# International Journal of Multidisciplinary
## Research in Science, Engineering and Technology

*(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)*

# Inventory and Logistic Supply Chain in Pharmaceutical Industry

**Saurabh Tukaram Shinde, Dr. Rajendra Jarad, Dr. Dhananjay Bhavsar, Prof. Nilambari Mohalkar,**

**Dr. Mahendra Yadav, Dr. Praveen Suryavanshi**

Department of MBA, Dr.D.Y.Patil Institute of Technology, Pimpri, Pune, India

**ABSTRACT:** Indian pharmaceutical industry is one of the fastest growing sectors of Indian economy but the medicines we take suffer from serious ills: they are not stored and transported the way they ought to be. Pharmaceutical companies face issues related to choosing and working with the right logistics partners and designing the right system of transportation. This paper present logistics issues affecting pharmaceutical sector in India. It is borne out of the need felt by sales managers, logistic providers and academicians to address logistics practices in India. Our research is based on both field visits and secondary data.

**KEYWORDS**: Indian pharmaceutical market; logistics; logistics management; supply chain; India.

Jayanthi Ranjan is a Professor in IT Management area at IMT, Ghaziabad. She has more than 18 years of teaching experience. She has published various papers on data clustering, data mining, database security, business intelligence, educational technologies that appeared in International Journal of Business

Information Systems, International Journal of Indian Culture and Business Management, International Journal of Business Innovation and Research, International Journal of Business Excellence, Information Management and Computer Security and many more. She has over 130 publications which include 60 publications in various international journals, 15 national conference proceedings and 53 international conference proceedings till date. She has published eight edited books.

## I. INTRODUCTION

Indian pharmaceutical industry is not only one of the fastest growing sectors of Indian economy but also a leading player in the world – ranking third in volume and 14th in value terms. It is growing with an average annual growth rate of 14%. Indianpharmaceutical market, which is currently valued at US $ 20 billion, could see the figure almost double in next five years primarily propelled by the steady growth in the domestic segment. As per Mckinsey's report, Indian pharmaceutical market is expected to touch US $ 55 billion by 2020. The domestic market which is growing at almost 10% to 14% at present itself will provide US$ 20 to 24 billion in 2015. There are several driving factors such as the diseases landscape, rising income levels, increase in awareness, better infrastructure, and emergence of several health insurance. All these factors are going to influence the growth of healthcare in general, and the pharmaceutical industry in particular, in India. Since the last two decades, India has emerged as a hot spot for clinical trials, manufacturing and R&D of pharmaceutical drugs. According to Ranjan and Puri (2010), the stability of pharmaceutical industry is all the more fascinating given the consistent and strong demand for better drugs to improve the quality of life and support rapidlyageing population. In fact, for a long time, the pharmaceutical industry has been one of the most profitable industries (Bradley and Weber, 2004). While the potential cost savings has been a vital factor in India's economic growth, lack of modern transport infrastructure in the country has hampered the overall growth of logistics. Papageorgiou (2009) argued that pharmaceutical drug supply chains are in urgent need of efficient optimisation

techniques in order to reduce costs and to increase productivity and responsiveness. Supply chains of generic drugs, are, typically, more susceptible to falsification with the supply chains of some of the over-the-counter products, such as vitamins or aspirins, also vulnerable to adulteration. Pharmaceutical companies are required to practice very high standards of good manufacturing practices (GMP) during manufacturing of drugs and also need to pass through very strict quality assurance (QA) requirements for the finished medicines. Having done so in the best possible manner, the moment a company releases its medicines for distribution in the market; it is the responsibility of the transporter to reach the drugs to company depots, distributors and retailers. The transporters totally ignore the fact that medicines need to be treated very carefully as the medicines pass through various stages of handling and transport. India's cold chain market is still in its developing stages, and there is a lack of temperature-sensitive services from the point of origin to the point of consumption. This compounded with India's average temperature of 30° C poses a challenge to providing temperature-controlled logistic services. For them, these products only represent one of the 'goods' they are handling on a regular basis. Special care warranted for medicines is not at all their concern. This becomes more critical in the case of long distance destinations, usually requiring transhipments on the way. All these handling procedures can affect the nature of the medicines. Mentzer (2004) suggested that competitive advantage can be obtained not just through the products sold, but also through the way in which we manage the flows in a supply chain.

