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MEASURING SUPPLY CHAIN PERFORMANCE IN SELECTED ENGINEERING INDUSTRY

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Abstract
Today's competitive pressures compel companies to continually seek new ways of doing business. Supply chain management (SCM) is one such area which can provide an effective tool to build an advantage that no longer resides with the company's own capabilities, but with the relationships that the firm can forge with their external partners – the customers, the suppliers and other service providers, forming a network called the supply chain. If the supply chain is not managed properly then the delivery gets affected resulting in customer dissatisfaction and hence loss of business. The overall purpose of this study was to measure the supply chain performance in selected companies in Engineering Industry by using SCOR Level-1 metrics covering cycle time, cost, assets and quality. The study was exploratory in nature during initial phase which focuses on primary data and descriptive in nature in the final phase comparing the results with previous study. The research instrument consisted of a structured questionnaire that was specially designed for the study. The questionnaire consisted of 23 statements related to the performance measurements metrics, business profile of the company, better practices and systems that are followed by the company. Ratio scale was used to capture the data. The 17 companies were selected from the data base of IIMM in engineering industry covering all regions of India. The study revealed that supply chain performance is an important tool available for the companies to bench mark their performance with best-in-class companies. The companies that adopted strategies such as integration, joint venture, alliances, merger and acquisitions had performed better than their competitors. The companies that sourced the inputs from nearby operations and implemented IT tools such as GPS, RFID etc were able to achieve better performance. The other IT enabled systems such as EDI, Electronic Procurement System, and ERP could help the companies to perform better. This study can be helpful to the companies, suppliers, customers and channel partners to identify the performance gaps in the supply chain.

Keywords: Supply Chain Management, Performance Metrics, Engineering Industry, Bench Marking.

1.0 Introduction

Shortened product life cycle, increased competition and high expectations of customers have forced many leading – edge companies to move from physical logistics management to more advanced Supply Chain Management (SCM).Additionally, in recent years it has been seen that many companies have reduced their manufacturing cost as much as it is practically possible. Therefore in many cases the only possible way to further reduce the cost and lead times is with effective SCM.

In addition to cost reduction, the SCM also facilitates customer service, inventories, transportation systems and whole distribution networks so that organizations are able to meet or even exceed and delight their customers' expectations.

The SCM is the integration of key business process from goods end user through original suppliers, which provides products, services and information that add value for customers and other stakeholders. The SCM initiatives could be considered as competitive tool and a cost reduction approach. It is also seen from the literature that Indian companies are yet to leverage the SCM for competitive advantage.

2.0 Current Scenario of Indian Engineering Industry

The engineering sector is the largest of the industrial sectors in India and can be categorized into two parts, namely, heave engineering and light engineering. India's engineering industry accounts for 27 percent of the total factories in the Industrial sectors and represents 63% of the overall foreign collaborations. It has emerged as the

largest contributor to the country's total merchandise exports. The sector has a comparative advantage in terms of manufacturing costs, market knowledge, technology and creativity.
The engineering sector is among the top two contributors to the total Indian export basket with total shipments of USD 56.7 billion in 2012-13. Engineering exports from India include transport equipment's, capital goods, other machinery / equipment and light engineering products like castings, forgings and fasteners. The employment oriented engineering sector, which encompasses a large number of micro, small and medium enterprises (MSMEs) , would be contributing something like USD 65 billion to the overall export shipments of USD 326 billion, as targeted by the government (Source: EEPC Reports, India).

Alongside, the National Manufacturing Policy aims at enhancing the sectors share in Gross Domestic Product (GDP) to 25 percent within a decade and creating 100 million jobs by 2022. The engineering sector is relatively has fragmented at the top, as the competencies required are high, while it is highly fragmented at the lower end and is dominated by smaller players.

3.0 Review of Literature
The metrics that are used in performance measurement and improvement should be those that truly capture the essence of organizational performance. A measurement system should facilitate the assignment of metrics to where they would be most appropriate. For effective performance measurement and improvement, measurement goals must represent organizational goals and metrics selected should reflect a balance between financial and non-financial measures that can be related to strategic, tactical and operational level of decision making and control [8]. Since, "what gets measured, gets managed" it is inevitable that once such measures are put in place, management attention will be directed to these key issues (Lapide, 1992&2002). Studies conducted by researchers / groups earlier viz, Korgaonkar, Shah, IIMM etc, on supply chain performance were reviewed and discussed.

