

# **Chapter 5**

## **Analysis and**

## **Interpretation of data**

## 5.1 Internal Consistency Reliability

The reliability of the instrument is estimated when similar results are obtained by the items that measure similar conduct. Hence a group of people are administered and monitored with a single instrument of measurement with different items to check whether the results are consistent, as they measure the same construct. There are many internal consistency measures that can be used. One of the most commonly used estimates of internal consistency is Cronbach Alpha.

A 7 point “**Likert Scale**” is used in the questionnaire for better accuracy. Pilot testing has been conducted to ensure the internal consistency of the questionnaire for which Cronbach’s Alpha test is used. The Cronbach’s Alpha test value ranges from 0 to 1, the more it is close to 1, the higher is the internal consistency and the higher is the reliability of the questionnaire.

In pilot testing, the survey of 30 people was conducted and then the reliability was checked which came out to be 82.2 %. The Cronbach’s Alpha test and the result obtained in pilot testing is explained in the next section.

Further when the Cronbach’s Alpha test was successful, the questionnaire was sent in many industries including upstream, midstream, downstream, consultants and various academic institutes. A total of 395 responses were received and after that factor analysis is used to reduce the number of variables.

Cronbach’s Alpha test is used to check the internal consistency i.e. how closely a set of variables are related as a group and the extent to which all the items in a test measures the same concept. Cronbach’s Alpha test is present in the SPSS 16.0 software. SPSS software is used here for further evaluation as well. As the correlation between the items increases the Cronbach’s Alpha value increases.

*Table- 5.1 Interpretation of different scores in Cronbach's Alpha test*

| Cronbach's Alpha           | Internal Consistency                   |
|----------------------------|--|
| $\alpha \geq 0.9$          | <b>Excellent (High-Stakes testing)</b> |
| $0.7 \leq \alpha \leq 0.9$ | <b>Good (Low-Stakes testing)</b>       |
| $0.6 \leq \alpha \leq 0.7$ | <b>Acceptable</b>                      |
| $0.5 \leq \alpha \leq 0.6$ | <b>Poor</b>                            |
| $\alpha < 0.5$             | <b>Unacceptable</b>                    |

Generally if the instrument's internal consistency in Cronbach's Alpha comes out to be 0.7 or more than 0.7 the reliability of that instrument is considered to be very high.

*Table- 5.2 Result obtained in the analysis of pilot testing*

| Reliability Statistics |  |             |
|------------------------|--|-------------|
| Cronbach's Alpha       | Cronbach's Alpha on Standardized Items | No of Items |
| <b>0.822</b>           | <b>0.820</b>                           | <b>29</b>   |

Alpha coefficient of 0.822 signifies a high level of internal consistency.

This score proves the reliability of the instrument.

## **5.2 Factor Analysis**

Factor analysis is a method of data reduction. There are many methods which can be used for the purpose of extraction in factor analysis some of them are listed below:

- Principle Component Analysis
- Un-weighted least squares
- Generalized least square
- Maximum likelihood
- Principal axis factoring
- Alpha factoring
- Image factoring

In the factor analysis done here, the Principle Component Analysis (PCA) method is used. Before using the PCA method, sampling adequacy needs to be checked, this is done by the Kaiser-Meyer-Olkin (KMO) and Bartlett's test, here the KMO and Bartlett's test sampling adequacy came out as 0.910. This signifies that the variables are dependent on each other and are correlated, which is a necessary condition to proceed with factor analysis.

The sampling adequacy of more than 0.90 is excellent, while below 0.50 it is unacceptable.

*Table- 5.3 Sampling adequacy test*

| <b>KMO and Bartlett's Test</b> |                    |              |
|--------------------------------|--------------------|--------------|
| Kaiser-Meyer-                  |                    | <b>0.910</b> |
| Bartlett's Test of Sphericity  | Approx. Chi-Square | 5.187E3      |
|                                | Df                 | 406          |
|                                | Sig.               | .000         |

*Source: SPSS V 16.0 Software analysis*

As the sampling adequacy came out is 0.910, hence PCA method of factor analysis can be applied. In PCA method, Eigen value method is used to determine the factors. With the help of PCA, 6 factors were determined whose cumulative percentage of total variance is explained by 60.045%. In simple words it implies that the 60.045% of variance is explained by the 6 factors.