Logistics is about moving materials, information and resources from one business to another business or from a business to the consumer. Logistics is a vital part of thebusiness-economic system. In fact, 10%–15% of product costs are logistics related. For any country, the logistics cost are estimated to be between 9%–20% of GDP. India today spends about 14% of its US $ 691 billion GDP on logistics, and transportation accounts for 35% of the country's logistics costs.

Another critical factor is good security environment in terms of risk-free supply chain systems. With the presence of a security setup that is not very developed, there is a potential risk of theft and tampering of shipments. Also, the growth of the industry has led to customer needs being more specialised and there is a need for specific and customised logistical services. Lastly, pharma distribution volumes are quite similar to retail and FMCG, where 50% of the monthly volume tends to come in towards the end of the month leading to bunching of orders. Hence good logistic management becomes more vital for the pharmaceutical industry.

With a large population in the rural areas, it becomes difficult for pharmaceutical companies to rely on any single mode of distribution and this further adds to the logistic complexity and costs. We conducted several rounds of discussions with sales managers and logistic managers of pharmaceutical companies and logistic providers to have their views about logistics issues hampering the Indian Pharmaceutical Industry. We found that most of these problems are a result of poor infrastructure and logistics underlying the pharmaceutical supply chain. This paper elaborates the logistic issues affecting the Indian Pharmaceutical market

## II. Significance of logistics for Indian Pharmaceutical Industry:

As per The Council of Logistics Management, Logistics can be defined as the process of planning, implementing, and controlling the efficient, effective flow and storage of goods, services, and related information from point of origin to point of consumption for the purpose of conforming to customer requirements. Logistics can also be defined as a systems approach to planning, operating and controlling the total materials flow  (raw-material, in-process inventories and finished goods) within the firm.

Logistics in pharmaceutical industry is very vital in providing the right medicine to the right patient at the right time, place and dosage and most importantly at the right price. For example, at one large multinational pharmaceutical company, over 25,000 stock keeping units (SKUs) are distributed worldwide, which in many cases includes some very specialised medicines. To reach the final customer different channels are available viz. distributors, wholesalers, retailers, doctors or other channels. It is really a great challenge for a company to reduce finished goods inventory, as

these 25,000 SKUs have to go through a complex network, before reaching the final customer. Efficient logistics management offers competitive advantage to pharmaceutical companies as it affects their bottom line.

New drug development, clinical trials, R&D and packaging have always been the key focus of the pharmaceutical industry in India but when it comes to logistics, the industry is driven usually by the cost and not by the quality. This is a highly sensitive supply chain where customer service level of less than 100% is unacceptable as it directly impacts the health and safety. The solution that many Pharmaceutical companies adopt is to carry a massive inventory in the supply chain to ensure almost 100% fill rate. However, it is an enormous task to ensure 100% product availability at an optimal cost unless supply chain processes are streamlined towards customer needs and demands. Most of thepharmaceutical companies look at logistics only as a cost saver. They hire conventional transporters, who neither have domain knowledge nor the intention to build an infrastructure to transport drugs as per the required guidelines for the transportation of drugs.

With growing rural population and a rise in urban buying power, it is becoming imperative for pharmaceutical companies to have efficient logistic management as it can also serve as a competitive advantage in the long run. Efficient logistic management is very vital as it helps to maintain the complex network relationship between the pharmaceutical companies, trading partners to source raw materials and delivery of products to retailers and hospitals. Supply chain is a critical part of the pharmaceutical industry since the supply chain activities are extremely time sensitive. In addition, many pharmaceutical products need temperature-controlled storage and distribution. Pharmaceutical industry has given importance to logistics by focusing on supply chain and supply chain activities such as delivering the product to the end-customer at the right time, right place, in a secure mode and at a competitive operational cost.

