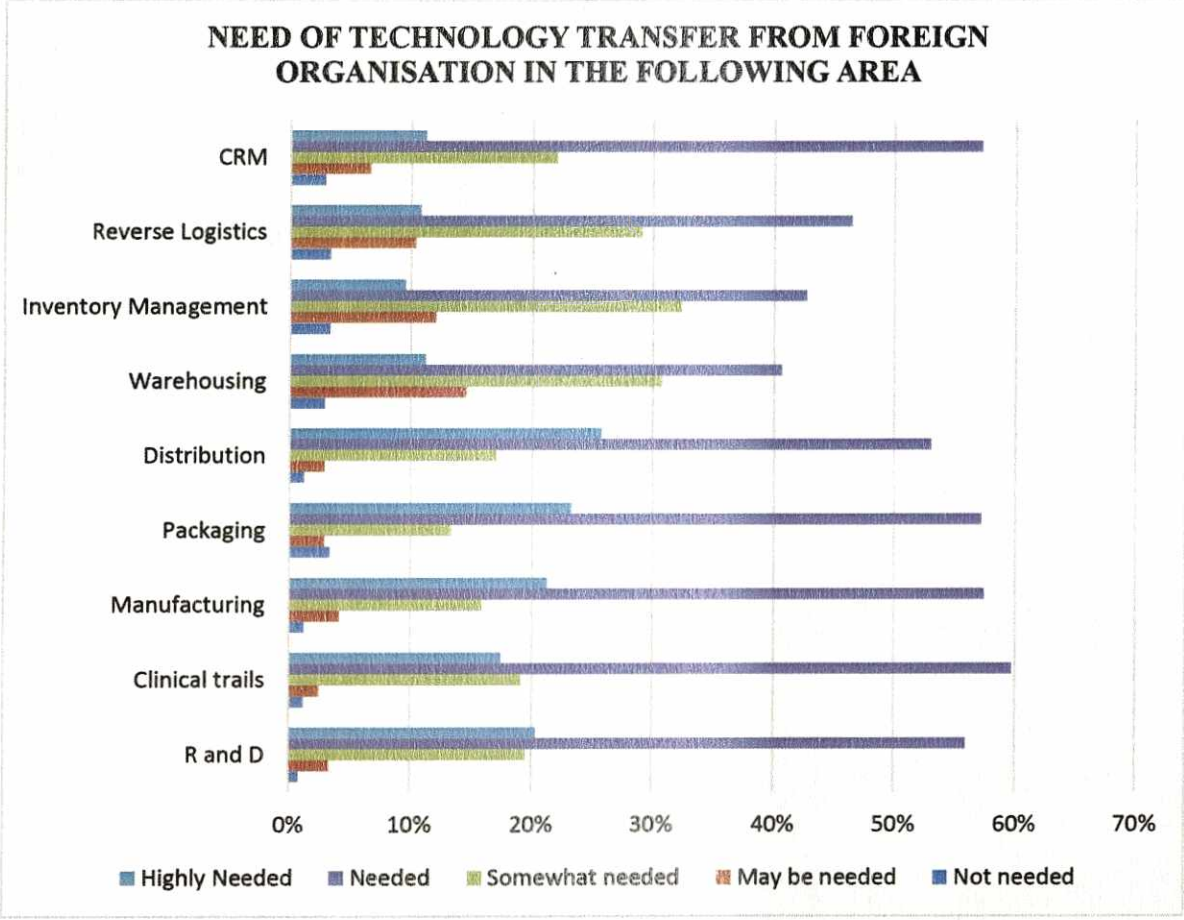


Figure 4-27 Response to "How technology transfer from foreign organisation?"

4.4 Chapter summary

This chapter summarises data analysis on; demographic profile of respondents, R & D related analysis on secondary data, supply chain practices, R&D factors, barriers ,system ,science and technology intervention ,KPIs, quality dimensions , and need of technology transfer .

CHAPTER 5. DEVELOPMENT OF MEASUREMENT MODEL

5.1 Introduction

SEM is a combination of factor analysis and multiple regression. It also goes by the aliases "causal modelling" and "analysis of covariance structure". Special cases of SEM include confirmatory factor analysis and path analysis. The variables in SEM are measured (observed, manifest) variables (indicators) and factors (latent variables). The factors are weighted as linear combinations that we have created/invented.

Even though no variables may have been manipulated, variables and factors in SEM may be classified as "independent variables" or "dependent variables." Such classification is made on the basis of a theoretical causal model, formal or informal. The causal model is presented in a diagram where the names of measured variables are within rectangles and the names of factors in ellipses. Rectangles and ellipses are connected with lines having an arrowhead on one (unidirectional causation) or two (no specification of direction of causality) ends.