The total variance explained by the 6 factors is shown in table below:

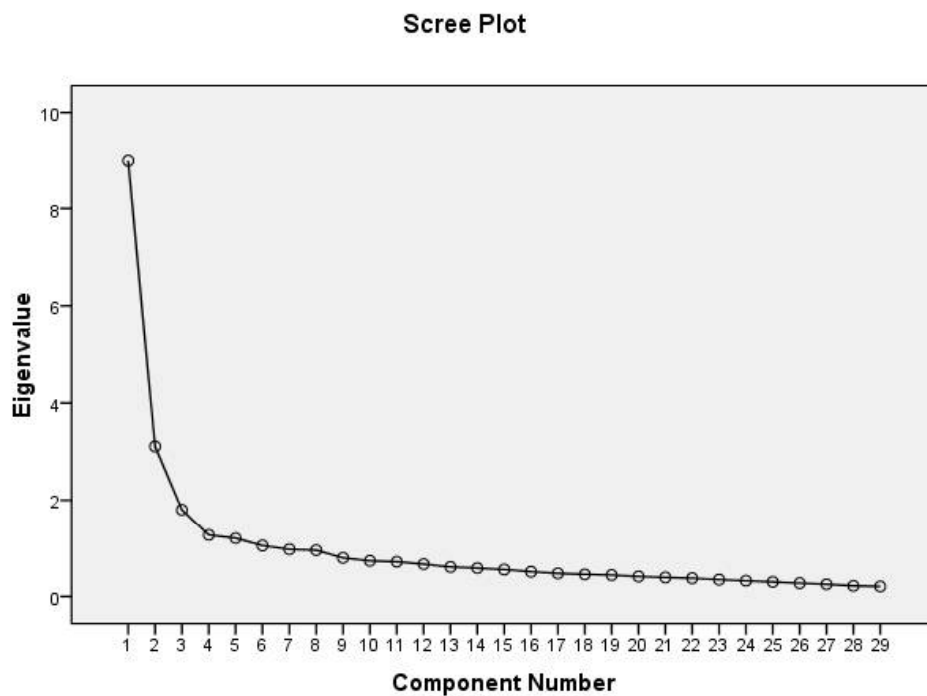
*Table- 5.4 Total Variance Explained from SPSS Software Analysis*

| Component | Initial Eigenvalues |               |              | Rotation Sums of Squared Loadings |               |              |
|-----------|---------------------|---------------|--------------|-----------------------------------|---------------|--------------|
|           | Total               | % of Variance | Cumulative % | Total                             | % of Variance | Cumulative % |
| 1         | 8.980               | 30.967        | 30.967       | 6.310                             | 21.758        | 21.758       |
| 2         | 3.109               | 10.719        | 41.686       | 3.774                             | 13.012        | 34.771       |
| 3         | 1.802               | 6.215         | 47.901       | 2.091                             | 7.210         | 41.981       |
| 4         | 1.269               | 4.377         | 52.278       | 1.918                             | 6.612         | 48.593       |
| 5         | 1.202               | 4.146         | 56.424       | 1.833                             | 6.322         | 54.915       |
| 6         | 1.050               | 3.621         | 60.045       | 1.488                             | 5.130         | 60.045       |
| 7         | .974                | 3.358         | 63.404       |                                   |               |              |
| 8         | .955                | 3.295         | 66.698       |                                   |               |              |
| 9         | .796                | 2.745         | 69.443       |                                   |               |              |
| 10        | .735                | 2.533         | 71.976       |                                   |               |              |
| 11        | .714                | 2.464         | 74.440       |                                   |               |              |
| 12        | .668                | 2.302         | 76.741       |                                   |               |              |
| 13        | .608                | 2.095         | 78.837       |                                   |               |              |
| 14        | .585                | 2.017         | 80.854       |                                   |               |              |
| 15        | .555                | 1.913         | 82.767       |                                   |               |              |
| 16        | .511                | 1.763         | 84.530       |                                   |               |              |
| 17        | .477                | 1.646         | 86.176       |                                   |               |              |
| 18        | .457                | 1.576         | 87.752       |                                   |               |              |
| 19        | .441                | 1.521         | 89.273       |                                   |               |              |
| 20        | .413                | 1.423         | 90.696       |                                   |               |              |
| 21        | .393                | 1.355         | 92.051       |                                   |               |              |
| 22        | .376                | 1.297         | 93.348       |                                   |               |              |
| 23        | .349                | 1.202         | 94.549       |                                   |               |              |
| 24        | .324                | 1.119         | 95.668       |                                   |               |              |
| 25        | .301                | 1.040         | 96.708       |                                   |               |              |
| 26        | .275                | .949          | 97.657       |                                   |               |              |
| 27        | .253                | .871          | 98.529       |                                   |               |              |
| 28        | .220                | .758          | 99.286       |                                   |               |              |
| 29        | .207                | .714          | 100.000      |                                   |               |              |

Extraction Method: Principal Component Analysis.