With the ever rising competition among various pharmaceutical players, inventory management will play a decisive role in pharmaceutical value chain as lots of inventory exists in the supply chain. The key drivers for the pharmaceutical supply chain competitiveness are the speed, flexibility, visibility, responsiveness, costs and safety. The collaborative planning and forecasting with supply chain partners like contract manufactures and third party logistics providers, outsourcing, technology integration andcontinuous improvements through supply chain metrics are the key strategies for the efficient supply chain in pharmaceuticals to ensure the product availability at optimal costs.

### III. LITERATURE REVIEW

This study looks at a very broad topic of pharmaceutical logistics. Specifically, the main objective of this research is to assess the logistic issues affecting the pharmaceutical industry in India. The subject of logistics has been explored by various researchers and practitioners from various perspectives viz. understanding, models, applications, designs,analysis etc., there is lot of variance in the opinions of different researchers as for as the concept is concerned.

The problems faced by the pharmaceutical industry are slightly different. It is riddled with fundamental problems which inhibits its rapid transformation. As a result of its peculiar environment, these problems have a debilitating effect on every aspect of the industry, especially the supply chain. This argument is reinforced by Fisher (1997) in his paper by highlighting the topic of matching supply chain design with the product demand characteristics. Fisher advocated that matching supply chain design to the demand characteristics is so vital to the success of the organisation that it should consider developing multiple supply chains, if necessary, to maximise performance.

Logistics refers, in general way, to gain competitive advantages by one supply chain on the other (competitive supply chain/chains). Logistics comprised of competitiveness of all the supply chain components like suppliers, manufacturers, distributors and retailers. An organisation can gain competitive advantage by performing strategically important activities more economically or better than its competitors. Many attributes have been defined to explain the

determinants of logistics. Many researchers have tried to describe logistics and a wide range of strategies have been considered for the same.

Bradley and Weber (2004) argued that companies may compete if they develop and manage cooperation and collaboration partnerships. La Londe (1997) emphasises on inter-firm cooperation to satisfy customers as the power in supply chains has shifted downstream toward the customer or end users.

Mentzer (2004) suggested that competitive advantage can be obtained not just through the products sold, but also through the way in which we manage the flows in a supply chain. He presented twelve drivers of supply chain competitive advantage. The different components of supply chain have to be competitive enough so that the overall competitive advantage can be achieved.

La Londe and Powers (1993) suggested information and communication as the most profound and influencing changes that affect the companies as well as the supply chain efficiency. They suggested the use of internet and other communication systems for improving supply chain efficiency. According to them, organisations must be quick, agile, and flexible to compete efficiently, which cannot be obtained without coordination of the companies in supply chains

Lambert and Cooper (2000) emphasised on the importance of cooperation and coordination for achieving competitive advantage with supply chain and Pine (1993), stressed on mass customisation for gaining competitiveness of supply chains.

Amaro and Barbosa-Povoa (2008), Tsiakis and Papageorgiou (2008), and Sousa et al. (2008) applied mixed-integer linear programming techniques to solve various problems of planning, capacity allocation, and distribution of medication drugs.

Papageorgiou (2009) and Yu et al. (2010) surveyed the challenges and methodologies in the area of pharmaceutical supply chains.

Goyal and Giri (2001) and Nahmias (2011) presented wide-ranging analyses of perishable inventory management systems.

Rossetti et al. (2011) described the complexities of pharmaceutical supply chains based on interviews and text analysis, and provided insights into this industry and the challenges that it faces. While there is abundance of literature that explains or espouses logistics, there is a dearth of empirical studies examining logistics practices.

Galt and Dale (1991) study ten organisations in the UK and find that they are working to reduce their supplier-base and to improve their communications with the suppliers.

Fernie (1995) carried out an international comparison of SCM in the grocery retailing industry. He found significant differences in inventory held in the supply chain by the US and European grocery retailers, which could be explained by difference in degrees of their SCM adoption.

Tan and Wisner (2000) compared SCM in the USA and Europe. Tan (2002) relates SCM practices and concerns to firm's performance based on data from US companies. He listed nine important supply chain factors such as lack of sophisticated ICT infra-structure, insufficient integration due to lack of trust and collaboration among the supply chain stakeholders and thereby lack of supply chain effectiveness and efficiencies.