3.1 Performance Measurements and Metrics in SCM
A variety of measurement approaches have been developed, including the following important approaches as reported in the AMR Research Report (Lapide, 1992). The following approaches are considered as important for performance measurements:

a) The Balanced Score Card
b) Supply Chain Council's SCOR Model
c) The Logistics Score Board
d) Activity Based Costing (ABC) and
e) Economic Value Added (EVA)

Very limited literature exists on the measurements specific to the industries, more specifically, in the Indian context. The studies conducted by performance measurement group (LLC Report, 1999, Korgaonkar, 2001, & Shah, 2003) and others were reported in the literature review. The main research findings from these studies were comparison of metrics of delivery performance, total logistics cost, cash-to-cash cycle time, assets turns, inventory days of supply, production flexibility inventory carrying cost and cost due losses in general.
In the present study efforts have been made to measure cycle time, cost, quality, and assets metrics from various sectors of engineering industry. The review of literature ranges from the year 1990 to 2008.

4.0 Research Objectives
The overall purpose of this research was to measure the supply chain performance in selected companies in engineering industry including a) Compressor and Compressor parts, b) Metal cutting tools, c) Tube products, d) Engine and Engine components e) Pumps and its parts, f) Forgings and g) Bicycle and Bicycle parts. The main **objectives are**

i) To determine and measure performance metrics in the supply chain of engineering industry.
ii) To study and bench mark the supply chain performance metrics
iii) To assess the current supply chain metrics those are followed across various industries in India and compare the same with best practices in the respective industries.

iv) To compare the Indian practices with that followed globally, wherever possible.
v) To provide inputs on improvements possible in supply chain metrics across various industry verticals.

5.0 Research Methodology

Research Methodology includes research design and the research procedures followed for conducting the study. Specifically, this includes the instrument development process, pilot study and pre-testing, data collection and analysis procedures.

5.1 Research Instrument

The research instrument consisted of a questionnaire that was specially designed for the study. The questionnaire consisted of 23 statements related to the performance measurement metrics, business profile of the company, better practices and systems that are followed in the company (copy enclosed at **Appendix-I).** The questionnaire was designed with the inputs from previous studies (Korgaonkar, 2001, Eicher research group report, 2002, Gunasekaran, Patel & Tirtiroglu, 2001, Shah, 2003 and Sengottuvelu, 2008). The research instrument was refined on the basis of the feedback received during the pilot study. After the questionnaire was pilot tested, each question / statement was examined for its clarity and relevance to the purpose of the research, which resulted in some modifications / deletions in the questions. To make the questionnaire user-friendly, definition of each metric was enclosed along with the questionnaire. Statements related to Economic Value Added (EVA), supply chain mapping, Activity Based Costing (ABC) etc were deleted after the pilot test. Finally, SCOR Level -1 metrics were only considered for data collection. Other details like business profile, bench marking practices of the companies etc also considered for data collection.

5.2 Sampling Procedure

The population of interest was the entire database of Indian Institute of Materials Management (IIMM), which is the largest of its kind membership professional body in India. The IIMM database consists of companies of repute spread all across the country. More than 500 companies registered with them formed the sample frame for the study. The IIMM database is itself segregated into broad industry type's i.e. discrete manufacturing, process industries and FMCG. Of these, companies representing engineering industry were selected for the study. This resulted in a sample of 17 companies. The stratified sampling method was adopted for data collection.

5.3 Data Collection Procedure

The researcher then collected the data in various stages through post / courier, email, personal visits and continuous follow up. In stage one about 30% and stage two about 50% and the remaining 20% in stage three after repeated reminders and follow up.
Thus, there were 17 usable responses obtained from the selected companies through stratified sampling method. Statistical Package for Social Studies (SPSS) was used for conducting statistical analysis.

5.4 Method of Analysis

Descriptive statistics: Descriptive statistics such as minimum, mean and maximum were computed for analysis.

5.5 Analysis and interpretation of Descriptive Statistics

Preliminary analysis of data collected are tabulated and further analysis carried out Table 1 shows that the percentage of sample coverage. The coverage of sample is 100%.

