CHAPTER 3
RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter describes in length, the methodology applied by the researcher in conducting the proposed research work. The chapter provides details about the research design used for the study, the nature and source of data collected for the study and details about the research instrument used for the research. Further, the chapter provides a brief description of the variables used for the study and provides details about the various tests employed to establish the reliability and validity of the collected data for the purpose of data analysis. Finally, the chapter provides details about the statistical packages and statistical tools used for analyzing the data to empirically test the hypotheses developed from the literature review.

3.2 NOTATIONS

B - Beta Coefficient
e - Level of precision
H-Hypothesis
i- Number of items in the construct
\( \lambda_i \) - Squared sum of factor loading for each construct
Li- Standardized factor loading
N- Number of observation
P- Total number of items in a variable
p value- Significance level
R^2 - Coefficient of determination
Z- Z test value on Normal curve
\( \theta_{\delta} \) - Sum of the error variance terms for a construct
\( \chi^2 \) - Chi Square value
\( \lambda \) - Wilk’s lambda value
\( \rho_c \) - Construct reliability
\( \sigma^2 \) - Variance of an attribute in the population
3.3 RESEARCH DESIGN

The purpose of this research work is to analyze and describe the existing characteristics and nature of manufacturing enterprise with respect to supply chain context. This study also aims to test the causal analysis of relationship among supply chain management related variables and organizational performance of manufacturing industries. Hence, the proposed research is descriptive in nature.

3.4 JUSTIFICATION FOR SELECTING UT OF PUDUCHERRY

The striking point about the Union Territory (UT) of Puducherry is that the manufacturing sector contributes to 50% of the UT’s Gross State Domestic Product (GSDP), while the sector contributes to about 16% of India’s Gross Domestic Product (GDP). The sector accounts for 35.17% of the labour force of the UT, while the sector accounts for 39.3% of the country’s labour force. It can be found that there is some degree of correlation between the labour force engaged in the industrial sector and the sector’s contribution to GDP of the UT, which is a healthy scenario and annual growth rate of GDP in UT of Puducherry is 12.28% which is higher than the national average and some other socio-economic indicators like industrial production index, literacy rate, below poverty index purchasing power parity and per capital income are par and higher when compare with India (Indiastat and CMIE). Hence, the researcher felt that the UT of Puducherry shall be the appropriate for the proposed study the impact of important components of SCM on the performance of the supply chain per se and also on the organizational performance of the manufacturing enterprises.

3.5 NATURE AND SOURCE OF DATA

This study is based on both primary and secondary data. Secondary data pertaining to Gross Domestic Product of India and other related countries for the relevant periods, Gross Domestic State Product for state of Pondicherry, the break up details of number of manufacturing industries, production index in the UT of Pondicherry and India have collected from India stat, Central Statistical Organization, National Statistical Survey Organization, Department of Industries and commerce, Government of Pondicherry, Pondicherry Economics and Statistics department, and Working papers and publications of CMIE.

Primary data pertaining to the supply chain management related variables and organizational performance and profile of manufacturing firms in the Union Territory of Puducherry has been collected using the survey method by administering a well
structured questionnaire to the executives of the manufacturing firms located in the UT of Puducherry.

3.6 RESEARCH INSTRUMENT

Well structured questionnaire has been used to collect primary data, which was administered personally to the executives of the manufacturing firms in the Union Territory of Puducherry. Personal Interview method was employed to collect primary data. The questionnaire consisted of both quantitative and qualitative aspects relating to the manufacturing units surveyed and their position related to the supply chain components and their likely impact on the supply chain performance and organizational performance of the manufacturing firms.

3.7 DEVELOPMENT AND PURIFICATION OF DATA COLLECTION INSTRUMENT

A reliable and valid research instrument is absolutely indispensable for collecting accurate data for the conduct of any research and the process of development of the questionnaire used for the proposed research underwent many processes in the present research work. These processes have been explained in the forthcoming paragraphs.

3.7.1 Validity

Validity testing means testing the instrument whether it has ability to measure what it intends to measure. The two forms of validity testing are 1) Content validity and 2) Construct validity

3.7.1.1 Content Validity

The research instrument must consist of a comprehensive list of items and constructs. These items and constructs can be generated initially from the existing review of literature available. Variables used for measuring the supply chain concerns, supply chain competence, supply chain practices, supply chain performance and organizational performance of the manufacturing firms were collected from an extensive review of literature.