Basnet et al. (2003) reported the status of SCM in New Zealand, while Sahay and Mohan (2003) discussed supply chain strategies and structures in India. These surveys rank the perceived importance of some SCM activities, types of hindrances and tools on the success of SCM using representative samples mostly from manufacturing. There is little literature related to logistics practices in Pharmaceutical sector in India. Available literature focuses either on the best
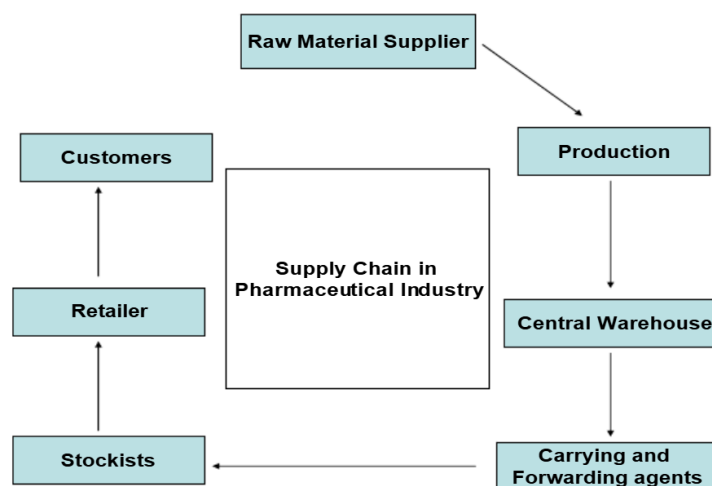
practices (Joshi and Chopra, 2004) or on reengineering of internal operations of the firms (Deshmukh and Mohanty, 2004). The4.1 C&F agents

Figure 1     Supply chain in pharmaceutical industry (see online version for colours)



C&F agents are required because of India's taxation systems. Usually, large pharmaceutical companies have one C&F agents in each state but all states may not warrant a C&F agent. The margin given to these C&F agents is usually in the range of 2%–10% depending upon the turnover

**3.1 Stockists/wholesalers**

Stockists/wholesalers work as a link between the retailers and the company.

Stockists/wholesalers usually market products of 5–10 companies

only a few distribute products of more than 20 companies. They generally have margins of 8%–10%.

**3.2 Retailers**

The retailers comprise a wide variety of different kinds of operation, ranging from small shops to large retail chains. Retail pharmacy chains like Apollo, Viva, Guardian, Rx Pharmacy are relatively new to India. These chains are generating considerable conflict with the existing retailers as they are bypassing the wholesale chain by directly buying from the companies. These retailers work on margins of 16%–20%.

Some of the pharmaceutical companies are following a different model of supply chain. Here the medicines go from production to the C&F agents. C&F agents send the goods to various distributors, who then send the goods to stockists/wholesalers as per their instructions. From the wholesalers, the products reach out to the retailers in Tier II and Tier III cities. From retailers the medicines move to the final customers. This model of supply chain can be seen in Figure 2