Table 1 Percentage of samples Coverage

Sl. No	Segment	Samples Size
1.	Engineering Industry	17

5.5.1 Geographical location

Table 2 Geographical location

Sl. No	Segment	South	West	North	East	Total
1.	Engineering Industry	6	10	1	0	17

Table 2 shows the geographical location of the sample. A total of 17 companies were contacted across various locations namely, Chennai, Mumbai, Pune, and Faridabad. All the 17 companies have responded for participation in the data collection process.

5.5.2 Profile of the Respondents

The total number of respondents contacted most of the respondents are found to be having more than 15 yrs of experience in production, procurements, logistics, marketing quality and finance areas.

5.5.3 Profile of the Responding Units

Sample size: 17 of the total companies responded, all the companies found to be having a turnover of more than Rs. 50 Cr.

5.5.4 Profile of the Supply Chains

a) Compressor and Compressor parts, b) Metal cutting tools, c) Tube products, d) Engine and Engine components e) Pumps and Pump parts, f) Forgings and g) Bicycle and Bicycle parts.

5.6 Analysis and Interpretation of Descriptive Statistics

Summary of performance measurements of engineering industry with regard to cycle time, cost, quality and assets metrics are shown in table 3, 4, 5 and 6. The best-in-class, industry average and maximum values were computed for analysis.

Table 3 Best-in-class Vs Industry Average-Sum up (Cycle Time Metrics)

Sl. No.	Metrics	Best –in-class (Minimum)	Industry Average (Mean)	Maximum
1.	Procurement time (Days)	5	22	56
2.	Production cycle time (Days)	3	25.11	60
3.	Delivery time (Days)	3	8.17	16
4.	Total cycle time (Days)	10	52.23	96
5.	Cash to cash cycle time (Days)	18	59	106
6.	Supply chain flexibility (%)	4	11.05	30*

* Maximum value indicates the best-in-class

Bar Chart of Cycle Time Metrics

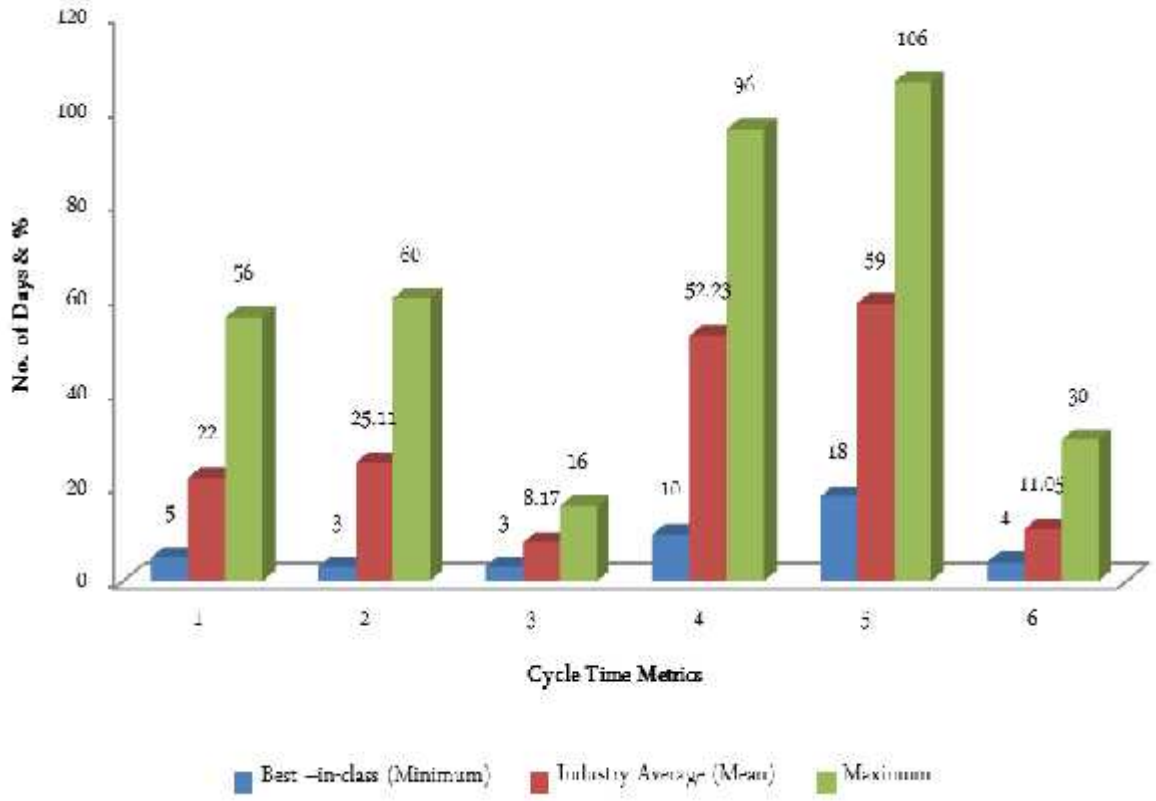

Figure 1 Descriptive Statistics –Cycle Time Metrics

Table 4 Best-in-class Vs Industry Average-Sum up (Cost Metrics)