After generating the required variables, the next step is to ensure that the statements included in the research instrument is easily understandable and commands the required content validity. For this, a careful validation process was employed. The instrument was first given to two research scholars and their remarks about the questionnaire were obtained. Next, six professors who were experts in the field of statistics, management, commerce and economics were requested to examine the
instrument and their suggestions were recorded. Finally, two practitioners from
manufacturing industries were requested to read the instrument and their comments
were also recorded. These suggestions were given due consideration and the variables
included in the questionnaire were added, deleted and suitably modified. Thus,
questionnaire content validity was confirmed based on the option and suggestion of
the subject experts and some of the following changes were made to make the
questionnaire clear and more understandable and purposeful:

1) One new question in respect of supply chain concerns was added;
2) Two questions about product design and information and decision support system
   of supply chain concerns were deleted;
3) The wordings of some questions with respect to supply chain competence were
   reframed to avoid bias of response.
4) Questions with respect of supply chain practices namely, information sharing,
   aggregate planning and managing inventories, supply chain integration and
   strategic partnering, planning demand and supply, designing distribution network
   and reduced response rate were deleted.
5) Supply chain performance related variables were reduced from three construct
   variables to single construct variable.
6) Questions in respect of organizational performance such as overall customer
   services levels, return on assets, average production cost, and customer retention
   rate were deleted.
7) Pharmaceutical and plastics industries were included in the manufacturing profile
   section.
8) The question on the approximate total capital invested in the company was added
   in the manufacturing profile.
9) The question on type of business organization was added to the manufacturing
   profile questions.

The above changes were incorporated after extensive consultations with
subject experts and by exercising due diligence to ensure that the objectives of the
research shall be effectively and efficiently accomplished by the data collection
through administering the instrument. Thus, a skeleton of the questionnaire was
arrived. Multiple choice questions relating to the profile of the manufacturing
enterprises constitute the first section, while the opinion of the executives about the
different supply chain components and the organization performance of their
enterprises, to be obtained in a five point scale, and constitute in different sections. The finalized questionnaire consists of six sections. The first section is on supply chain concerns and it contains totally 9 questions. It aims to collect perception about supply chain issues of manufacturing organization. The second section are on supply chain competence and it contains totally 14 questions. It aims to collect the perception of the executives about supply chain competence of their enterprises. The third section is about supply chain practices. It contains totally 12 questions about the opinion of the executives about the extent of implementation of supply chain practices in their respective enterprises. The fourth section consists of questions related to supply chain performance. This section contains eight statements about the opinion of the executives about supply chain performance of their enterprises over the past 3 years.

The fifth section consists of questions in respect of the organizational performance of the manufacturing enterprises. This section contains eight statements to measure the opinion of the executives about the organizational performance of own enterprise when compared with their major competitors. The sixth and final section contains questions related to the profile of the manufacturing units studied. Totally this section consists of 20 questions.

3.7.1.2 Construct Validity

Construct validity denotes the extent to which the constructs used for the study actually measure the intended performance in comparison to the intended measurement standards. It includes the following:

1) Composite Reliability
2) Convergent Validity
3) Unidimensionality and Discriminate Validity

3.7.1.2.1 Composite Reliability

Usually, the Cronbach coefficient is used to assess reliability of survey instrument. Only if the Cronbach reliability value exceeds 0.60, the instrument shall be treated as reliable. On the other hand, it has been observed that Cronbach value does not provide equal weightage to all items in the construct and hence the results of reliability may be biased. Hence, an alternative test of composite reliability needs to be carried out. Composite reliability is computed using the formula (3.1)
Results of composite reliability for each constructs are shown in Table 3.1. From the calculation, it is observed that all composite reliability values are greater than 0.73. This clearly shows that the reliability of the data is well established.