**Figure 2**  Supply chain in pharmaceutical industry (see online version for colours)
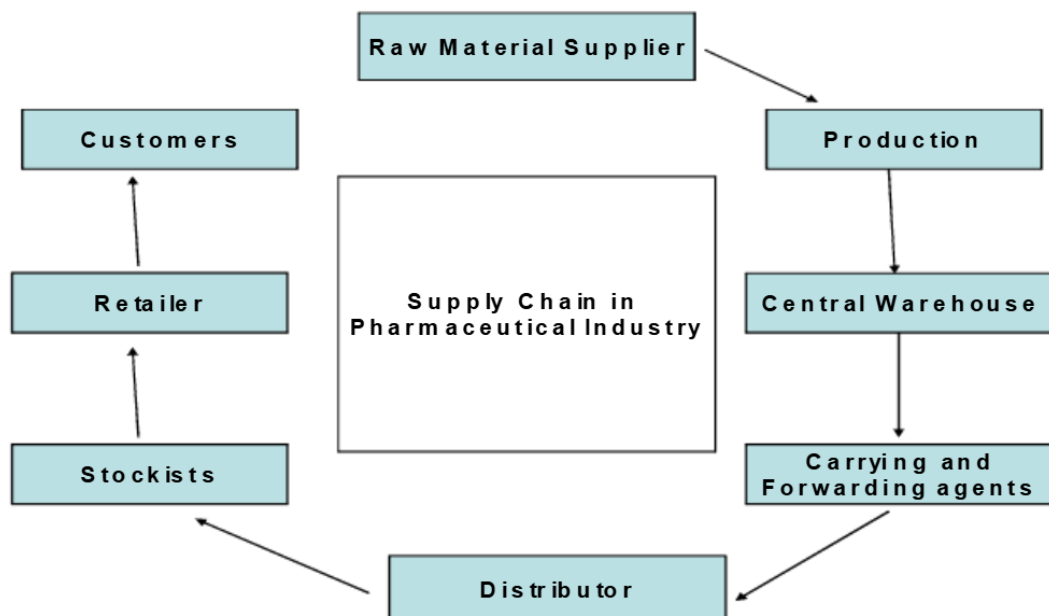
This model is mostly used for supply of medicines to the rural areas where the size of market in terms of sales is on a lower side and the orders need to be supplied in small shipments. This model increases the logistic costs as distributor margin is also added to the costs.

## IV. MAJOR CHALLENGES IN PHARMACEUTICAL LOGISTICS

Long lead time, multi-layered routes to market due to different state tax regimes, and high import duties on some medicines have added to the overall supply chain costs for pharmaceutical products. As Mr. Hemanshu Mehta, Sales Manager, Ranbaxy India, points out, "The pharmaceutical supply chain costs are as high as approximately 12.4percent of the total sales, as against the world average of 6.5 percent. On the other hand, inventory turns are quite low at 3.3 percent in comparison to the world average of 5.1 percent."

Major problems affecting Indian pharmaceutical logistics are transportation and infrastructure. The roads in India are not well connected in comparison to the western countries. It not only takes lot of time to deliver medicines in the remote rural areas but this time gap can also affect the potency of the certain drugs having a short shelf life. Other challenges are customised packaging and rigid documentation. The government's inaction on VAT and central sales tax phase-out has further compounded the logistics problems of pharmaceutical industry in India. We conducted several rounds of discussions with sales managers and logistic managers of pharmaceutical companies and logistic providers to have their views about logistics issues impeding the Indian Pharmaceutical Industry. We found the following challenges underlying the pharmaceutical supply chain in India:

### 4.1 Fragmented and unorganised logistics network

The pharmaceutical supply chain faces problems in terms of a fragmented logistics network. Currently, there is no centralised logistics network for transportation of medicines all across India. Few of the pharmaceutical companies outsource their logistic activities to third-party logistics (3PLs) service providers for delivering their products to wholesalers/stockists. From the stockists, the drugs reach out to retailers all across the country. During this transfer, small logistics operators and even courier companies come into play at the state, district and sub-districts levels. All these transactions make it very difficult to manage and monitor such a vast and diverse supply chain network.

### 4.2 Cold chain management

Most local transporters of medicines are unaware of the sensitivity of handling these products. Also, they usually do not have proper resources, and so offer cheap transportation services for supply of medicines to the pharmaceutical companies. The pharmaceutical industry caters to some very sensitive products such as biotech drugs.

These drugs require unbroken cold chain logistics which are very difficult to maintain while being shipped, as they pass through different temperature zones of Indian subcontinent. A specific temperature needs to be maintained for some drugs, at every node, along the supply chain – right from the origin to the final destination. This requires the medicines to be transported and stored at every point and node of the chain under similar condition. This is one of the biggest issues that the pharmaceutical industry is facing currently, especially as it looks for more geographic expansion. It is said that 20% of drugs being sold in the Indian market are temperature sensitive and this number is expected to increase in the coming years with the advent of new biomedicines. Moreover, a number of new patented products are entering Indian pharmaceutical market and they will not survive for more than three to four hours, if not maintained at the specific temperature