Sl. No.	Metrics	Best –in-class (Minimum)	Industry Average (Mean)	Maximum
1.	Total supply chain cost (% of sales)	2	7.05	12
2.	Inbound Transportation cost (% of TSCC)	16	33	44
3.	Outbound Transportation cost (% of TSCC)	24	32	38
4.	Warehousing cost (% of TSCC)	4	6.5	9
5.	Inventory carrying cost (% of TSCC)	12	19.05	26
6.	Cost of transit losses (% of TSCC)	0	0.11	1
7.	Cost of damages (% of TSCC)	0	1.02	2
8.	Other cost (Insurance, Freight & Clearance)	1	3.58	5
9.	Return Inventory cost	0	2.05	4
10.	Return Processing cost	0	0.5	1

Bar Chart of Cost Metrics

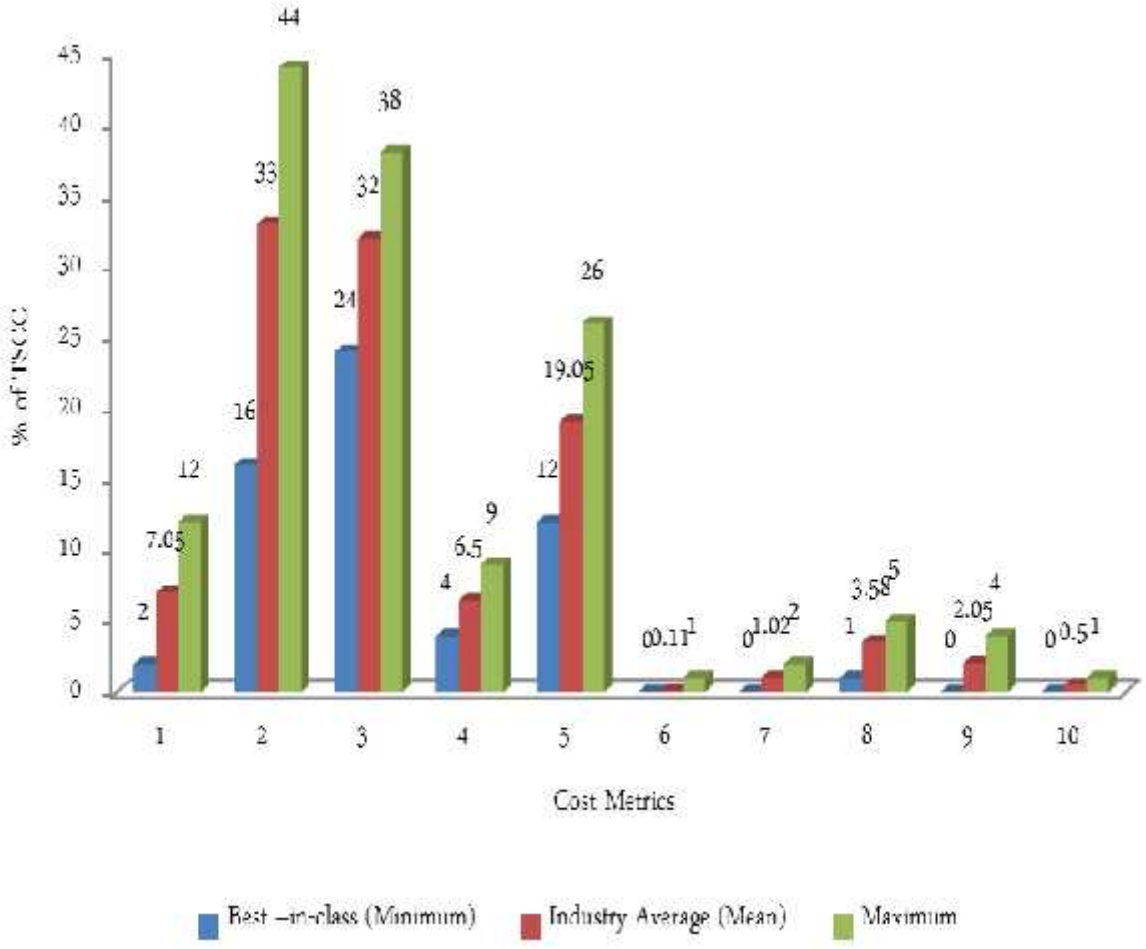

Figure 2 Descriptive Statistics –Cost Metrics

Table 5 Best-in-class vs. Industry Average-Sum Up (Quality Metrics)

Sl. No.	Metrics	Best –in-class (Minimum)	Industry Average (Mean)	Maximum*
