CHAPTER 3

RESEARCH METHODOLOGY

This chapter deals with need for the study, the problem statement, research objectives, scope of the study, the research frame work, the research methodology, selection criterion, reliability and validity of the instrument, method of analysis and assumptions of the research study. The chapter concludes with limitations of the study.

3.1 NEED FOR THE STUDY

Based on the research findings, practical approaches of professional and academic discussions on various issues of supply chain management and its performance measures, a part of which has been summarized in the previous chapter, the inferences made are described in the paragraphs that follow.

The supply chain is not a chain of business with one-to-one, business-to-business relationships, but a network of multiple businesses and relationship. It is effective and efficient supply chain management that ensures goods delivery in time from one place to another. Companies which will survive and grow in this new economic reality will have to constantly create sustain competitive advantage supply chain has emerged as a powerful means to create and sustain this competitive advantage. For this Supply chain management (SCM) performance has to be measured and monitored on continuous basis new targets and new metric measurement should be added in the measurements. Anything which is not measured can't be improved (Lapide, 2001). Right – metrics and right approach for measurement should be selected.
3.2 THE PROBLEM STATEMENT

The problem thus identified and titled as above contains 4 key concepts – measuring performance, Supply chain management (SCM), manufacturing and fast moving consumer goods (FMCG) Industries. To better understand and work on the objectives of this study the concepts are elaborated below.

Performance Measures

A performance measure or a set of performance measures is used to determine the efficiency and / or effectiveness of an existing system, or to compare competing alternative systems. Performance measures are also used to design proposed system, by determining the values of the decision variables that yield the most desirable levels of performance. Available literature identifies a number of performance measures as important in the evaluation of supply chain effectiveness and efficiency. These measures described in thus section may be categorized as either qualitative or quantitative.

Considering this a number of measures have been developed to evaluate the performance. Monitoring supply chain performance is an intriguing new field. Performance measures can be classified broadly into two categories. 1) Qualitative measures (such as customer satisfaction and product quality) and 2) Quantitative measures (such as order-to-delivery, lead time, supply chain response time, flexibility, resource utilization, delivery performance etc). Improving supply chain performance requires a multi-dimensional strategy that addresses how the organization will service diverse customer needs (www.supply-chain.com). Supply chain measurements or metrics such as cycle time, cost, service / quality and assets are used to track supply chain performance commonly used by supply chain management. Metrics can help to understand how the company is operating over a given period of time. Measurements are used for optimization of the supply for continuous improvement and Bench mark with best-in-class companies for better practices.
SCM

"Supply chain management is the integration of key business processes from end user through original suppliers that provides products, services and information that add value for customers and other stakeholders" (Global supply chain forum). Supply networks can be defined as “sets of supply chains, describing the flow of goods and services from original sources to end customer (Lamming 1996). In today’s world, Supply chain management (SCM) tracks movement of men, material, machinery and information from one point to another. Supply chain management (SCM) is commonly described as a systematic method where the right material is delivered to the right customer, in right quality and quantity and at the right place at the right price. In the era of globalization and liberalization, systematic implementation of Supply chain management (SCM) is vital. The supply chain management is an interface or bridge between the demand and supply. But it involves a complex process (Altekar, 2005).

3.2.1 Current Scenario of FMCG Industries

In an article in the magazine Industry 2.0 (January, 2006) mentioned that the FMCG sector is expected to clock over 40% growth in the next five years. The size of which will go up from Rs.43,000 crores to Rs.50,000 crores by 2010. FMCG industry in India which had been on a roll for many years faces tough times ahead although many segments still show good growth. Some of the products which are in high demand includes soaps, detergents, consumer, durables, tooth pastes, batteries, biscuits, napkins, cold beverages, mosquito repellants, refined oil and hair oil. Some of the major FMCG players which have been aggressively targeting these markets in the recent times. Companies are already increased their penetration in some measures in the semi-urban and rural areas through projects such as projects Shakti and e-Choupal. (Kulkarni & Sharma, 2004; Shenoy, 1994 & Business today, 1995). Special features of these FMCG sectors are a) Highly competitive industry b) Very low net margins; falling continuously c) Credit based Industry and d) Collection period is longer. The supply chains of these industries should be market responsive
and also physical efficient (Fisher, 1997). Therefore, performance measures are considered as important, tool for improvement.

