CHAPTER 3
RESEARCH
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3.1. Significance of the Study

3.1.1. India currently accounts for only 3.3% of the total chemical market. Indian chemical industry accounted for ~13% of the total India’s exports. Indian chemical sector is very crucial for the economic development of country. The chemical industry is today the largest and fastest growing in Gujarat's manufacturing sector. Also there is a rising concerns around climate change and depleting natural resources, focus on sustainability is another key trend impacting the chemical industry.

3.1.2. One of the biggest challenges for the chemical industries in 21st century is the growing need for integrating environmentally sound practices into supply chain management in logistics practices. Green supply chain management (GSCM) is one such idea that covers every stage in manufacturing from the first to the last stage of life cycle, i.e. from product design to recycle.

3.1.3. The chemical industry in India is fragmented and dispersed. It is Multi product and multifaceted – which really makes it complex and a challenging task to address sustainability issues. Diverse products are manufactured, using conventional and semi modern technologies. The sector has been labeled to be one of the most polluting industries.

3.1.4. After going through the available literature it was found that very little research has been done in area of GSCM in chemical industries in India. Even since the chemical industries are more crucial for implementing this GSCM to reduce their continuously increasing effect on the environment. This calls for the research in chemical industries for GSCM practices and is being undertaken as the topic for the research study with a special focus on chemical industries in Gujarat state.
3.2. Objectives of the study

3.2.1. As the focus of the Green supply chain management in Chemical Industries in Gujarat the objectives of the study are envisaged as under.

a. To study the current scenario of Green Supply Chain Management in Chemical industries and find out the awareness of GSCM practices in chemical industries in Gujarat Region.

b. To measure the current status perception, practices and future direction of “green or Sustainable development” activities within the supply chain of the chemical Industries in Gujarat and to identify the inadequacies.

c. To identify and investigates the macro and micro factors leading to the development of a green or environmental supply chain.

d. To identify the green supply chain management practices adopted by the chemical industries in Gujarat and its critical factors.

e. To identify the Critical factors affecting the performance of implementation Green Supply chain Management Practices in chemical industries.

f. To identify the benefit expected and achieved through the Integrating the sustainable development and “green” factor to the Supply Chain Management of the chemical Industries.

g. To establish the potential link among GSCM Drivers, GSCM practice initiatives and GSCM and their interrelationships with each other.

h. The overall aim of this research is to develop a strategic ‘roadmap’ for successfully overcoming the barriers that Chemical Industries in Gujarat face in adopting green Supply chain Management practices and moving towards sustainable business development.

i. To investigate the various problems that enterprises may face during implementation of Green Supply Chain Management practices.
j. To provide the practical suggestions to solve the problems faced by chemical industries and the managerial implication.

### 3.3. Research Approach

3.3.1. The entire research is based upon both the secondary as well as primary research. The secondary information has been collected from the various previous published as well as unpublished research articles. The major focus is on primary research conducted through structured questionnaire and personally handled detailed primary information collected from the various industries.

**Secondary Data:**

To get insight into the research area and develop the hypothesis, the literature from the following sources is reviewed:

a. Library of leading B-Schools like IIM-A, AMA and NIM

b. E-libraries and Information available on Internet.


**Primary Data:** Primary data is collected through structured questionnaire.

3.3.2. The entire research is carried out in the two phases.

In **First phase**, exploratory research design is used to study the macro environment in which the Chemical Industries are operating. Mainly focus group interviews and Depth interviews techniques are used during this exercise. Literature review is done to study the overall business environment and relate various findings of it are with the outcome of exploratory research to identify critical success factor for Green supply chain networks.

In **Second phase**, specific Field (applied) research is conducted to test the hypothesis and to understand the criticality of individual factors, which have been derived as critical success factors from exploratory research.
3.4. Sampling Procedure

3.4.1. This study used an exploratory research design and descriptive research design to determine the relationships among various components of Green Supply Chain Management Practices and interrelationships among them. The non-probability convenience sampling method is used for data collection out of the Chemical Industries List provided by iNDEXTb published in 2010. The data provided by iNDEXTb for Chemical Industries in Gujarat published on 2010 is as follows: (Note: After this there is no other published data available.)