1.	% of on time deliveries	80	90.29	100
2.	% of supplies made as per the quantity ordered	85	94	100
3.	% of supplies made as per the desired quality	85	97.47	100

* Maximum value indicates best-in-class

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Bar Chart of Quality Metrics

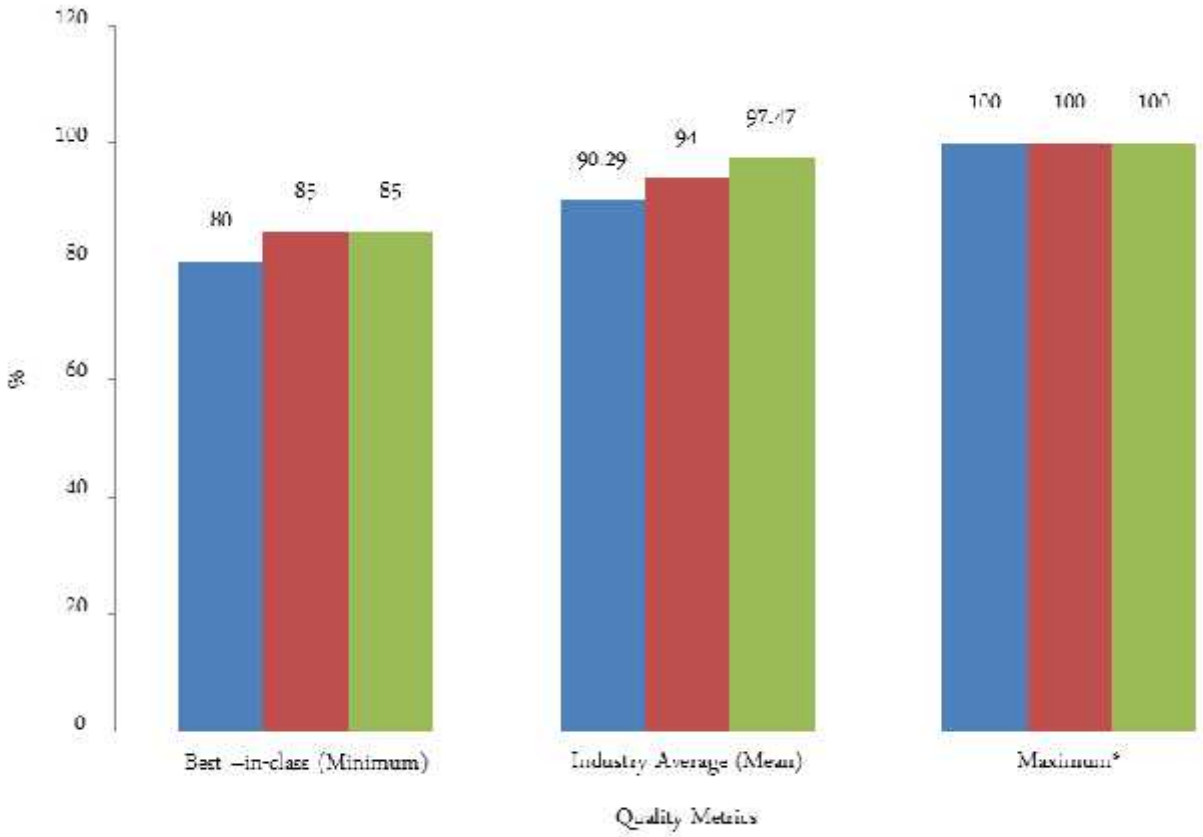

Figure 3 Descriptive Statistics –Quality Metrics

T**able 6 Best-in-class vs Industry Average-Sum up (Assets Metrics)**

Sl. No.	Metrics	Best –in-class (Minimum)	Industry Average (Mean)	Maximum
1.	Raw Material Inventory holding (Days)	3	23	36.0
2.	Work-in-Progress Inventory holding (Days)	3	17.52	36.0
3.	Finished Goods Inventory holding (Days)	3	7.52	14.0
4.	Inventory Turnover (No. of Turns)	5	18.05	31.0*

* Maximum value indicates best-in-class.