### 3.2.2 Current Scenario of Manufacturing Industries

Manufacturing factory of the world continues to register the highest growth rate globally year after year. Manufacturing is nothing but a wealth creation process. First manufacturing involves production of materials or tangible goods (Crosby, 1984; Erickson, 1998; Esparrago 1988; Forrester & Wright, 1961). The utility of tangible goods lasts beyond production. Manufacturing provides the underpinnings for the entire economy (Harmon, 1996). Manufacturing operations fall into two very broad groups a) Continuous flow (or) Process type and b) Discrete parts manufacturing (also known as discrete production). The term discrete parts manufacturing denotes operations involving products that can be counted. Discrete manufacturing makes distinct parts. A special feature of discrete manufacturing is that the end product, generally made of several components, can be disassembled and re-assembled examples: automobile, computers, electronics equipments, refrigerator, pumps and motors. Where as continuous flow manufacturing makes same items / produces continuously, examples. Refining of oil, fertilizers, and other process industries (Eilon, 1999; Gaither & Frazier, 2002; Hitomi, 1999; Lee, Krajewski & Ritzman, 2000; Buffa & Sarin, 2002; Genek, 1979; & Mukhopadyay, Nandi & Pradip, 2000).

Manufacturing is currently, undergoing a transition (Naisbit, 1984) which, through evolutionary from a technology viewpoint, is revolutionary in its impact on the economy and employment. Supply chains performances of these industries are becomes very important for cost competition and competitive advantage.
3.3 RESEARCH OBJECTIVES

A well defined problem is half – solved. No problem should be dealt with as a whole, but in parts. In order to achieve the goals it is advisable to break the problem and specify the statement of the present research problem in the form of specific objectives. Each research objective pertains to the sample of manufacturing and fast moving consumer goods (FMCG) Industries selected for this research.

The overall purpose of this research was to measure the supply chain performance in selected segments in manufacturing which included auto & auto components, electronics, white goods, engineering and also FMCG sector. The objectives were:

1. To determine and measure performance metrics in the supply chain of FMCG and manufacturing segments.
2. To study the significance of cycle time metrics in fast moving consumer goods (FMCG) and manufacturing industries.
3. To study the significance of cost metrics, in fast moving consumer goods (FMCG) and manufacturing industries.
4. To study the significance of quality metrics, in fast moving consumer goods (FMCG) and manufacturing industries.
5. To study the significance of assets metrics in fast moving consumer goods (FMCG) and manufacturing industries.
6. To study the significance of logistics cost metrics in fast moving consumer goods (FMCG) and manufacturing industries.
7. To study the significance of cycle time metrics, within manufacturing industries.
8. To study the significance of cost metrics within manufacturing industries.
9. To study the significance of quality metrics within manufacturing industries.
10. To study the significance of assets metrics within manufacturing industries.
11. To study the significance of logistics cost metrics within manufacturing industries.
12. To study the relationship among the SCM performance metrics.
13. To assess the current supply chain metrics followed across various industries in India and compare the same with best practices in the respective industries.
14. To compare the Indian practices with that followed globally, wherever possible.
15. To provide inputs on improvements possible in supply chain metrics across various industry verticals.

3.4 SCOPE OF THE STUDY

Multidimensional classification of manufacturing and fast moving consumer goods (FMCG) Industries and the wide spectrum of performance measurements of supply chains and its metrics made it necessary to define the domain made it necessary to define of the present research study.