Table 3.1. Target Population Statistics

<table>
<thead>
<tr>
<th>Category</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large and Medium Scale and Factory Units</td>
<td>2052</td>
</tr>
<tr>
<td>Small Scale Industries</td>
<td>16000</td>
</tr>
<tr>
<td>Total Population</td>
<td>18,000</td>
</tr>
</tbody>
</table>

3.4.2. The managers of Environment, Health and Safety (EHS) and Environment Management System (EMS) departments at various Chemical Industries are considered as sample universe for sampling procedure. The study combines issues related to the environment issues with others supply chain functions. Therefore, the appropriate person from which the required data could be obtained should ideally have knowledge about both aspects. Chemical Industries especially the Large and Medium sized industries have found to usually appoint a team for handling the Environment, Safety and Health related issues for the organization or for handling environment management systems department. The team members are often designated as Environment Management Representatives (EMR). This team keeps all the documents related to green issues in the firm and helps in certification process of ISO 14001 etc and makes regular updates in information and reports the progress of various environment activities at Industry. In many Large and Medium Industries there is a separate Environment, Safety and Health department of Environment Management Department itself. Since Managers and officials from such Department are expected to be more informative about green issues in the firm. The Questionnaires are addressed to them.
3.5. Sample Design

3.5.1. There exists a large population of small medium and large chemical industries in Gujarat. Thus the standards sample size for a large population with the 95% confidence interval and the 5% error give 384. Thus 384 numbers of chemical firms in Gujarat is being surveyed.

\[ n = \left( \frac{Z_{\alpha/2}}{E} \right)^2 \frac{p^*(1-p^*)}{\sigma^2} = \frac{1.96^2 \times 0.5 \times 0.5}{0.05^2} = 384.16 \]

This was initial estimation of sample, after conducting the initial sample survey and pilot study; it was revealed that the Small Scale Industries awareness for Green Supply Chain Management (GSCM) Practices is very less and almost nil implementation. Therefore, only Large and medium size Industries and large factory units are considered in Population. As per the data published and provided by iNDEXTb the Large and Medium size Chemical Industries including Factory Units in Gujarat are 2082 in numbers. After considering this finite population of Large and Medium size Chemical Industries in Gujarat. New sample size calculation performed with consideration of Finite Population correction factor with \( N = 2052, n = 384, p = 0.5, q = 0.5 \), Confidence level = 95%, \( \alpha = + \text{ or } - 5\% \) gives \( n = 324 \) as sample size as shown below.

\[ nf' = \frac{nN}{n + (N-1)} = \frac{384.16 \times 2052}{384.16 + (2052-1)} = 323.71 = 324(\text{approx}) \]

3.6. Instrument (Questionnaire) Design

3.6.1. The first step is selecting GSCM attributes by reviewing the literature on green/environmental logistics and supply chain management research. This was followed by the design of the questionnaire and personal interview with the GSCM practitioners. Information sought is first specified, and then the following issues were settled: questionnaire type and its method of administration, the content of question, form of response to the sequence of the questions. The final questionnaire contains three major portions:
a. The first portion contains the statements regarding major drivers of Green Supply Chain Management which motivates the Chemical Industries to implement GSCM practices across their organization.

b. The second portion contains the statements regarding six major Green Supply Chain Management (GSCM) practices followed and implemented by Chemical Industries to implement GSCM practices across their organization.

c. The third portion contains the variables regarding benefits of using GSCM Practices at Chemical Industries. It includes statements related to GSCM performance variables.