**Table 3.1 Assessment of Construct Reliability**

<table>
<thead>
<tr>
<th>Construct</th>
<th>Indicators</th>
<th>Reliability (α)</th>
<th>Composite reliability (ρ_c)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Chain Concerns</td>
<td>9</td>
<td>0.7153</td>
<td>0.73</td>
</tr>
<tr>
<td>Supply Chain Competence</td>
<td>14</td>
<td>0.8595</td>
<td>0.84</td>
</tr>
<tr>
<td>Supply Chain Practices</td>
<td>12</td>
<td>0.7458</td>
<td>0.73</td>
</tr>
<tr>
<td>Supply Chain Performance</td>
<td>8</td>
<td>0.7694</td>
<td>0.75</td>
</tr>
<tr>
<td>Organizational Performance</td>
<td>8</td>
<td>0.7854</td>
<td>0.75</td>
</tr>
</tbody>
</table>

3.7.1.2.2 Unidimensionality

Unidimensionality explains whether all items are measuring a single theoretical variable or construct. Multiple goodness of fit index is used to test the unidimensionality. Two widely used goodness of fitness indexes are GFI and RMR. If GFI values more than 0.90, and if RMR value is not beyond 0.10 then that construct is meant to be unidimensionality construct.

3.7.1.2.3 Convergent Validity

Convergent validity indicates the degree to which consistency is accomplished by the measurement instrument across multiple operationalization. Only those variables with convergent validity should be included for study. Items with Average Variance extracted (AVE) of more than 0.50 possesses convergent validity and all other variables should be dropped. AVE is computed using the formula (3.2).

Unidimensionality and Convergent Validity results are shown in Table 3.2 and it depicts that the AVE value is around 0.50, GFI value exceeds the threshold limit of 0.90 and value of RMR is less than 0.10. Hence, it is implies that the research instrument possesses the desired convergent and unidimensionality validity.
Table 3.2 Assessment of Unidimensionality and Convergent Validity

<table>
<thead>
<tr>
<th>Construct</th>
<th>Indicators</th>
<th>$X^2$(DF)</th>
<th>P-Value</th>
<th>Goodness of Fit Index (GFI)</th>
<th>RMR</th>
<th>AVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Chain Concerns</td>
<td>9</td>
<td>81.49(27)</td>
<td>0.000</td>
<td>0.93</td>
<td>0.052</td>
<td>0.47</td>
</tr>
<tr>
<td>Supply Chain Competence</td>
<td>14</td>
<td>206.97(77)</td>
<td>0.000</td>
<td>0.90</td>
<td>0.054</td>
<td>0.46</td>
</tr>
<tr>
<td>Supply Chain Practices</td>
<td>12</td>
<td>353.58(54)</td>
<td>0.000</td>
<td>0.81</td>
<td>0.080</td>
<td>0.55</td>
</tr>
<tr>
<td>Supply Chain Performance</td>
<td>8</td>
<td>50.20(20)</td>
<td>0.002</td>
<td>0.93</td>
<td>0.041</td>
<td>0.54</td>
</tr>
<tr>
<td>Organizational Performance</td>
<td>8</td>
<td>71.86(20)</td>
<td>0.000</td>
<td>0.93</td>
<td>0.042</td>
<td>0.49</td>
</tr>
</tbody>
</table>

3.7.1.2.4 Discriminant Validity

Discriminant validity denotes the independence of the constructs used for the study. It indicates the degree to which the five constructs used in the study are distinct among themselves. Constructs studied shall be having discriminant validity if the Variance Explained (VE) value of any two constructs exceeds the square of the correlation among the two constructs.

Results of square correlation between constructs are shown in Table 3.3.

Table 3.3 Square Correlation between Constructs

<table>
<thead>
<tr>
<th>Construct</th>
<th>VE</th>
<th>Square Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organizational performance versus performance</td>
<td>0.595</td>
<td>0.5929</td>
</tr>
<tr>
<td>Organizational performance versus practices</td>
<td>0.59</td>
<td>0.4489</td>
</tr>
<tr>
<td>Organizational performance versus competence</td>
<td>0.53</td>
<td>0.2601</td>
</tr>
<tr>
<td>Organizational performance versus concerns</td>
<td>0.46</td>
<td>0.3844</td>
</tr>
<tr>
<td>Performance versus competence</td>
<td>0.45</td>
<td>0.5476</td>
</tr>
<tr>
<td>Performance versus concerns</td>
<td>0.51</td>
<td>0.1521</td>
</tr>
<tr>
<td>Performance versus practices</td>
<td>0.48</td>
<td>0.4489</td>
</tr>
<tr>
<td>Practices versus concerns</td>
<td>0.58</td>
<td>0.5476</td>
</tr>
<tr>
<td>Practices versus competence</td>
<td>0.47</td>
<td>0.1521</td>
</tr>
<tr>
<td>Concerns versus competence</td>
<td>0.51</td>
<td>0.1521</td>
</tr>
</tbody>
</table>

Table 3.3 depicts that Variance Explained (VE) value in respect of all construct is greater than squared correlation of two construct values. Hence, it can be concluded that the research instrument used for this study possesses the desired discriminate validity.