Dependent variables are those which have one-way arrows pointing to them and independent variables are those which do not. Dependent variables have residuals (are not perfectly related to the other variables in the model) indicated by e's (errors) pointing to measured variables and d's pointing to latent variables.

The SEM can be divided into two parts. The measurement model is the part which relates measured variables to latent variables. The structural model is the part that relates latent variables to one another.

Statistically, the model is evaluated by comparing two variance/covariance matrices. From the data a sample variance/covariance matrix is calculated. From this matrix and the model an estimated population variance/covariance matrix is computed. If the estimated population variance/covariance matrix is very similar to the known sample variance/covariance matrix, then the model is said to fit the data well. A Chi-square statistic is computed to test the null hypothesis that the model does fit the data well. There are also numerous goodness of fit estimators designed to estimate how well the model fits the data.

5.2 Identification of the Structural Model.

This portion of the model may be identified if none of the latent dependent variables predicts another latent dependent variable. When a latent dependent variable does predict another latent dependent variable, the relationship is recursive, and the disturbances are not correlated. A relationship is recursive if the causal relationship is unidirectional (one line pointing from the one latent variable to the other). In a no recursive relationship there are two lines between a pair of variables, one pointing from A to B and the other from B to A. Correlated disturbances are indicated by being connected with a single line with arrowhead on each end. If the model is not identified, the SEM program will throw an error and then you must tinker with the model until it is identified. Some iteration and deletion of lower loading values would enhance the model.

5.2.1 Estimation

The analysis uses an iterative procedure to minimize the differences between the sample variance/covariance matrix and the estimated population variance matrix. Maximum Likelihood (ML) estimation is that most frequently employed. We have used IBM SPSS 21 for preparing and testing our model.

5.2.2 Model Fit

With large sample sizes, the Chi-square testing the null that the model fits the data well may be significant even when the fit is good. Accordingly there has been great interest in developing estimates of fit that do not rely on tests of significance. In fact, there has been so much interest that there are dozens of such indices of fit (please see table 5-3).

5.3 Model Fit Summary

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	87	986.902	318	.000	3.103
Saturated model	405	.000	0		
Independence model	54	5000.652	351	.000	14.247

5.4 Reliability Statistics

Table 5-1 Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	No. of Items
0.941	0.942	27

5.5 SEM Results

The model analyzes the relationships between a set of observed variables and a predetermined number of latent variables. The response data were tested for multivariate normality. It was found that the multivariate normality assumption was not violated. Therefore, maximum likelihood estimation was used for the second-order confirmatory SEM analysis (Nusair and Hua, 2010). The data were analyzed using the statistical package AMOS 21. The reliability (please see table 5-1), validity, and the overall model fit were tested and are discussed below (please see table 5-2, figure 5-1 and figure 5-2).

Table 5-2 Second order confirmatory structural equation modelling analysis results

Construct	**Measure**	**Standardised loading**	**Overall relative weights (SEM-weights)**
Operational performance	Operational KPIs	**.812**	
	Process waste level	.827	0.672
	Order fulfilment cycle time	.860	0.698
	Inventory shrinkage rate	.870	0.706
	Return on innovation investment	.791	0.642
	Quality index	.733	0.595
	capacity utilisation rate	.707	0.574
	Time to market	.516	0.419
Market performance	Market KPIs	**.724**	
	Market share	.858	0.621
	Brand Equity	.787	0.570
	Market growth rate	.857	0.620
	Customer online engagement level	.783	0.567
	Social networking	.794	0.575
	Customer conversion rate	.814	0.589
Financial Performance	Financial KPIs	**.756**	
	Net profit	.763	0.577
	Operating profit margin	.813	0.615
	Revenue growth rate	.764	0.578
	Economic value added	.793	0.600
	Return on investments	.664	0.502

	Return on equity	.699	0.528
	Operating expense Ratio	.534	0.404
	Capex to sales ratio	.709	0.536
Customer performance	Customer KPIs	.572	
	Net promoter score	.834	0.477
	Customer retention rate	.775	0.443
	Customer satisfaction index	.815	0.466
	Customer profitability score	.842	0.482
	Customer complaints	.813	0.465
	Customer engagement	.692	0.360

Construct validity is the extent to which a scale, or a set of measures, accurately represents the concept of interest.