1. This study is confined to the discrete parts manufacturing in manufacturing and some segments in fast moving consumer goods FMCG.
2. Major emphasis of the study is on comparison within groups FMCG and manufacturing and between manufacturing segments.
3. Companies had a sales turnover of above Rs.5 crores during 2004-05 were selected.
4. The study concern with only cycle time cost quality / service, assets and logistics cost metrics of performance measurements.
5. Companies are already taken some initiatives in Supply chain management (SCM) performance measurements only selected for the study.
6. The IIMM database consists of companies of repute spread all across the country. More than 300 companies registered with them formed the sample frame for the study. The IIMM database is itself segregated into broad industry types i.e. fast moving consumer goods (FMCG) and manufacturing. Of these, companies representing auto & components, electronics, white goods, engineering segments and fast moving consumer goods segments were selected for the study. This resulted in a sample of 100 companies.

3.5 THE RESEARCH FRAME WORK

A framework for conducting the study was prepared in accordance with the nature of the objectives; it was divided into the following two parts. 1) Measures to achieve the objectives and 2) Research Hypotheses.

3.5.1 Measures to Achieve the Objectives

Performance metrics of supply chains such as 1) Cycle time 2) Cost 3) Quality / service and 4) Assets and 5) Logistics cost metrics were selected to measure the SCM performance. The following metrics were used for measurements in the supply chains of selected segments of auto & auto components electronics, engineering, white goods in manufacturing and FMCG segments (Appendix-C).

A. Cycle Time Metrics

1. Procurement cycle time : ___________ days
2. Production cycle time : ___________ days
3. Delivery time : ___________ days
4. Total cycle time : ___________ days
5. Cash – to – cash cycle time : ___________ days
6. Supply chain flexibility (%) : ___________ %
B. Cost Metrics

7. Total supply chain cost (% of sales) : __________ %
8. In-bound transportation cost (% TSCC) : __________ %
9. Out-bound transportation cost (% TSCC) : __________ %
10. Ware – housing cost (% of TSCC) : __________ %
11. Inventory carrying cost (% of TSCC) : __________ %
12. Cost of transit losses (% of TSCC) : __________ %
13. Cost of damages (% of TSCC) : __________ %
14. Other costs (Insurance, Freight Clearance) (% of TSCC) : __________ %
15. Return inventory cost (% of TSCC) : __________ %
16. Return processing cost (% of TSCC) : __________ %

C. Service / Quality Metrics

17. % of on-time deliveries : __________ %
18. % of supply made as per the quantity ordered : __________ %
19. % of supply on desired quality : __________ %

D. Asset Metrics

20. Raw material inventory holding : __________ %
21. Work in process inventory holding : __________ %
22. Finished goods inventory holding : __________ %
23. Inventory turnover (No. of turns) : __________

E. Logistics cost metrics

24. Logistics cost (In-bound + Out-bound) : __________ %

The metric measurement values are compared within the segment and between segments of industries and also compared with Best-in-class of that particular segment of supply chain. Best practices are identified across the industries and bench marked. Statistical analysis such as descriptive statistics including means,
frequencies, and percentages, T-test, F-test (ANOVA), Correlation and Regression analysis and Factor analysis were conducted. The established significance level for rejecting null hypotheses was 0.05 (with 95% confidence level).

3.5.2 Research Hypotheses

Descriptive statistic such as mean, minimum, and maximum standard deviation etc are calculated. Based on this, 24 null hypotheses were tested to investigate the significance of metrics such as cycle time, cost, quality, assets and logistics cost in the supply chain performance.

3.5.2.1 Null Hypotheses

The research hypothesis were formulated with respect to various metrics of performance measurements related to fast moving consumer goods (FMCG) and manufacturing segments relevant to selected industries in India. The null hypotheses considered for the study were:

\( H_{01f} : \) There are no significant differences in the mean of procurement cycle time between FMCG and manufacturing groups. (\( H_{01f} \) 'f' denotes FMCG)

\( H_{02f} : \) There are no significant differences in the mean of production cycle time between FMCG and manufacturing groups.

\( H_{03f} : \) There are no significant differences in the mean of Delivery time between FMCG and manufacturing groups.

\( H_{04f} : \) There are no significant differences in the mean of Total cycle time between FMCG and manufacturing groups.

\( H_{05f} : \) There are no significant differences in the mean of cash-to-cash time between FMCG and manufacturing groups.