3.7.2 Reliability Test

Reliability means the ability of a measuring instrument to give accurate and consistent results. The question of reliability arises only for the questions used to measure perception which cannot be accurately measured. In this research, statements are used to measure supply chain management related variables and organizational
performance of manufacturing enterprises. For all the statements five points scale is used.

Before the launch of full-fledged data collection, a small pilot study carry out to check required reliability of the constructs included in the questionnaire. This shall ensure that the constructs included in the questionnaire shall capture the necessary data needed for the research. From the pilot study results, the questionnaire was further modified to ensure that the questionnaire shall best serve the cause of capturing the desired information regarding supply chain of manufacturing enterprises. This final questionnaire shall be used for the full scale survey.

To measure the reliability of instrument Cronbach alpha is calculated using SPSS 16. If the alpha value is more than 0.6, it is presumed that the instrument is reliable. Initially, alpha value was calculated for the data collected through pilot study. This survey has been conducted not only for testing reliability of instruments but also for making required changes in the questionnaire in order to elicit necessary information from respondents. The questionnaire has been altered according to the feedback given by the respondents during the initial pilot study. The altered questionnaire is again put under reliability test with another thirty respondents. The Cronbach alpha value has been calculated again for the next set of respondents. This process has been repeated again with another set of respondents to ensure consistency. The measured reliability values in different stages are shown in Table 3.4.

<table>
<thead>
<tr>
<th>Sl. no</th>
<th>Constructs</th>
<th>Alpha value</th>
<th>Pilot Study</th>
<th>First 30 Respondents</th>
<th>Next 30 Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Supply chain concerns</td>
<td>0.5863</td>
<td>0.6866</td>
<td>0.7153</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Supply chain competence</td>
<td>0.8447</td>
<td>0.8682</td>
<td>0.8595</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Supply chain practices</td>
<td>0.6990</td>
<td>0.8197</td>
<td>0.7458</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Supply chain performance</td>
<td>0.7524</td>
<td>0.7763</td>
<td>0.7694</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Organizational performance</td>
<td>0.7234</td>
<td>0.7532</td>
<td>0.7854</td>
<td></td>
</tr>
</tbody>
</table>

From the above table, it is clear that the alpha value has improved after pilot study. The alpha values for data collected from the first 30 respondents after making changes are more than 0.6 which means the items or statements employed to assess the dimensions or variables are reliable. The alpha values for the data, collected from second set of 30 respondents are more or less same as the alpha values for data collected from first 30 respondents. This implies that no change is required to be effected in the research instrument and there is no early response bias.
This reliability test shows the statements used to measure Supply Chain Concerns, Supply Chain Competence, Supply Chain practices; Supply Chain Performance and Organizational Performance of the manufacturing enterprises are reliable. Hence, it can be inferred that every statement is useful to measure the opinion of the executives about their manufacturing enterprises. The variance of individual characteristics can be measured by using these statements. Now, the research instrument is absolutely ready for large scale survey.

3.8 SAMPLING DESIGN

The list of manufacturing enterprises operating in different districts was collected from Department of Industry and commerce and statistics of Union Territory of Puducherry. This list was taken as sample frame of this research work. The manufacturing enterprises that were operating under micro level enterprises were excluded. The sampling units for the survey were chosen through simple random sampling using lottery method.

3.9 SAMPLE POPULATION

Sample population refers to the population from which the sample for the proposed study is drawn. The manufacturing enterprises operating in different enclave (Karaikal, Mahe and Yanam) of the Union Territory of Puducherry constitute the population for the research work. Karaikal is located in Tamil Nadu, Mahe is located in Kerala and Yanam is located in Andhra Pradesh hence sample population represents the four southern states behavior of India.

3.10 SAMPLE SIZE DETERMINATION

The formula (Israel, 2009) used to arrive at the sample size for the research work is indicated below:

\[
n_0 = \frac{Z^2 \times \sigma^2}{e^2}
\]

where \( n_0 \) - sample size,
\( Z \) - Value of Z in normal distribution curve,
\( \sigma^2 \) - Level of precision and variance of an attribute in the population.
\( Z = 1.64 \)
\( \sigma = 9.65 \)
\( e = 1 \)

\[
n_0 = \frac{1.64^2 \times 9.65^2}{1^2} = 250.46
\]
Hence, the sample size for the study is fixed as 255.