3.6.2. All the questions in final questionnaires are close-ended in nature except two at last which asks for their customized answers. To ensure the validity of the content in the questionnaire items the organized review of the survey instrument’s content to ensure it includes everything it should and does not include anything it should not. Experts from academia, and chemical Industries as well as GSCM Practitioners were asked to review the draft questionnaire to confirm that the questionnaire covered the main aspects on GSCM and can be understood by the respondents. Five point scales where 1 is for strongly disagree and 5 is for strongly agree to indicate the level of agreement for the GSCM implementation.

3.6.3. Pilot Study

A pilot study conducted to test and refines the questionnaire. A total of 26 valid responses from the 40 were received in the pilot test. Based on the suggestion from the respondents, minor modifications were made to the questionnaire.
Table 3.2: Pilot Study Details

<table>
<thead>
<tr>
<th>No. of Respondents</th>
<th>Geographical Classification</th>
<th>Respondents form Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>North Gujarat</td>
<td>Gandhinagar, Mehsana, Patan,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sabarkantha, Patan</td>
</tr>
<tr>
<td>8</td>
<td>South Gujarat</td>
<td>Surat, Navsari, Vapi, Valsad</td>
</tr>
<tr>
<td>8</td>
<td>East Gujarat</td>
<td>Vadodara, Panchmahal, Dahod</td>
</tr>
<tr>
<td>8</td>
<td>West Gujarat</td>
<td>Rajkot, Bhavnagar, Junagadh, Amreli,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Veraval, Jamnagar</td>
</tr>
<tr>
<td>8</td>
<td>Central Gujarat</td>
<td>Ahmedabad, Anand, Kheda</td>
</tr>
</tbody>
</table>

3.7 Major Hypothesis

a. There is an association between the state of green supply chain management process ISO 14001 certification achieved by an organization.

b. There is an association between the state of green supply chain management process and adoption of Environmental Management System.

c. There is an association between the state of green supply chain management process and the size of an organization.

d. The preferences of organizations to work with various external parties/stakeholders differ. (There are three Hypothesis to check the change in preference difference of Chemical Industries of working with all 6 external stakeholders namely Competitors, Suppliers, Consultants, 3PL providers, Governmental Agencies and Customers)

e. There is a significant impact of GSCM Drivers (X) on GSCM Practice (Y) adopted by firms.

Here X – 8 GSCM Drivers derived from the Factor Analysis and Y – 7 GSCM Practices derived from the Factor Analysis

Where $Y =$ Green Manufacturing, Green Procurement, Green Designing, Green Supplier Development, Green Management, Green Logistics, Green Marketing. (There are 48 Hypothesis to check the significance)

f. There is a significant impact of GSCM Practices ($Y$) on GSCM Performance ($Z$) of firms.

Here $Y = 7$ GSCM Practices derived from the Factor Analysis and $Z = 5$ GSCM Performance factors derived from Factor Analysis

Where $Y =$ Green Manufacturing, Green Procurement, Green Designing, Green Supplier Development, Green Management, Green Logistics, Green Marketing.

Where $Z =$ Environmental Performance, Financial Performance, Operational Performance, Competitive Advantage and Reducing Penalties. (There are 35 Hypothesis to check the significance).

g. There is a significant impact of GSCM Drivers on GSCM Practices.

h. There is a significant impact of GSCM Practices on GSCM Performance.

3.8. Data Collection Procedure

3.8.1. During the primary discussion with Environment Management representatives and Managers of EHS and EMS departments of some of the Chemical Industries in Gujarat, the researcher found that some of the managers are reluctant to fill the Questionnaires in hard copies and ask for online filling of Questionnaires. Some of them even also ask for excuses that they will not be able to give their honest opinion if they are filling hard copies. Thus the questionnaires along with copy of introductory letter and permission letter from the director of my institute are sent to the managers having middle or
senior level management experience at various Chemical industries in advance of actual personal contact made. The questionnaire were sent to the managers in advance so that they could study it well in advance and provide them time to understand the technicality of various terminologies used in questionnaire.