\( H_{06f} : \) There are no significant differences in the mean of supply chain flexibility (%) between FMCG and manufacturing groups.

\( H_{07f} : \) There are no significant differences in the mean of Total supply chain cost (% of sales) between FMCG and manufacturing groups.
$H_{08f}$: There are no significant differences in the mean of In-bound transportation cost (% TSCC) between FMCG and manufacturing groups.

$H_{09f}$: There are no significant differences in the mean of Out-bound transportation cost (% TSCC) between FMCG and manufacturing groups.

$H_{010f}$: There are no significant differences in the mean of ware-housing transportation cost (% TSCC) between FMCG and manufacturing groups.

$H_{011f}$: There are no significant differences in the mean of Inventory carrying cost (% TSCC) between FMCG and manufacturing groups.

$H_{012f}$: There are no significant differences in the mean of cost of transit losses (% TSCC) between FMCG and manufacturing groups.

$H_{013f}$: There are no significant differences in the mean of cost of damages (% TSCC) between FMCG and manufacturing groups.

$H_{014f}$: There are no significant differences in the mean of other costs (% TSCC) between FMCG and manufacturing groups.

$H_{015f}$: There are no significant differences in the mean of return Inventory costs between FMCG and manufacturing groups.

$H_{016f}$: There are no significant differences in the mean of return processing cost between FMCG and manufacturing groups.

$H_{017f}$: There are no significant differences in the mean of % of on-time deliveries between FMCG and manufacturing groups.

$H_{018f}$: There are no significant differences in the mean of % of supply made as per the quantity ordered between FMCG and manufacturing groups.

$H_{019f}$: There are no significant differences in the mean of % of supply on desired quality between FMCG and manufacturing groups.

$H_{020f}$: There are no significant differences in the mean of Raw material. Inventory holding between FMCG and manufacturing groups.

$H_{021f}$: There are no significant differences in the mean of Work in progress Inventory holding between FMCG and manufacturing groups.

$H_{022f}$: There are no significant differences in the mean of Finished goods Inventory holding between FMCG and manufacturing groups.

$H_{023f}$: There are no significant differences in the mean of Inventory Turnover (No. of turns) between FMCG and manufacturing groups.

$H_{024f}$: There are no significant differences in the mean of logistics cost (inbound + outbound transpiration cost) between FMCG and manufacturing groups.
Similarly, the research hypotheses were formulated with respect to various metrics of performance measurements related to manufacturing segments. The same null hypotheses were repeated for testing significant differences in the mean values of metrics between the manufacturing groups:

\( H_{01m} \) : There are no significant differences in the mean of procurement cycle time between manufacturing groups. (\( H_{01m} \) 'm' denotes manufacturing).

\( H_{02m} \) : There are no significant differences in the mean of production cycle time between manufacturing groups.

\( H_{03m} \) : There are no significant differences in the mean of Delivery time between manufacturing groups.

\( H_{04m} \) : There are no significant differences in the mean of Total cycle time between manufacturing groups.

\( H_{05m} \) : There are no significant differences in the mean of cash-to-cash time between manufacturing groups.

\( H_{06m} \) : There are no significant differences in the mean of supply chain flexibility (%) between manufacturing groups.

\( H_{07m} \) : There are no significant differences in the mean of Total supply chain cost (% of sales) between manufacturing groups.

\( H_{08m} \) : There are no significant differences in the mean of In-bound transportation cost (% TSCC) between manufacturing groups.

\( H_{09m} \) : There are no significant differences in the mean of Out-bound transportation cost (% TSCC) between manufacturing groups.

\( H_{10m} \) : There are no significant differences in the mean of ware-housing transportation cost (% TSCC) between manufacturing groups.

\( H_{11m} \) : There are no significant differences in the mean of Inventory carrying cost (% TSCC) between manufacturing groups.

\( H_{12m} \) : There are no significant differences in the mean of cost of transit losses (% TSCC) between manufacturing groups.

\( H_{13m} \) : There are no significant differences in the mean of cost of damages (% TSCC) between manufacturing groups.