3.11 SAMPLING TECHNIQUE

Sampling technique used in the present research work is simple random sampling using lottery method.

3.12 DATA COLLECTION METHOD

Data collection of this research work is personal interview using structured questionnaire with manufacturing executives of Union Territory of Puducherry.

3.13 CHECKING ASSUMPTIONS

The following section is process of checking the multivariate data analysis assumptions (Hair et al., 2010). Multivariate techniques having a set of assumptions that based on fundamental statistical theory. Although many assumptions or requirements come into play in multivariate statistical techniques, four of them potentially affect every multivariate statistical technique especially SEM which are given below:

1. Normality
2. Homogeneity
3. Multicollinearity
4. Linearity

3.13.1 Normality

Figure 3.1 depicts the shape of the distribution of data and diagram of the histogram that compares the observed data with normal distribution.

![Figure 3.1 Normality Plot](image)

The above figure portrays that most of the data come under normal distribution curve and hence, the data set is confirmed to be possessing normality.
For probing the normal probability plot, normality of data can be evaluated using statistical tests through Kolmogorov-Smirnov test.

One-sample Kolmogorov-Smirnov test result are shown in Table 3.5

<table>
<thead>
<tr>
<th>Normal Parameters</th>
<th>CON</th>
<th>COM</th>
<th>PRA</th>
<th>PER</th>
<th>OP</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>255</td>
<td>255</td>
<td>255</td>
<td>255</td>
<td>255</td>
</tr>
<tr>
<td>Mean</td>
<td>2.97</td>
<td>3.35</td>
<td>3.20</td>
<td>3.30</td>
<td>3.21</td>
</tr>
<tr>
<td>Std. Deviation</td>
<td>0.69</td>
<td>0.55</td>
<td>0.65</td>
<td>0.60</td>
<td>0.70</td>
</tr>
</tbody>
</table>

Most Extreme Differences

<table>
<thead>
<tr>
<th></th>
<th>CON</th>
<th>COM</th>
<th>PRA</th>
<th>PER</th>
<th>OP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absolute</td>
<td>0.06</td>
<td>0.06</td>
<td>0.06</td>
<td>0.05</td>
<td>0.06</td>
</tr>
<tr>
<td>Positive</td>
<td>0.06</td>
<td>0.06</td>
<td>0.06</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>Negative</td>
<td>-0.06</td>
<td>-0.05</td>
<td>-0.04</td>
<td>-0.03</td>
<td>-0.06</td>
</tr>
</tbody>
</table>

Kolmogorov-Smirnov Z

<table>
<thead>
<tr>
<th></th>
<th>CON</th>
<th>COM</th>
<th>PRA</th>
<th>PER</th>
<th>OP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.09</td>
<td>1.06</td>
<td>1.04</td>
<td>0.94</td>
<td>0.97</td>
<td></td>
</tr>
<tr>
<td>Asymp. Sig. (2-tailed)</td>
<td>0.17</td>
<td>0.21</td>
<td>0.22</td>
<td>0.33</td>
<td>0.29</td>
</tr>
</tbody>
</table>

It can be inferred from the above table that the significant value is greater than 0.05. It means that data of each construct are possessing normal distribution properties.

3.13.2 Homogeneity

Homoscedasticity is another of multivariate technique assumption that dependant variable demonstrate equal variance existence across the variety of predictor variables. For testing the homogeneity, levene statistic was used to check the homogeneity issues and the homogeneity of variances are shown in Table 3.6.

<table>
<thead>
<tr>
<th>Constructs</th>
<th>Levene Statistic</th>
<th>df1</th>
<th>df2</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concern</td>
<td>1.952</td>
<td>11</td>
<td>243</td>
<td>0.05</td>
</tr>
<tr>
<td>Competence</td>
<td>1.204</td>
<td>11</td>
<td>243</td>
<td>0.285</td>
</tr>
<tr>
<td>Practice</td>
<td>1.502</td>
<td>11</td>
<td>243</td>
<td>0.131</td>
</tr>
<tr>
<td>Performance</td>
<td>0.956</td>
<td>11</td>
<td>243</td>
<td>0.488</td>
</tr>
<tr>
<td>Organizational</td>
<td>1.449</td>
<td>11</td>
<td>243</td>
<td>0.152</td>
</tr>
<tr>
<td>Performance</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

From the above table, it is observed that the significant value is greater than 0.05. Hence, it can interpret that the five constructs does not have any homogeneity issues.
3.13.3 Multicollinearity

Multi Collinearity is important issue when researcher uses more than one independent variable to predict a dependent variable. If there is any relationship among independent variables then multicollinearity problem will be there. Collinearity Statistics contains Tolerance and VIF (Variance inflation factor). If value of VIF higher than five and tolerance level is less than 0.2 then it shows that presence of multicollinearity problem and Results of multicollinearity test are shown in Table 3.7.