3.8.2. The personal contact method is used for final discussion and filling up the questionnaire by the managers of various Industries in Gujarat. During personal discussion, the respondents’ doubts were clarified, which has improved the accuracy of responses given by them. It provided them the chance to study the questionnaires in detail and clarify the doubts during the personal discussion with the researcher. The other group of respondents is filling the questionnaires online after initial correspondence and discussion on phone calls, email and chats about GSCM practices and objectives of the research study. Thus for such respondents mail survey has been conducted.

3.9. Data Analysis Tools and Techniques

3.9.1. Cross tabulation is used to study the level of Green Supply Chain Activities among the Chemical Industries in Gujarat, the Stage of activities data of the Chemical Firms are cross tabulated against the phases of green activities implementation specifically in Procurement/Purchasing, Manufacturing and Marketing. The association between the state of green supply chain management process ISO 14001 certification achieved by an organization, association between the state of green supply chain management process and adoption of Environmental Management System and association between the state of green supply chain management process and the size of an organization is also analyzed with the help of cross tabulation.

3.9.2. The Chi-square test of independence as well as Chi-Square Goodness-of-Fit test are used to find out the association and variations among adoption of GSCM practices among organization having ISO 14000 certification and having adopted EMS practices.

3.9.3. The exploratory factor analysis is done to find out the suitable factors of GSCM drivers, GSCM practices and GSCM Performances. Factor analysis is
a method of data reduction. It does this by seeking underlying unobservable (latent) variables that are reflected in the observed variables (manifest variables). Factor analysis is a technique that requires a large sample size. Factor analysis is based on the correlation matrix of the variables involved, and correlations usually need a large sample size before they stabilize. The factor analysis is done here as per the guidelines by Hair et al (2005).

3.9.4. Cronbach’s Alpha Test of Reliability is the most popular estimate for measuring the internal consistency (reliability) of items in a scale, in other words it measures the extent to which the responses collected for given item correlate highly with each other. The results of this test produce an R-score, which is a number between 0 and 1. The higher the R-score is, the more reliable the measured construct is. Furthermore, alpha score exceeding 0.7 indicates high internal reliability of the scale items, but there are still researchers who use different cut-off R-scores like 0.8 or even 0.6. In this study the cut off rate for Cronbach Alpha is considered 0.6 (Hair et al 2005; pp.118).

3.9.5. Multiple regression analysis is a multivariate statistical technique used to examine the relationship between a single dependent variable and several independent variables. The objective of multiple regression analysis is to use the independent variables whose values are known to predict the single dependent value selected by the researcher. The set of weighted independent variables forms the regression variate, a linear combination of the independent variables that best predicts the dependent variable (Hair et al., 2009). The regression analysis method has been used explore the relationships among GSCM drivers, GSCM practices and GSCM Performances. The analysis is done using 95% confidence level. In addition to regression analysis, Pearson correlation and variance inflation factor (VIF) statistics were used to assess both pair wise and multiple co linearity among independent variables in regression analysis. In first part, Regression analysis is used to find out the degree of impact of various dimensions of GSCM drivers on GSCM practices. In second part, regression analysis is used to find out degree of impact of various dimensions of GSCM practices on GSCM performance.
3.9.10. Single regression analysis to find the overall impact and relationship of GSCM Drivers on GSCM Practices and Impact of GSCM Practices on GSCM Performances.

3.10. Scope and Limitations of the Study

3.10.1. The study is concentrated only on Chemical Industries in Gujarat State as they are generally referred as Environment Sensitive Industries. The geographic scope of the study is only focused on Gujarat state Chemical industries which can be extended to the study on Chemical Industries in other states of India or Chemical Industries in pan India.

3.10.2. Presently the research is concentrated only to Large and Medium Chemical Industries and Factory Units in Gujarat State. As initial survey had revealed that the Small Scale Industries do not have much awareness about the Green Supply Chain Management Practices. Also there is almost negligible implementation of GSCM in Small Scale Industrial Units because of unavailability of required funds for the initial investment for Green activities implementation in Supply Chain.