\( H_{14m} \) : There are no significant differences in the mean of other costs (% TSCC) between manufacturing groups.

\( H_{15m} \) : There are no significant differences in the mean of return Inventory costs between manufacturing groups.
H_{016m}: There are no significant differences in the mean of return processing cost between manufacturing groups.

H_{017m}: There are no significant differences in the mean of % of on-time deliveries between manufacturing groups.

H_{018m}: There are no significant differences in the mean of % of supply made as per the quantity ordered between manufacturing groups.

H_{019m}: There are no significant differences in the mean of % of supply on desired quality between manufacturing groups.

H_{020m}: There are no significant differences in the mean of Raw material Inventory holding between manufacturing groups.

H_{021m}: There are no significant differences in the mean of Work in progress Inventory holding between manufacturing groups.

H_{022m}: There are no significant differences in the mean of Finished goods Inventory holding between manufacturing groups.

H_{023m}: There are no significant differences in the mean of Inventory Turnover (No. of turns) between manufacturing groups.

H_{024m}: There are no significant differences in the mean of logistics cost (inbound + outbound transpiration cost) between manufacturing groups.

3.6 THE RESEARCH METHODOLOGY

This section presents an overview of how this research work is planned and completed referring to the research design, sampling process, and data collection.

3.6.1 Research Design

Exploratory, descriptive and causal defined as 3 general categories of research based on the type of information required and the volume of relevant knowledge pertaining to the subject available at hand. Since these categories of research are not mutually exclusive, any combination of them can, therefore be applied to a research process according to the need. The nature of the present research work also suggests that exploratory approach is appropriate for pilot test. However, after the pilot test descriptive research study was applied. For data
collection the researcher included the entire population in the study. As the population of the sample is small, researcher considered the entire population from the list for data collection. (Tripathi, 2002; Zigmund, 1995; Boud, West fall & Stasch, 2004 & Kottari, 2001). This type of research is called as census study. The list of respondents is enclosed in Appendix-E.

3.6.2 Research Instrument

The research instrument (Appendix-C) consisted of a questionnaire that was specially designed for the study. The questionnaire consisted of 24 statements related to the performance measurement metrics, business profile of the company, better practices and systems that are followed in the company. The questionnaire was designed with the inputs from previous studies (Korgaonkar, 2001; Eicher Research group, 2002; IIMM, 2003; Shah, 2003; and Lapide, 2004, 2006). 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 Economics value added (EVA), Supply chain mapping, Activity based costing (ABC) etc were deleted after the pilot test.

3.6.3 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 based industry body in India. The IIMM database consists of companies of repute spread all across the country. More than 300 companies registered with them formed the sample frame for the study. The IIMM database is itself segregated into broad industry types i.e. fast moving consumer goods (FMCG) and manufacturing. Of these, companies representing auto & components, electronics, white goods,
engineering segments and fast moving consumer goods segments were selected for the study. This resulted in a sample of 100 companies.

Primary data were collected from these samples, through structured questionnaire, followed by interview. In case of non-probability sampling, the sample size decisions are made by calculating size either as if it were a probability sample or else on an “all-you-can afford” basis (Tull & Hawkins, 1984; Wilcox, 2001; Zigmund, 1995; Thompson, 1999 & McNabb 2006). Samples are drawn from the data base maintained by Indian Institute of Materials Management (IIMM). As the samples are drawn from the list, census method has been followed in the present study (www.statpaco.com).

The sample plan proposed for the study is as shown in table 3.1

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Industry segments</th>
<th>Samples (planned)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>FMCG</td>
<td>20</td>
</tr>
<tr>
<td>II.</td>
<td>Manufacturing</td>
<td></td>
</tr>
<tr>
<td>a)</td>
<td>Auto &amp; Auto components</td>
<td>20</td>
</tr>
<tr>
<td>b)</td>
<td>Electronics</td>
<td>20</td>
</tr>
<tr>
<td>c)</td>
<td>White goods</td>
<td>20</td>
</tr>
<tr>
<td>d)</td>
<td>Engineering</td>
<td>20</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>100</td>
</tr>
</tbody>
</table>

3.6.4 Data Collection Procedure

The researcher then collected the data in various stages as described below:

**Stage 1**: Herein, the researcher sent the structured questionnaire to all 80 companies from manufacturing group and 20 companies from the FMCG group that were part of the sample. The questionnaire was sent through post & courier to production, procurement, quality, finance, material planning and marketing heads of these
companies. It included a covering letter highlighting the academic nature of the study and a business return envelope. In all, 18 responses were received from the manufacturing sector and 8 from the FMCG group.