Table 5-3 Summary of model fit indices for second order confirmatory SEM analysis

Model	**Chi-square**	**Degree of freedom(df)**	**Df/chi square**	**RMSEA**	**GFI**	**CFI**
Second order Model	986	318	.322	.094	.842	.856
Suggested value			*<2*	*<0.10*	As good as near to 1	*>0.9*

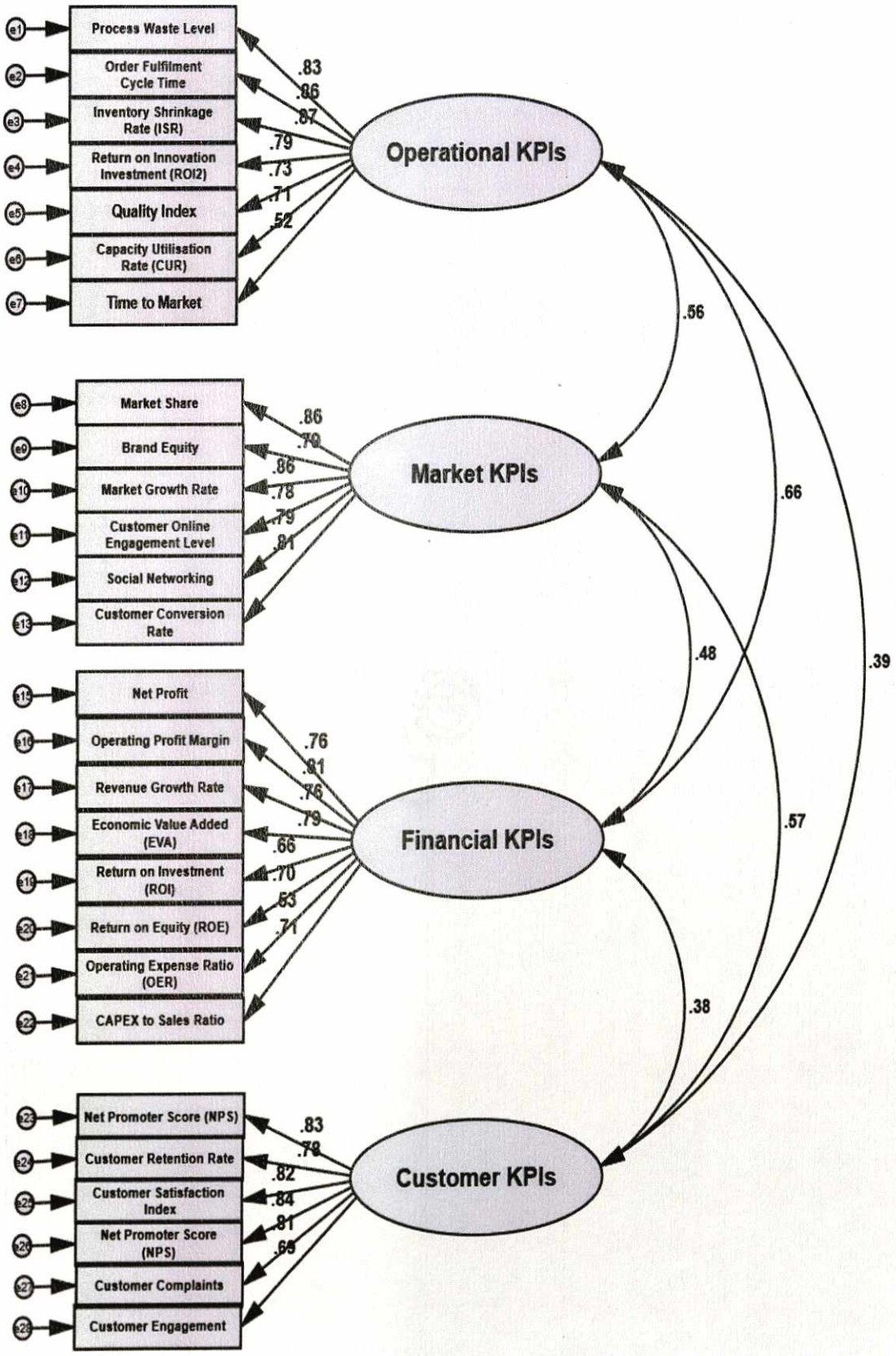


Figure 5-1 Measurement Model for Pharma Supply Chain Performance Measurement

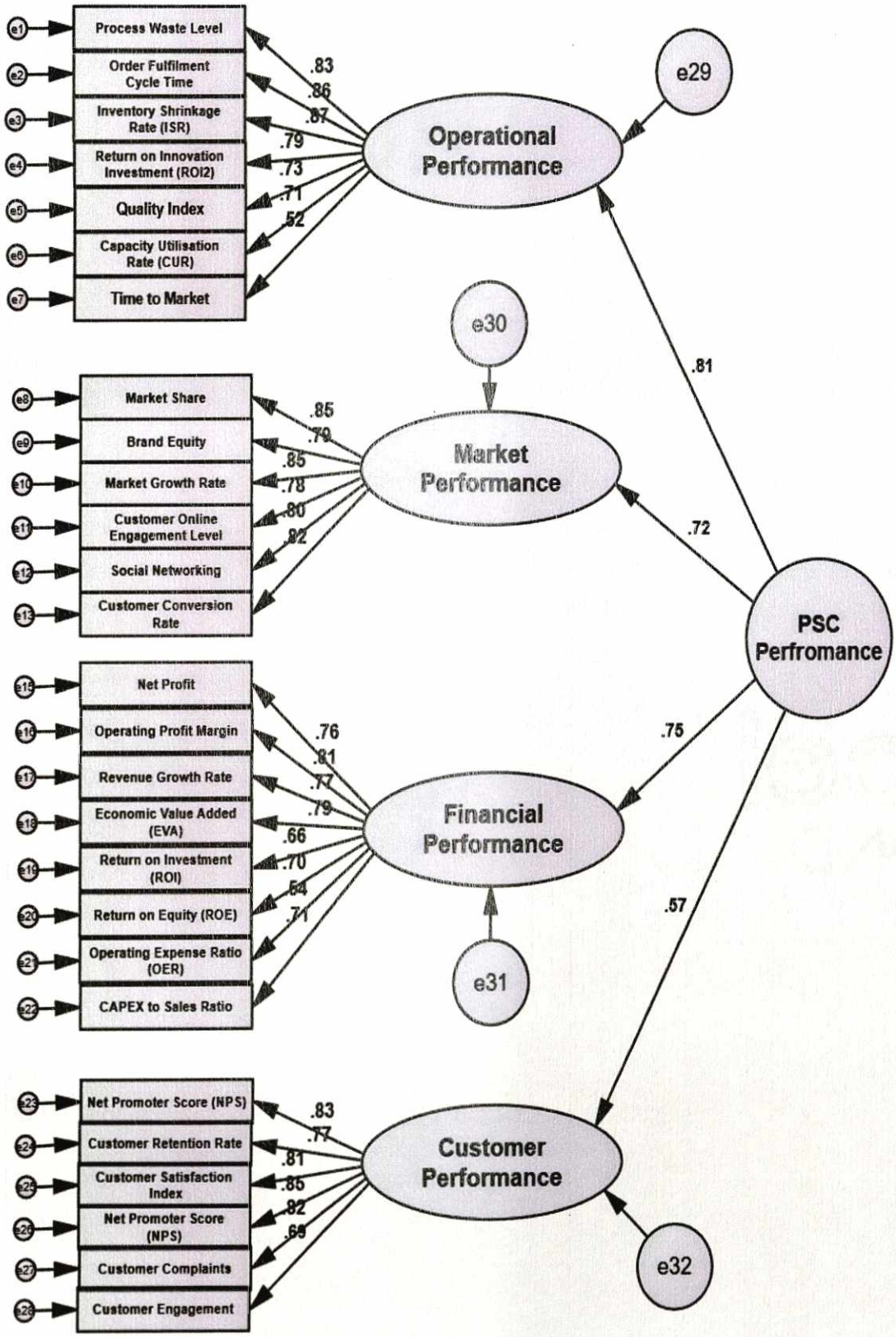


Figure 5-2 Structured Model for Pharmaceutical supply chain performance Measurement

5.6 Convergent Reliability

There are two types of validities: convergent and discriminant. Convergent validity assesses the degree to which dimensional measures of the same concept are correlated. The average variance extracted (AVE) is used to assess convergent validity. A higher AVE value implies that the indicators are truly representative of the latent construct. Table 5-4 shows that the AVE values ranged from 0.63 to 0.52, and exceeded the threshold value of 0.50.

Table 5-4 Convergent validity and AVE

Convergent Validity	Composite Reliability CR	Average Variance Extracted AVE
Customer Performance	0.912	0.635
Operational Performance	0.907	0.587
Market Performance	0.923	0.666
Financial Performance	0.896	0.522

CR: sum all factor loadings, square this sum (call this SSI); sum all error variances of each indicator (call this SEV); comp rel. = SSI/(SSI+SEV)

AVE: sum up each squared factor loading, divide it by the number of indicators

5.7 Discriminant Validity

Discriminant validity is the degree to which conceptually similar concepts are distinct (please see table 5-5). To ensure discriminant validity, the AVE for each construct must be greater than the squared correlations between the construct and all other constructs in the model (Nusair & Hua, 2010). The AVE for each construct was found to be significantly higher than the calculated squared correlations between the construct and all other constructs.