Table 3.7 Multicollinearity

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>Collinearity Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B Std. Error Beta t Sig.</td>
<td>Tolerance VIF</td>
<td></td>
</tr>
<tr>
<td>I (Constant)</td>
<td>0.171 0.284 0.184 3.420 0.001</td>
<td>.603 0.547 .919 1.088</td>
<td></td>
</tr>
<tr>
<td>CON</td>
<td>0.188 0.055 0.184 3.167 0.002</td>
<td>.760 1.316 .707 1.415</td>
<td></td>
</tr>
<tr>
<td>COM</td>
<td>0.236 0.074 0.188 2.278 0.024</td>
<td>.759 1.318</td>
<td></td>
</tr>
<tr>
<td>PRA</td>
<td>0.150 0.066 0.140 5.362 0.000</td>
<td>.759 1.318</td>
<td></td>
</tr>
<tr>
<td>PER</td>
<td>0.368 0.069 0.318 6.925 0.001</td>
<td>.759 1.318</td>
<td></td>
</tr>
</tbody>
</table>

a. Dependent Variable: Organizational Performance

The multiple regression analysis results displayed by Table 3.7 serves as testimony to the fact that there is no multicollinearity issues in the data set as the VIF value is less than 5 and tolerance level value is greater than 0.2.

3.13.4 Linearity

For checking the linearity in the data set curvilinear regression was used and Results of linearity are shown in Table 3.8.

Table 3.8 Linearity

<table>
<thead>
<tr>
<th>Equation</th>
<th>R Square</th>
<th>F</th>
<th>df1</th>
<th>df2</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linear</td>
<td>0.025</td>
<td>6.438</td>
<td>1</td>
<td>253</td>
<td>0.002</td>
</tr>
<tr>
<td>Logarithmic</td>
<td>0.016</td>
<td>4.068</td>
<td>1</td>
<td>253</td>
<td>0.014</td>
</tr>
<tr>
<td>Inverse</td>
<td>0.008</td>
<td>2.087</td>
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<tr>
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<td>6.859</td>
<td>2</td>
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<td>5.035</td>
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<td>0.021</td>
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<tr>
<td>Compound</td>
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<td>6.925</td>
<td>1</td>
<td>253</td>
<td>0.001</td>
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<tr>
<td>Power S</td>
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From the above table, it can be observed that the curvilinear regression results show the significant value in linear regression equation model. This indicates that the data possesses the desired linearity, satisfying the linearity assumption. So data fulfills all the four assumptions related to multivariate analysis. Hence, structural equation model (SEM) can be aptly used for this data.

3.14 RESEARCH TOOLS AND SOFTWARE PACKAGE USED

Research tools are statistical techniques used for data analysis and arrive at meaningful conclusions. The statistical packages of SPSS 16, LISREL 8.72 and STATA 10 were used. The following statistical tools were used to analyse data:

1) Simple Mean
2) Chi-square test
3) Independent Sample T-Test
4) Analysis of Variance (ANOVA)
5) Factor Analysis
6) Cluster Analysis
7) Discriminate Analysis
8) Correspondence Analysis
9) Canonical correlation
10) Structural Equation Modeling (SEM) - Confirmatory Factor Analysis (CFA) and Path analysis

3.14.1 Simple Mean

The simple mean is the commonly used measure of central tendency used in the present research on many occasions like ranking the priority of supply chain concerns, competence, practices, performance and organizational performance of manufacturing industries.