Bar Chart of Assets Metrics

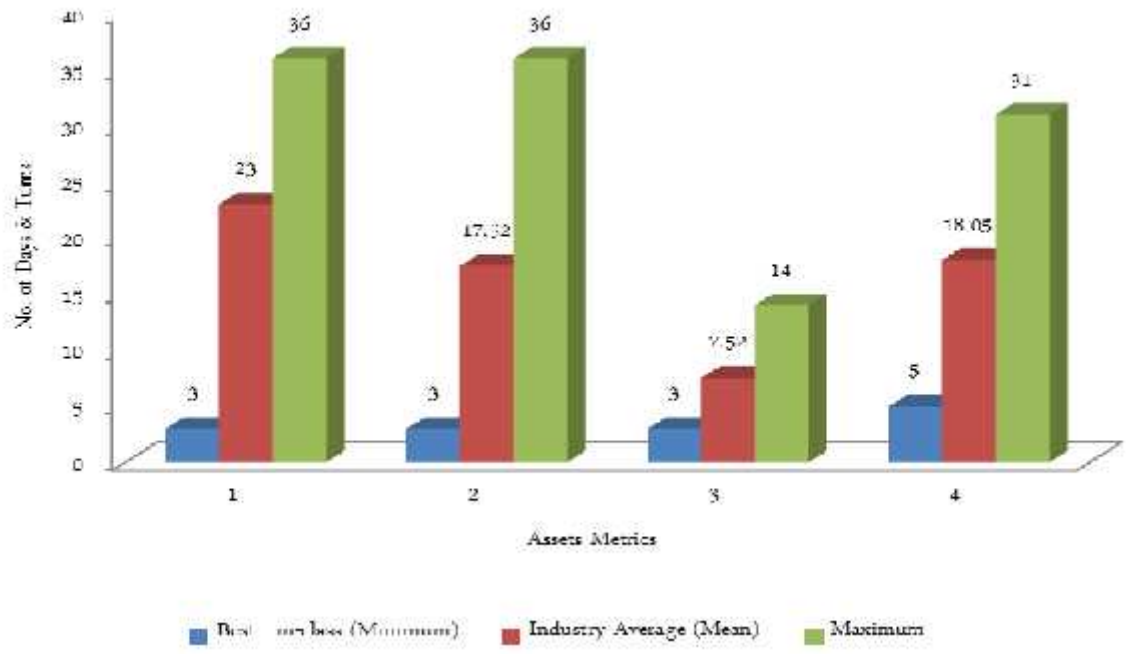

Figure 4 Descriptive statistics –Assets metrics

5.6.1.Cycle Time Metrics

a.Procurement time

Of the companies contacted, around 50% of them revealed that the procurement time is usually between 5-15 days. However for some (25%) the procurement is greater than 30 days. For some companies the procurement time is as low as 5 days.

b) Production cycle time

It was found that production cycle time of more than 25% of the companies is between 3-16 days, of which production cycle time of around 20% of the companies is more than 25 days.

c) Delivery time

Of the companies contacted, over 70% of them revealed that the delivery time is usually between 3-8 days. For some companies (30%) delivery seems to be more than 10 days.

d)Total cycle time

Total cycle time for almost 20% of the companies contacted during the study seems to be between 10-24 days. or some companies (30%) it is more than 75 days and industry average comes to 60 days..

e) Cash to cash cycle time

Cash to cash cycle time of 50 % of the companies contacted seems to be in the range of 61-90 days. However, around 25% of the companies reported that their cash to cash cycle time is between 18-32 days and for others it ranges from 33 to 60 days. .

f) Supply chain flexibility (%)

About 50% of the companies revealed that they could meet above 10% of the demand surge when there is an unexpected increase in demand. For others it varies between 5-10 %

5.6.2Cost Metrics

Total supply chain (% of sales)

The supply chain cost of over 70% of the companies contacted seems to be around 6-8%. But for around 30% of the company's total supply chain cost seems to be around 5%. Inbound Logistics Cost (IBL) is 36% and Outbound

Logistics Cost (OBL) is 33%. The IBL cost is more than the OBL cost and cost of transit losses ranges between 0% and 1%.