Table 5-5 Discriminant validity

Discriminant validity	Customer Performance	Operational Performance	Market Performance	Financial Performance
Customer Performance	**0.797**			
Operational Performance	0.392	**0.766**		
Market Performance	0.569	0.560	**0.816**	
Financial Performance	0.385	0.665	0.475	**0.722**

5.8 Chapter summery

This chapter explained the development and testing of SCM performance assessment model, hence fulfil our desired goal to develop and implementation framework for supply chain performance measurement. The model has been found reliable and industry may assess the performance of pharmaceuticals industry. Industry may adopt such model or develop in a similar way as per their capabilities. The next chapter deals with conclusion and provides recommendations.

CHAPTER 6. CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This chapter summarizes inferences came out from the entire study. The results and observations from each section of the designed questionnaire have been listed below. Later this chapter also contributes suggestions and recommendations.

6.2 Conclusions

The Indian pharma industry has come a long way and made significant progress in infrastructure development and technical and R&D capabilities. This study found enough response to draw some valuable conclusions. With the integration of the Indian pharma market with the global market, new issues are being faced and tackled by the industry.

With numerous strengths and a growing consumer class, the pharma industry in India may face certain legacy and new issues, but it is expected to grow multi fold and continue to be an attractive investment destination.

Our study has been conducted in three major pharmaceutical clusters of India. We found major contribution from medium (81%) and large (13%) enterprises. The Indian pharmaceutical industry is having larger contribution medium sized enterprises as key area to focus upon. The more than half of the responses came from Mumbai and Pune region which shows favourable for industry and growth potential. Northern region like Haridwar; industry is struggling with infrastructure and lack of operational support from government policy.

The prominent gender found as respondents are males (92%) , at higher levels, shows typical Indian industrial scenario which lacks women leadership. The major respondents (around 80 %) are graduate and higher qualifications which show well qualified employee status of the industry.

Most of the Information collected through personal interviews with middle and higher level management holding key positions likes, CEOs, GM or operations mangers which is about 77% of the response collected. This justifies the authenticity of information with reliability and can be considered to frame policies and some future actions.

Human resource in industry found very mature as majority of respondents aged around 35 years which shows experienced intellectual base. The industry age is around 11-15 years as we can see last decade shows promising growth of the industry with rising numbers of MSMEs in India. The age and size of the organisations found sound, with presence of medium size (81%) of enterprises, which shows they are growing successfully.

Although SMEs are struggling with basic infrastructure problems and lack of technology adoptions .Still some old challenges such as IPR and pricing continue to be contentious issues in the market. As we can see the trends of increased foreign interest in the markets and increased investments in R&D are expected to stay and could improves performance of industry.

Indian pharma is based on outsourcing and holding the key strengths to make their business profitable. The survey portrays the trends in R&D outsourcing with large companies; which are trying to hold the R&D facility within premise.

While global pharma MNCs are well advanced in terms of innovative R&D, technology partnerships, open innovation and crowd sourcing, domestic Indian players are yet to follow the race. However, this type of technological innovation is yet to take shape in India, as Indian companies are not investing in R&D due to lack of adequate required capital. There are no companies in India which have already come up or are planning to install full-fledged virtual R&D centres due to the lack of technology and other funding requirements in India. The reactive nature of Indian pharma industry might act as a barrier to run in the global race where innovation tends to be the major factor to differentiate one pharma major from the other, so India needs to focus majorly up on promoting innovation.

6.3 Recommendations

R1. To compete globally, world class infrastructures and facilities are necessary. The pharmaceutical industry should invest in the development of adequate infrastructure.

R2. The Government policy should allow and promote foreign investment into the Indian pharma sector which has to play a balancing act between meeting the needs of the people and the capital needs of the industry.

R3. In the pharma context such increased investments should be accompanied with technology sharing, increased production and increased employment generation.

R4. The industry should address problems of cost and availability of essential medicines.

R5. The lack of innovation in drugs for more prevalent diseases should be addressed.

R6. The security of information could reduce counterfeit and improve quality production, so information security should be practiced throughout the supply chain.

R7. Information technology should be used as strategic tool to improve forecasting accuracy which will reduce bull whip effect and demand fluctuations.

R8. To overcome financial barriers, like lack of funds for PMS, industry should revise financial management practices to accommodate such funds to gain competitive advantage.

R9. To overcome market barriers, the policy should hold provisions to support the needs of small and medium enterprises.

R10. To overcome supply and supplier barriers, relationship among supplier should be transparent. They must share information and resources to enhance productivity.

R11. The supply chain complicacies arise due to varied demands, high quality production standards, which should be addressed through robust network design.

R12. Industry should develop their own contingent power needs, as there is a low power supply situation in some areas.

R13. Due to short shelf life, medicines and drugs needs immediate dispatching, industry should adopt just in time (JIT) system in order to reduce inventory levels.