### 4.3 Supply chain barriers by All India Organisation of Chemists and Druggists:

In western countries, medicines can be supplied directly to big retail chains by the pharmaceutical companies but the same cannot be done in India as the medicines cannot be supplied directly to the big retailers like Big Bazaar, Reliance etc., by the pharmaceutical companies as All India Organisation of Chemists and Druggists (AIOCD) ask them to supply the goods only through the authorised distributors. AIOCD is the representative body of around 5.5 lakh drug retailers and wholesalers in India. Any pharmaceutical company trying to send goods directly to the retailers may face a situation of boycott by the drug retailers and wholesalers in India. In order to avoid any confrontation with AIOCD, companies prefer to supply the goods only through their stockists to these big retailers. This not only increases an additional step in the supply chain but also increase the time lag in the supply of medicines.

### 4.4 Lack of monitoring:

Another issue of concern is monitoring of the supply chain and distribution network. India has CDSCO (a central drug regulatory body) which issues different categories of drug licenses to wholesalers/stockists and retailers on the basis their claims of storage facilities. When the products move through distributors to other middlemen, there are many issues of inventory reduction. It is usually believed that pharmaceutical products are under security at all stages, but when we look a little deeper, we find that much more need to be done to increase security in the pharmaceutical supply chain.

Today a manufacturer in Mumbai can sell and dispatch his medicines all across the country without the approval of drug regulatory bodies at state levels. This is a frail  link, which enables tampering in different forms: production of substandard drugs, deterioration in the quality of the medicines, or even counterfeit or spurious medicines. Inadequate training of site staff in the proper procedures for receiving and storage of these medicines is also an important issue.

## V. MANAGERIAL IMPLICATIONS

Logistics in the pharmaceutical industry is critical for providing the right medicine to the right patient at the right time, place and dosage and most importantly at the right total logistics cost. Pharmaceutical industry in India needs to recognise the extraordinary role played by the efficient logistic management. Logistic system in relation to the needs of pharmaceutical products should be organised and brought under a proper purview. Government intervention, in terms of regulation, is required to align the unorganised distribution system of the drugs till it reaches the retailers. Suitable infrastructure is crucial for proper transportation and storage of the drugs. Careful climate control throughout the transportation period is also very vital. We need to ensure that we have fully integrated upgraded software such as track and trace system and bar coding to monitor the total visibility of the position of the product. The pharmaceutical industry has got a huge potential to trap supply chain cost in the value chain as supply chain costs more than R&D

costs. Companies need to map their logistic processes and optimise the same to ensure the product availability at optimal costs. Optimising supply chain would result in 25% stock reduction, 20% increase invalue – added time and 8% reduction in supply chain costs, which has been proved by one large drug maker.

Many pharmaceutical companies have started viewing the role of 3PLs providers as an integral part of their supply chain. If a 3PLs provider offers a comprehensive solution at a pan-India level while maintaining standards required by pharmaceutical companies, it will add value not only to 3PL providers and pharmaceutical companies, but also to the consumers. This will address the fragmentation problem that the pharmaceutical logistics is facing today and will also lead to standardisation, to protect quality and monitoring. Continuous improvement in logistic infrastructure and increasing awareness about efficient logistic practices in India have led 3PL services to be perceived as a superior way of controlling both internal and external logistic processes. Many 3PL operators are developing vertically focused, specialised teams who understand the pharmaceutical language and know the products, customised packaging and other supply chain issues of pharmaceutical companies. These operators will help companies to address the various logistic problems and curtail the rising costs of transportation.

The major new technologies used by 3PL providers to address specific issues like guarding the supply chain from counterfeit drugs, protection from contamination, etc., are cool chain temperature monitors, specialised packaging, barcode scanners, data loggers for temperature control, temperature hooters to monitor variations in the temperature during transit, relative humidity indicators (RH),temperature mapping for the storage area before storing temperature sensitive products like vaccines and biotech products.