3.14.2 Chi-square test

Chi-square test is a testing tool used for testing hypothesis. Chi-square test is a non-parametric test in which no rigid assumptions are necessary about the population. In this research chi-square test is used as a test of independence to explain whether two attributes are associated or not without indicating strength or direction of relationship. When the SPSS 16 package is used for chi-square test, Pearson chi-square, likelihood-ratio chi-square, and linear-by-linear association chi-square are showed with degrees of freedom and significance value. Here, significance value means level of significance of particular chi-square value for those degrees of
freedom. If the level of significance is less than 0.05 then the particular null hypothesis can be rejected and the alternate hypothesis can be stated that there exists a significant association between those two attributes. In this research work Chi-square test of independence was used to find out the association among manufacturing industry profile variable and clustered variables of supply chain concerns, competence, practices, performance and organizational performance groups.

3.14.3 Independent Sample T-Test

The Independent-sample T-test procedure compares means for two groups of cases. Independent sample T-Test is used to find out whether SCM related software usage of manufacturing industries is different with factored variables of supply chain concerns, competence, practices, performance and organizational performance. SPSS 16 produces statistics like mean, standard deviation, and standard error of the mean for each variable. For arriving conclusion only t-value along with the significance is used. If the significance value is less than 0.05, then the null hypothesis will be rejected and the accepted alternate hypothesis is that there exists a significant difference between usage and not usage of SCM related software on that particular dependent variable.

3.14.4 Analysis of Variance (ANOVA)

Analysis of variance is used compare more than two means are equal or not. For post-hoc analysis Duncan method is used. The analysis of variance is used to find out the impact of manufacturing profile variables and factored variables of supply chain concerns, competence, practices, performance and organizational performance. If the significant value is less than 0.05, then it is presumed that categories in independent variable are differing on the mean values of dependent variable.

3.14.5 Factor Analysis

Factor analysis was applied to condense the number of items or variables into minimum number of manageable items or variables. The need to use factor analysis is to test the two statistical test that is Bartlett’s test and KMO test. The Kaiser-Meyer-Olkin (KMO) test of sampling adequacy signifies the proportionate variance of variables or items which may be caused through new factors. A higher value that is more than 0.50 value of KMO test depicts that factor analysis will helpful for particular data set. But if result value is less than 0.50 then that factor analysis will not useful for the data analysis. Seven methods of factor extraction are available but in this study Principle Component analysis is used. Five methods of rotation are
available but in this study Varimax rotation were used for the purpose study. The researcher took mean value of variables included into factor are used for further analysis. The factor analysis applied in this research work on the variables of supply chain concerns, competence, practices, performance and organizational performance into manageable factor based on loadings of each variable.

3.14.6 Cluster Analysis

Cluster analysis is applied to group the manufacturing industries based on the variables of supply chain concerns, competence, practices, performance and organizational performance and in this research work, K-means cluster method is used.

3.14.7 Discriminant Analysis

In the present study discriminant analysis is used for two purposes. One is to test the reliability of cluster by studying whether the clusters are distinctive groups to be studied separately and the second purpose is to find out the most influencing variable among all influencing variables.

3.14.8 Correspondence Analysis

The Correspondence analysis gives pictorial representation of association between different categories of two variables. This is also very widely used in this research. In this research work was used to find out the association among manufacturing industry profile variable and clustered variables of supply chain concerns, competence, practices, performance and organizational performance groups

3.14.9 Canonical Correlation

Canonical correlation is normally applied to estimate the sharing relationship among two or more set of variables. These analysis results provide individual relationship that is between two variables and also provide overall relationship that is between two or more set of variables. In this research work, STATA 10 software was used to estimate the canonical correlation analysis and it was used to find out the overall relationship among selected manufacturing industry profile variable and variables of supply chain concerns, competence, practices, performance and organizational performance are tested

3.14.10 Structural Equation Modeling (SEM)

SEM is consists of two components that is measurement model or confirmatory analysis and structural model or path analysis. Measurement model is employed to identify the items of each construct or variable and also evaluate
reliability and validity of each variable or construct. On the other hand, the structural model is employed to examine the causal relationship among constructs or variables. In this research work, LISREL 8.72 (Linear Structural Relations) software was developed by Joreskog and Sorbomin 1989 is one among the generally applied software for structural equation modeling estimations. To test data set fitting to proposed conceptual model will be estimate model. The conceptual model tested the proposed ten hypotheses using structural equation modeling (SEM) framework.

3.15 CONCLUSIONS

It can be inferred from the above discussion that the research instrument used for this present research work is highly valid and reliable as it has passed all the tests needed to achieve the reliability and validity of the data collected. Further, the research process used for conducting this study is also highlighted in this chapter and the results of the study is discussed elaborately in the next chapter on “Results and Discussions”.