Stage 2: A reminder letter was sent to the remaining companies and 10 responses were received. Some of the companies sought clarifications through email and surface mail. All clarifications were addressed either through email, surface mail or telephone.

Stage 3: During this stage, the researcher contacted the companies through telephone and email. Soft copies of the questionnaire were sent to those companies, who lost / misplaced questionnaire. After the telephonic conversations continuous follow up with the companies, and personal visits to some of the companies, the researcher could get 54 more responses.

Thus, there were 88 usable responses obtained from the selected companies through census method. Statistical package for social studies (SPSS) – 13 was used for conducting statistical analysis.

3.7 SELECTION CRITERION

1) The company should have a sales turnover of above Rs.5crores (minimum)
2) The unit should be in discrete parts manufacturing in the case of manufacturing.
3) The unit should fit into one of the supply chain selected for data collection.
4) The unit should have taken some initiative in Supply chain performance measurements.
5) The IIMM database consists of companies of repute spread all across the country. More than 300 companies registered with them formed the sample frame for the study. The IIMM database is itself segregated into broad industry types i.e. fast moving consumer goods (FMCG) and manufacturing. Of these, companies representing auto & components, electronics, white
goods, engineering segments and fast moving consumer goods segments were selected for the study. This resulted in a sample of 100 companies.

3.8 RELIABILITY AND VALIDITY OF THE INSTRUMENT

Measures of variables should have validity and reliability (Cronbach, 1971; Nunnally, 1978) in order to draw valid inferences from the research. Reliability deals with how consistently similar measures produce similar results (Rosental & Rosnow, 1984), and it has the two dimensions of repeatability and internal consistency (Zigmund, 1995). Internal consistency refers to the ability of a scale item to correlate with other items in the scale that are intended to measure the same construct. Items measuring the same construct are expected to be positively correlated with each other. A common, measure of the internal consistency of a measurement instrument is Cronbach’s alpha. If the reliability is not acceptably high, the scan can be revised by altering or deleting items that have scores lower than a pre-determined cut-off point. If a scale used to measure a construct has an alpha value greater than 0.70, the scale is considered reliable in measuring the construct (Hair, Anderson, Tatham & Black, 1998’ Nunnally, 1978; Leedy, 1997; Venkatraman & Ramanujam, 1996; Seock, 2003; & Sakakibara, Flynn & Schroder, 1993). According Schuessler (1971), a scale is considered to have a good reliability if it has an alpha value greater than 0.60. Hair et al, (1998) suggest that reliability estimates between 0.6 and 0.7 represent the lower limit of acceptability for reliability estimates. In this research, the statements under cycle time, cost, quality and assets metrics were checked for reliability by determining cronbach’s alpha and as alpha value of 0.60 or greater was considered acceptable (Appendix-D). The cronbach alpha value for all the 4 major metrics is shown in the table 3.2 below.