R14. Pharmaceutical industry should also start focusing on improving customer service levels and trust building.

R15. Pharmaceutical industry should implement ERP, so that, the information is available to all SKUs.

R16. New product development capability should be strategically adopted in pharmaceutical policy for medium type enterprises.

R17. Need to develop effective performance framework for pharmaceutical supply chain considering contingent situation.

R18. The Indian pharmaceutical industry, with government support should develop a single window licensing system for centralized clearances and approvals.

R19. Firms should take initiatives to implement performance management systems with supply chain wide integration to gain future benefits and position among competitors.

R20. Firms should develop PMS for benchmarking their performance or adopt it from some other organizations with similar operational and cultural capabilities.

R21. The Indian pharmaceutical industry needs supply chain wide integration, restructuring with support of technology transfer and adoption of world class practices to compete globally.

CHAPTER 7. LIMITATIONS AND FUTURE WORK

7.1 Introduction

Primary reasons to revamp a pharma supply chain in India can be outlined as a shifting global trend towards in-life licensing, continuous manufacturing and value based pricing. There is a huge potential left in terms of 'innovation' in which the aforementioned three parameters play a vital role.

7.2 Research Limitation

The study was done in state of Andhra Pradesh, Maharashtra and Uttrakand. Pharmaceutical supply chain consists of several players like, raw material suppliers, manufacturers, distributors, and retailers. This study has been performed only on manufacturers. The other players have not been considered. A nationwide and study on all the players may give different results. This is a cross-sectional study; a longitudinal study may give better results.

Further research is required to ascertain whether the same practice is evident across organisation of different size, culture and groups.

For the successful implementation of performance management system in a company, it is necessary to concentrate on all aspects of performance management including non-financial measures, behavioural aspects, top management commitment, and supplier relationships.

This study provides basic structured questionnaire approach to capture the inferences. Further details design of broader study which could incorporate detailed interview and qualitative approach or case based studies can be taken up.

Consequently this study provides many interesting and novel insight, there is urgent need for follow-up studies, which employ alternative techniques, targets, different set of profiles of industry to access the performance for improvement and betterment of the industry.

7.3 Future of Indian Pharmaceutical

Indian pharma companies are yet to bring innovative R&D, patient management & assistance programmes which need to be integrated into the supply chain. This industry is also dependent on the high volume segment (generic drugs). Indian pharma industry is currently in a nascent stage in terms of technological innovation and new advancements such as open

innovation, crowd sourcing, etc. The socio-economic conditions in India are driving the patient segment towards low cost drugs. Hence, generics segment in India is growing at a faster rate as compared to patented drugs. Though, global pharma companies are innovative in terms of technology, open innovation, crowd sourcing, in-licensing etc., Indian pharma companies are yet to follow the global race.

Indian pharma segment has an intensive patient pool with varying genotypes as compared to developed regions. Global pharma MNCs can leverage the patient pool for conducting their clinical trials in India. This will provide opportunities for increased partnerships (which leads to increased R&D trials) of global pharma MNCs with domestic CROs. A shift in the industry trend from high volume to high value can be (Roethlein & Ackerson, 2004) expected if pharma MNCs focus to drive to increase their R & D expenditure. This will increase vertical integration in terms of increased partnerships from raw material manufacturers (APIs, excipients and other chemicals – back ward integration) to pharma distribution companies (forward integration) in the overall pharma supply chain.

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

DEPARTMENT OF MANAGEMENT STUDIES

IIT Roorkee

Dear Sir/Madam,

This questionnaire is for Department of Science and Technology (DST), Government of India sponsored Project titled **"Supply Chain Performance Evaluation: Study of Select Pharmaceutical Industry"** being implemented by Department of Management Studies at Indian Institute of Technology Roorkee. Kindly spare your valuable time in filling up the questionnaire.

GUIDELINES FOR RESPONDENTS

This questionnaire has four sections.
It would take approximately 20 minutes to fill up.
All the questions must be answered.

Your identity as well as responses will not be reviled to any one at any point of time.
Kindly send filled in questionnaire in enclosed return envelope:

For any query please contact:

Dr. M. K. Barua
Principle Investigator
Department of Management Studies
Indian Institute of Technology Roorkee
247667, Uttarakhand.
E-Mail: barua71@gmail.com
Phone: (O) 01332285678

SECTION –I

Note: Please tick (✓) appropriate option

1. Name of the Organization:

.....

2. Gender of the respondent Male ☐ Female ☐

3. Education qualification :

Diploma	Graduate	Post Graduate	PhD or equivalent	Any other .....