## VI. CONCLUSION

Pharmaceutical is a sensitive sector and special consideration should be given to each process as it can directly affect the patient. Major problems affecting Indian pharmaceutical logistics are infrastructure, long lead time, multi-layered routes to market due to different state tax regimes, and customised packaging and rigid documentation. The government's inaction on VAT and central sales tax phase-out has further compounded the logistics problems of pharmaceutical industry in India.

Looking at the emerging business and technological trends, there are possibilities for the adoption of innovative logistics solutions specifically designed for Indian market conditions. A planned approach for integrated logistics is needed. Some companies are exploring solutions like RFIDs, bar-coding and temperature monitors etc, and have adopted other technology-based solutions towards vigorous product identification and sealing to prevent counterfeits and spurious drugs. However, it is yet to be seen whether these can be scaled up to allow universal application by all drug manufacturers throughout the country. The monitoring tools also need to be cost-effective in order to allow all drugs to be monitored.

Pharmaceutical companies need to ensure that their medicines reach customers with uncompromised quality. In India, because companies do not retain control over the multi layered logistic system, the cold-chain management process continues to be difficult and expensive. However, companies are increasingly realising the importance of an effective logistics, all the way to the end-customer and here 3PLs can play a bigger roleCoping with the challenges of streamlining the logistics in India will ultimately benefit the patient and the healthcare industry. Thus, in the coming days, logistics are expected to play a significant role in Indian pharmaceutical industry and could contribute towards the enhancement of productivity as well as growth of the industry.

## VII. LIMITATIONS OF OUR RESEARCH

This paper presents only a snap-shot view of the logistics in pharmaceutical sector in India. This is only an exploratory study where information regarding logistics in pharmaceutical sector was gathered from secondary sources and from discussions with sales managers and logistic managers. The managers from different pharmaceutical and logistic

companies for discussions were selected as a convenience sample and so may not be truly cross-sectional. Further, as the concept of supply chain and logistics for pharmaceutical sector is complex and involves a network of companies in the effort of producing and delivering a final product, its entire domain cannot be covered in just one study.

## VIII. FUTURE RESEARCH DIRECTIONS

This research opens the way for in-depth studies of some of the areas of concern identified for logistics for pharmaceutical sector in India. Empirical studies can be conducted to further substantiate the findings of this research. Research may also be carried out using specific cases to study these practices at firm level in detail. It should cover multiple functional areas (logistics, marketing, IT, operations, etc.) of a single firm in much more systematic manner. It may be worthwhile to investigate how these logistics practices differ across firms of different size. Some detailed study may be carried out in this area. Further, the role of 3PLs providers in providing efficient logistics to pharmaceutical companies may be explored in detail. Finally, more focusing on establishing actual performance improvements in logistics and supply chain management leading to cost-savings and customer satisfaction can be conducted.