Table 3.2 Reliability statistics

<table>
<thead>
<tr>
<th>Cronbach Alpha</th>
<th>Cycle time</th>
<th>Cost</th>
<th>Quality</th>
<th>Assets</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.811</td>
<td>0.660</td>
<td>0.651</td>
<td>0.760</td>
</tr>
</tbody>
</table>
The validity of a measurement instrument refers to how well it captures what it is designed to measure (Rosental & Rosnow, 1984). Several different types of validity are of concern: content validity, the degree of correspondence between the items selected to constitute a ratio scale and its conceptual definition; criterion validity, the degree of correspondence between a measure and a criterion variable, usually measured by their correlation; and construct validity, the ability of a measure to confirm a network of related hypotheses generated from a theory based on constructs. In this research, the content validity of the measurement instrument was assessed by asking experts to examine it and provide feedback for revision. The expert panel included Professors and research scholars at Indian Institute of Management Kozhikode. After they reviewed the questionnaire, changes were made to clarify and eliminate ambiguous statements in instructions and questions/statements according to their recommendations. Also, in the pilot test, each statement was examined for its clarity and relevance to the purpose of the research, which resulted in some modifications to the statements. For example, statements which are related to economic value added, balanced score card, supply chain mapping etc were deleted. After the data collection with the final questionnaire, the content validity of supply chains performance measurements metrics were assessed by factor analysis. Such analysis provides an empirical assessment of the interrelationships among items in a variable in forming items in a variable in forming the conceptual and empirical foundation.

Internal construct validity was also assessed by factor analysis. In the previous research only descriptive statistics such as mean, median, mode and std. deviations only computed. Because factor analysis provides evidence of the dimensionality of a measure, factor analysis with a varimax rotation was used to determine the number of factors contained in the supply chain performance metrics attributes scales. An eigen value greater than 1 is considered to indicate the presence of an interpretable factor so that factors with eigen values greater than 1 were taken into account for interpretation.
3.9 METHOD OF ANALYSIS

The data gathered from the structured questionnaire were entered with a computer database and then analyzed using the statistical package for the social sciences (SPSS)-13 versions. The data analysis consisted of descriptive statistics including means, frequencies, std. deviations and percentiles, t-tests, F-test (Anova), correlation and regression analysis and factor analysis.

3.9.1 Descriptive statistics

Descriptive statistics such as mean, media, mode, standard deviation etc were computed and used for analysis. Table 1 shows the descriptive statistics, summary of performance measurements between FMCG and manufacturing groups.

3.9.2 T-Test (2 tailed)

T-test was used for testing the significance difference in the mean values between the FMCG and manufacturing groups (Welch, 1938; Cohen & Lillian, 1963). Null hypothesis were tested at 5% significance level (95% confidence level). The metrics of significance and non-significance between the FMCG and manufacturing groups were computed.

3.9.3 F-Test (ANOVA) – one way

F-test procedure was applied for testing the significance difference in the mean values of metrics between manufacturing groups (Welch, 1938; Cohen & Lillian, 1963). Null hypothesis were tested at 5% significance level.
3.9.4 Correlation and regression analysis

Correlation analysis studies the joint variation of two or more variables for determining the amount of correlation between two or more variables. In each performance metrics groups dependent variables are correlated with independent variables. The functional relationships existing between two or more variables are studied. It is used to find out the best fit.

3.9.5 Factor Analysis

The main applications of factor analysis are: (1) to reduce the number of variables and (2) to detect structure in the relationships between variables that is to classify variables. Therefore, factor analysis is applied as a data reduction or structure detection method (Thurstone, 1931 & Gorsuch, 1983).

Some of the most commonly used guidelines are Kaiser – Guttman rule, percentage of variance, the scree test, size of the residuals and interpretability of variance and scree plot test were applied. Kaiser – Guttman rule states that the number of factors to be extracted should be equal to the number of factors having an eigen value (variance) greater than 1.0. Another criterion, related to the latent root criterion, is the percentage of proportion of the common variance (defined by the sum of communality estimates) that is explained by successive factors. The scree option in the PROC FACTOR statement produces a scree plot that illustrates the rate of change in the magnitude of the eigen values for the factors. The rate of decline tends to be fast for the first few factors but then levels off. The "elbow", or the point at which the curve bends, in considered to indicate the maximum number of factors to extract (Pohlmann, 2006; Tabachnick & Fidell, 1996; Thompson, 1999; Tripathi, 2002; Malhotra, 2006; Behrens, 1997; Chong – ho Yu, 2006 & Cooper & Schindler, 1999).
The data was then subject to principal component analysis (PCA), a method categorized under the broad area of factor analysis. Principal components (PC) analysis all the variance in the items. PC is generally considered the best method for the pragmatic purposes of data reduction. With PCA, the 24 metrics of supply chain performance related metrics contained in part-III of the questionnaire were reduced to 7 metrics under 5 broad dimensions which were assigned names such cycle time, cost, quality, assets and logistics cost. To give a bird’s eye view, the flow chart depicting the schema of analysis is presented in Figure 3.1.