4. Your position in organization :

Lower level management	Middle level management	Senior level management

5. Age in years :

Less than 25	25-30	31-35	36-40	Above 40

6. Experience in year :

Less than 5	5-10	11-15	16-20	Above 20

7. How old your organization (Years):

≤5	≤10	≤15	≤20	≥ 20

8. No. of employee :

≤100	≤200	≤500	≤1000	≥ 1000

9. Your organization turnover is (Rs):

≤10 Crores	≤20 Crores	≤30 Crores	≤50 Crores	≥ 50 Crores

10. Is Your Organization Listed in Share Market? Yes ☐ No ☐

11. Manufacturing Plants in: One State ☐ More than One State ☐

12. Sale of Products in: Domestic Market ☐ International Market ☐ Both ☐

13. Your industry belongs to:

Type of Enterprise	Tick here
Micro	
Small	
Medium	
Heavy	

14. Do you have separate

a. Operations and Production Department: Yes/No
b. Supply Chain Department: Yes/No
c. Logistics Department: Yes/No
d. R &D Department: Yes /No

15. What is your R&D investment during last three years?

Financial year	R & D Expenditure (in Lacs)	Remarks
2011-12		
2012-13		
2013-14		

SECTION –II

1. **To what level do you apply following practices in your organisation?**

(Please rate all the SCM *Practices* Given below.)	**Lowest level (1)**	**Low level (2)**	**Moderate level (3)**	**High level (4)**	**Highest level (5)**
Close partnership with suppliers					
Close partnership with customers					
JIT supply					
e-Procurement					
EDI					
Outsourcing					
Subcontracting					
3PL					
Plan strategically					
Supply Chain Benchmarking					
Vertical Integration					
Few suppliers					
Many suppliers					
Holding safety stock					
Use of external consultants					
TQM					
Quality Purchasing					
Inbound Inspection					
Quality Certification					
Ware House Safety					
Benchmarking					
Continuous Improvement Tools					
Lean Certification					
Communication Standard					
Use of Operational manuals					
Preventive Maintenance					
ERP Integration					
Team Work					
Any other Practices 1.					
2.					

2. **Do you feel following R&D related factors affect supply chain performance?**

(Please rate all R&D related *factors*)	**Not at all (1)**	**Somewhat (2)**	**Moderate (3)**	**High (4)**	**Very High (5)**
R&D within the company					
R&D outsourced to other companies:					
R&D outsourced to higher education institutions or public research organisations					
Purchase or licensing of intellectual property rights (patents, copyrights and designs) as well as know-how					
Acquisition of new or highly improved machinery, equipment and software:					
Training to support innovative activities					
Market research, launch advertising, and related marketing activities for new product introduction					

3. **Do you feel following Barriers affect supply chain performance?**

(Please rate all the *barriers*)	Not at all (1)	Somewhat (2)	Moderate (3)	High (4)	Very High (5)
Inefficient Information system					
Disparity in trading partner's capability					
Lack of fund for Performance Measurement System (PMS) implementation					
Lack of commitment by top management					
Unawareness about PMS in supply chain					
Lack of strategic planning					
Reluctance of support of dealers, distributors etc.					
Lack of reach and service					
Rising working capital constrains					
Rise in Bullwhip Effect					
Diversion of sales force focus					
Higher inventory caring cost					
Lack of motivation					
Global trade management					
Stringent Supply Chain Collaboration					
Need of service as complementary to product					
Guaranteed compliance					
Co-development of new substance/product					
Poor operations planning					
Inefficient supply network					
Changing patient target group					
Expanding regulations					
No implementation of supply chain wide PMS					
Dispersed IT infrastructure					
Non-availability of performance metrics					
Improper training of employees					
Corporate Culture					
Motivation for change/Support for Measurement					
Any other Barriers 1.					
2.					
3					

4. **Do you feel Science &Technology intervention affects following drivers?**

(Please rate all the *drivers*)	Not at all (1)	Somewhat (2)	Moderate (3)	High (4)	Very High (5)
Inventory					
Information					
Transportation					
Purchasing /Sourcing					
Pricing					
Facilities /Warehousing					
Flexibility					
Any other Drivers					

1.					
2.					

5. Do you feel following Systems, Science and Technology affect performance of supply chain?

	Not at all (1)	Somewhat (2)	Moderate (3)	High (4)	Very High s (5)
E-commerce					
E-business					
Decision support / expert system					
Radio Frequency Identification (RFID)					
Electronic Data Interchange (EDI)					
Bar coding					
Material Requirements Planning (MRP)					
Manufacturing Resources Planning (MRPII)					
Warehouse Management System (WMS)					
Customer Relationships Management (CRM)					
Supplier Relationships Management (SRM)					
Advanced Planning System (APS)					
Just In Time (JIT)					
Theory of Constraints (TOC)					
Any other System, Science & Technology:					
1.					
2.					
3.					