## REFERENCES

1.  Amaro, A. and Barbosa-Povoa, A. (2008) 'Planning and scheduling of industrial supply chains with reverse flows: a real pharmaceutical case study', Computers & Chemical Engineering, Vol. 32, No. 11, pp.2606–2625.
2.  Basnet, C., Corner, J., Wisner, J. and Tan, K-C. (2003) 'Benchmarking supply chain management practice in New Zealand', Supply Chain Management: An International Journal, Vol. 8, No. 1, pp.57–64.
3.  Bradley, S.E. and Weber, J. (2004) 'The pharmaceutical industry: the challenges in the new century', Harvard Business School Case Study, 9-703-489, April 2004.
4.  Deshmukh S.G. and Mohanty, R.P. (2004) 'Re-engineering of supply chain: lessons from select case studies', In Sahay, B.S. (Ed.): Supply Chain Management for Global Competitiveness, 2nd ed., pp.509–526, Macmillan, New Delhi. Fernie, J. (1995) 'International comparisons of supply chain management in grocery retailing', Service Industries Journal, Vol. 15, No. 4, pp.134–147.Fisher, M.L. (1997) 'What is the right supply chain for your product?', Harvard Business Review, March–April 1997, Vol. 75, No. 2, pp.105–116.
5.  Galt, J.D.A. and Dale, B.G. (1991) 'Supplier development: a British case study', International Journal of Purchasing & Materials Management, Vol. 27, No. 1, pp.16–22.
6.  Goyal, S.K. and Giri, B.C. (2001) 'Recent trends in modeling of deteriorating inventory', European Journal of Operational Research, Vol. 134, No. 1, pp.1–16.
7.  Joshi, V. and Chopra, S.K. (2004) 'Best practices in supply chain management at Modi xerox', in Sahay, B.S. (Ed.): Supply Chain Management for Global Competitiveness, 2nd ed., pp.549–562, Macmillan, New Delhi.
8.  La londe, B.J. and Powers, R.F. (1993) 'Disintegration and reintegration: logistics of the 21st century', International Journal of Logistics Management, Vol. 4, No. 2, pp.1–12.
9.  La Londe, B.J. (1997) 'Supply chain management: myth or reality?', Supply Chain Management Review, Spring, Vol. 1, No. 1, pp.6–7.
10. Lambert, D.M. and Cooper, M.C. (2000) 'Issues in supply chain management', Industrial Marketing Management, Vol. 29, No. 1, pp.45–56.
11. Mentzer, J.T. (2004) 'Fundamentals of supply chain management-twelve drivers of competitive advantages', University of Tennessee, Knoxville, Response books, New Delhi.
12. Nahmias, S. (2011) Perishable Inventory Systems, Springer, New York. Papageorgiou, L. (2009) 'Supply chain optimisation for the process industries: advances and opportunities', Computers and Chemical Engineering, Vol. 33, No. 12, pp.1931–1938.
13. Pine, Jr., B.J. (1993) Mass Customization: The New Frontier in Business Competition, Harvard Business School Press, Boston.
14. Ranjan, J. and Puri, S. (2010) 'Logistics issues in Indian pharmaceutical industry', Proceedings Of National Conference on Supply Chain Management, Macmillan Publishers, ISBN: 023-032-938-1.
15. Rossetti, C.L., Handfield, R. and Dooley, K.J. (2011) 'Forces, trends, and decisions in pharmaceutical supply chain management', International Journal of Physical Distribution & Logistics Management, Vol. 41, Nos. 5–6, pp.601–622.

16. Sahay, B.S. and Mohan, R. (2003) 'Supply chain management practices in Indian industry', International Journal of Physical Distribution & Logistics Management, Vol. 33, No. 7, pp.582–606.

17. Sahay, B.S., Gupta, J.N.D. and Mohan, R. (2006) 'Managing supply chains for competitiveness: the Indian scenario', Supply Chain Management: An International Journal, Vol. 11, No. 1, pp.15–24.

18. Sousa, R., Shah, N. and Papageorgiou, L. (2008) 'Supply chain design and multilevel planning: an industrial case', Computers and Chemical Engineering, Vol. 32, No. 11, pp.2643–2663.

19. Tan, K.C. (2002) 'Supply chain management: practices, concerns, and performance issues', The Journal of Supply Chain Management, Vol. 35, No. 1, pp.51–62.

20. Tan, K.C. and Wisner, J. (2000) 'Supply chain management practices in the United States and Europe', Research Paper Series of the APICS Educational and Research Foundation and The Supply-Chain Council, Stock No. 07029, p.43.

21. Tsiakis, P. and Papageorgiou, L. (2008) 'Optimal production allocation and distribution supply chain networks', International Journal of Production Economics, Vol. 111, No. 2, pp.468–483. Vrat, P. (2004) 'Supply chain management in India: issues and challenges', in Sahay, B.S. (Ed.): Supply Chain Management for Global Competitiveness, 2nd ed., pp.13–26, Macmillan, New Delhi.

22. Yu, X., Li, C., Shi, Y. and Yu, M. (2010) 'Pharmaceutical supply chain in China: current issues and implications for health system reform', Health Policy, Vol. 97, No. 1, pp.8–15

# INTERNATIONAL JOURNAL OF

## MULTIDISCIPLINARY RESEARCH

### IN SCIENCE, ENGINEERING AND TECHNOLOGY

| Mobile No: +91-6381907438 | Whatsapp: +91-6381907438 | ijmrset@gmail.com |