5.6.3Quality Metrics

a)% of on time deliveries

Around 6% of them revealed that every time they deliver the goods to their customer by the promised time is 100% on time delivery and others (25%) revealed that they are meeting on time deliveries 95% of the time.

b)% of supplies made as per the quantity ordered

55 % of the companies contacted indicated that it ships 100% of the total order in the initial shipment itself. However, 50% of the cases, the initial shipment carry 90-99% of the total order.

c)% of supply on desired quality

60% of the companies contacted reported that they are supplying the finished product 99%-100% as per the required quality. Some of the best- in- class companies (5%) they were able to meet the desired quality level and other they were able meet only 85% of the prescribed quality level.

5.6.4Assets Metrics

a)Inventory holding (Raw Material, Work in-Progress and Finished Goods inventory)

In over 40% of the cases, raw material inventories are held for 3-10 days. In general, work –in-progress inventories are held for 3-14 days in 40% of the cases. However, finished goods inventories, 50% of the cases are in the range of 3-7 days.

b)Inventory turnover

50% of the companies maintain an inventory turnover of 5-12 turns in the supply chain, followed by 15-30 turns for 50% of the companies. Some of the best-in-class companies (3%) they were able to maintain more than 30 turns.

5.6.5 Other Findings

The major challenges faced by the players in engineering industry are:

i. Labor is highly cost-competitive. Indian engineering industry is a highly capital intensive and cyclical industry.
ii. Inputs/ raw materials used are mainly local / indigenous in nature. It suffers from low technological competitiveness.
iii. High evidence of indirect taxation (excise duty, octroi, central sales tax, service tax etc)
iv. The companies in this sector in general lack export thrust, as the focus is largely on the domestic market. Focus /investment in branding and marketing and customer orientation are low.
v. Requirement of high level of capital investment poses as a major entry barrier.

6.0. Comparison of Previous Research Findings

The previous research major findings were reviewed and compared with the present study as shown in Table 7.

Table 7 Summary of Major Findings of Previous and Present Studies

Metrics	Performance Measurement Group (1999)	Korgaonkar, (2001)	Shah (2003)	Present Study
Delivery performance (%)	85-95%	81 – 97%	90-95%	80 - 100%
Total logistics cost (% of sales on TSCC)	3-13%	4-50%	3-8%	40 – 55%
Cash-to-cash cycle time (days)	28-80	24-66	28-46	18 – 106
Assets turns	8-19	4-5	12-19	6 – 30
Inventory days of supply	22-55	81	22-38	2-25
Supply Chain flexibility (%)	20-30	NA	NA	4 – 30%
Inventory carrying cost(% of TSCC)	NA	25%	NA	12-26%
Cost due to losses	NA	14%	NA	0-1%

NA – Not available

7.0 Conclusion

In the global engineering industry, bench marking has become an important tool to help companies compare and contrast their performance with others, identify performance gaps and share best practices. It is clear that the companies are taking a strategic interest in issues of supply chain managements. Organizations are seeking to achieve competitive advantage through closer and more collaborative relations, alliances, joint ventures and acquisitions that enhance and support the supply chain performance to extend possible.

Faced with the necessity of operating a cost effective supply chain, manufactures know what they must do to compete : reduce inventory carrying costs, improve operational efficiency, reduce stock outs, forge tighter relationships with third-party service providers and shorten order-to-cash cycle with their channel partners.

8.0. Key Recommendations

1. The business firms can consider to source inputs from suppliers nearby their operations to perform better.
2. The companies can implement e-Initiatives such as Electronic Data Interchange, e-Procurement, & Enterprise Resource Planning to achieve superior performance in their supply chains.
3. The companies can use IT tools such as Global Positioning Systems; Radio Frequency Identification etc toachieve supply chain performance.
4. The companies adopted forward and backward integration as business strategy could perform better thanothers in terms of cycle time, cost, assets management, supply chain flexibility etc,
5. Supply chain metrics are required to link with key financial performance indicators (KPI) to improve the supply chain efficiency.

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