SECTION -III

Following are the measures of supply chain performance related to pharmaceutical. How important are these for your organization? Please indicate your opinion on the following statements.

1. How following Key Performance Indicators (KPIs) are important to financial performance of pharmaceutical supply chain? (1=EUI=Extremely Unimportant, 2=UI=Unimportant, 3=SI=Somewhat Important, 4=I=Important, 5=EI=Extremely Important).

Please rate following *financial* performance indicators	Extremely Unimportant (1)	Unimportant (2)	Somewhat Important (3)	Important (4)	Extremely Important (5)
Net Profit					
Net Profit Margin					
Gross Profit Margin					
Operating Profit Margin					
EBITDA					
Revenue Growth Rate					
Total Shareholder Return (TSR)					
Economic Value Added (EVA)					
Return on Investment (ROI)					
Return on Capital Employed (ROCE)					
Return on Assets (ROA)					
Return on Equity (ROE)					
Debt-to-Equity (D/E) Ratio					
Cash Conversion Cycle (CCC)					
Working Capital Ratio					
Operating Expense Ratio (OER)					
CAPEX to Sales Ratio					
Price Earnings Ratio (P/E Ratio)					

2. How following Key Performance Indicators (KPIs) are important to Customer related Performance of pharmaceutical supply chain? (1=EUI=Extremely Unimportant, 2=UI=Unimportant, 3=SI=Somewhat Important, 4=I=Important, 5=EI=Extremely Important).

Please rate following *customers* related performance indicators	Extremely Unimportant (1)	Unimportant (2)	Somewhat Important (3)	Important (4)	Extremely Important (5)
Net Promoter Score (NPS)					
Customer Retention Rate					
Customer Satisfaction Index					

Customer Profitability Score					
Customer Lifetime Value					
Customer Turnover Rate					
Customer Engagement					
Customer Complaints					

3. How following Key Performance Indicators (KPIs) are important to Market Performance of pharmaceutical supply chain? (1=EUI=Extremely Unimportant, 2=UI=Unimportant, 3=SI=Somewhat Important, 4=I=Important, 5=EI=Extremely Important).

Please rate following ***market*** related performance indicators	Extremely Unimportant (1)	Unimportant (2)	Somewhat Important (3)	Important (4)	Extremely Important (5)
Market Growth Rate					
Market Share					
Brand Equity					
Cost per Lead					
Conversion Rate					
Search Engine Rankings (by keyword) and click-through rate					
Page Views and Bounce Rate					
Customer Online Engagement Level					
Online Share of Voice (OSOV)					
Social Networking Footprint					
Klout Score					

4. How following Key Performance Indicators (KPIs) are important to Operational Performance of pharmaceutical supply chain? (1=EUI=Extremely Unimportant, 2=UI=Unimportant, 3=SI=Somewhat Important, 4=I=Important, 5=EI=Extremely Important).

Please rate following ***operational*** performance indicators	Extremely Unimportant (1)	Unimportant (2)	Somewhat Important (3)	Important (4)	Extremely Important (5)
Six Sigma Level					
Capacity Utilisation Rate (CUR)					
Process Waste Level					
Order Fulfilment Cycle Time					
Delivery In Full, On Time (DIFOT) Rate					
Inventory Shrinkage Rate (ISR)					
Project Schedule Variance (PSV)					
Project Cost Variance (PCV)					
Earned Value (EV) Metric					
Innovation Pipeline Strength (IPS)					

Return on Innovation Investment (ROI2)					
Time to Market					
First Pass Yield (FPY)					
Rework Level					
Quality Index					
Overall Equipment Effectiveness (OEE)					
Process or Machine Downtime Level					
First Contact Resolution (FCR)					

Section- IV

1. **How a level of integration in supply chain affects the quality dimensions?** Fill all the rows and column with 1, 2 and 3. Where 1 indicates low affect Rate the impact (1- LOW to 3- HIGH) for each pair. Dimension here is Integration amongst players (dealers, retailers, etc.) of supply chain.

	No integration	Moderate integration	Full Integration
Drug performance			
Features of drug/ medicine			
Reliability of drug/ medicine			
Conformance to action requirement			
Self-life/usability			
Post sales services			
Packaging			
Perceived quality			

2. **Is there a need of technology transfer from foreign organisation in the following area?**

Chain Elements	Not needed	May be needed	Somewhat needed	Needed	Highly Needed
R and D					
Clinical trails					
Manufacturing					
Packaging					
Distribution					
Warehousing					
Inventory Management					
Reverse Logistics					
CRM					

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