In this research, we have used varimax rotation with Kaiser Normalization with which maximum possible simplification is reached. i.e., rotation converged with iterations. With varimax rotational approach there tends to be some high loadings close to -1 or +1 thus indicating a clear positive or negative association between the variable and the factor close to zero, indicating a clear lack of association varimax rotation gives clear separation of factors.
Figure 3.1 Flow chart depicting the schema of the analysis

Development of Research Instrument

Collection of data

Data validation

Interpretation of Factors

Reliability Analysis of the scale using Cronbach's alpha test.

Descriptive statistics
- Mean
- Median
- Mode
- Std. Deviation

Statistical Inference
- Correlation & regression analysis for association
- Factor analysis
- t-test (two tailed)
- F-test (one way)

Interpretation of Findings
3.10 ASSUMPTIONS OF THE RESEARCH STUDY

This research is undertaken with the following assumptions.

1. The subjects understood, responded to the questions correctly and honestly.
2. Instructions to search for information about supply chain performance in selected manufacturing and fast moving consumer goods (FMCG) industries on annual basis, assuming that there is no drastic change in the supply chains performance.
3. All these respondents are already taken up certain initiatives in the Supply Chain performance measurement front.
4. Samples are selected by Census method. Selection by choice not by chance, certain assumption are built in comparisons.

3.11 LIMITATIONS OF THE STUDY

Academic research on any topic itself a continuous and perhaps, an endless process. Each part of that research, therefore, has to have some limitations in the form of either the resource constraints like that of time and money or the self defined scope of the study this work too has some such constraints which, in fact were not confined to any particular stage of the work.

The following are limitations of this study:

1. While reviewing literature the researcher has tried his best to explore as many sources as possible for enrichment of the review. Yet some matter may have been inadvertently over looked. Such matter would have enabled a more critical identification of the research gap and setting of the objectives of this study.
2. All though the sample for this study is selected by census sampling method, the researcher has included the entire population restricted to the following segments a) fast moving consumer goods (FMCG) b) Auto & components c) Electronics d) Engineering and e) White goods.
3. Thus, the interpretation of the findings cannot be generalized to the larger population of fast moving consumer goods (FMCG) and manufacturing segments.

4. The sample size has been just sufficient to estimate population parameters in fast moving consumer goods (FMCG) segments.

5. Generally the companies are found to be apprehensive of any possible misuse of the information on researcher seeks from them about their business. Some of the managers are reluctant in answering some of the metric statement during measurement.

6. The long time period taken to collect the data. This was largely due to the work load of executives in senior positions and non-availability of data readily available with the companies.

7. It would indeed to fair to say that the numbers of units contacted were small, but it was not lack of effort, but want of time, financial resources and informational support.

8. Readily available information on global trends to supply chain performance metrics is very much limited.

9. Some of the respondents are not clear about certain metrics. Lot of discussions took place to make the respondent clear about the concepts involves.

10. The response rate in electronics and engineering segments are less compared to other segments.

11. Samples collected from fast moving consumer goods (FMCG) segments are small compared to manufacturing segments. Hence, F-test (Anova) could not be conducted for fast moving consumer goods (FMCG) segment.

12. The constant delays in obtaining data, and interview resulted in the write up of results only being conducted towards the end of the one year (2004-05). This limited the scope of any follow-up research in particular areas.

13. Some of the metrics such as supply chain flexibility, total supply chain costs, inventory costs etc are difficult to calculate accurately. This has resulted, some limitations in the research work.

14. Metrics in the upstream end are not fully covered. This is considered as major limitations of the research.

This completes the overview of the frame work within which the data is analyzed to meet the objectives. The next chapter presents the analysis and interpretation of data.