### 5.2.1 Scree Plot

Scree Plot is the plot between Eigen value and the number of factors in their order of extraction. It is a graphical way of extracting the number of factors. In the figure it can be clearly seen that the curve drops sharply at first and then it flattens after factor 6, this signifies that 6 factors are sufficient to explain the variance in the variables.



*Fig-5.1 Scree plot from SPSS Software Analysis*

After determining that the 6 factors will be enough to explain the 60.045% of variance, rotated component matrix is generated. The method used for the rotation is Varimax with Kaiser Normalization which is an orthogonal method of factor rotation.

Table- 5.5 Rotated Component Matrix from SPSS Software Analysis

**Rotated Component Matrix<sup>a</sup>**

|     | Component |       |       |       |       |       |
|-----|-----------|-------|-------|-------|-------|-------|
|     | 1         | 2     | 3     | 4     | 5     | 6     |
| q1  | .108      | .062  | -.035 | .827  | -.026 | -.028 |
| q2  | .254      | .140  | .099  | .695  | .240  | .012  |
| q3  | .254      | .041  | -.029 | .611  | .427  | .257  |
| q4  | .732      | -.091 | -.035 | .227  | .231  | .069  |
| q5  | .693      | -.018 | .033  | .115  | .298  | .068  |
| q6  | .737      | .086  | .241  | .184  | .026  | .000  |
| q7  | .754      | .095  | .200  | .126  | .125  | -.164 |
| q8  | .676      | .150  | .150  | .077  | .352  | -.088 |
| q9  | .224      | .520  | -.045 | .045  | .156  | -.297 |
| q10 | .773      | .200  | .063  | .072  | .132  | -.051 |
| q11 | .622      | .081  | -.100 | -.036 | .189  | .219  |
| q12 | .740      | .229  | .244  | .120  | -.081 | -.071 |
| q13 | .691      | .151  | .149  | -.034 | .065  | .269  |
| q14 | .115      | .231  | .172  | .305  | -.121 | .590  |
| q15 | .629      | .294  | .271  | .145  | .076  | -.183 |
| q16 | .616      | .198  | .365  | .175  | .005  | -.141 |
| q17 | .397      | .125  | .162  | .078  | .685  | -.004 |
| q18 | .245      | .069  | .111  | .199  | .777  | .009  |
| q19 | .115      | .478  | .138  | .015  | .199  | .361  |
| q20 | .049      | .542  | .194  | .036  | .016  | .167  |
| q21 | .183      | .693  | .120  | .112  | .126  | -.070 |
| q22 | .013      | .755  | .087  | .066  | -.074 | .106  |
| q23 | -.122     | .728  | .102  | .037  | -.105 | .226  |
| q24 | .026      | .176  | .667  | -.040 | .074  | .155  |
| q25 | -.083     | .177  | -.061 | -.055 | .073  | .691  |
| q26 | .197      | .661  | .029  | -.056 | .107  | .165  |
| q27 | .336      | .693  | .015  | .110  | .055  | -.030 |
| q28 | .361      | .135  | .704  | .059  | .175  | -.054 |
| q29 | .408      | .099  | .741  | .021  | .029  | -.035 |

After getting the rotated component matrix, it is identified that which variable will come under which factor, the details are as follows:

*Table- 5.6 Variable Categorization*

| <b>Variables</b>                                     | <b>Factor<br/>- 1</b> | <b>Factor<br/>- 2</b> | <b>Factor<br/>- 3</b> | <b>Factor<br/>- 4</b> | <b>Factor<br/>- 5</b> | <b>Factor<br/>- 6</b> |
|--|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| Aware ness about the CGD scenario                    |                       |                       |                       | 0.827                 |                       |                       |
| CNG & PNG suitable replacement of conventional fuels |                       |                       |                       | 0.695                 |                       |                       |
| Awareness about the gas storage                      |                       |                       |                       | 0.611                 |                       |                       |
| Support from government bodies                       | 0.732                 |                       |                       |                       |                       |                       |
| Revenue generation                                   | 0.693                 |                       |                       |                       |                       |                       |
| Gas price fluctuation                                | 0.737                 |                       |                       |                       |                       |                       |
| Customers' satisfaction                              | 0.754                 |                       |                       |                       |                       |                       |
| Employment opportunities                             | 0.676                 |                       |                       |                       |                       |                       |
| Balancing supply and demand scenario                 | 0.773                 |                       |                       |                       |                       |                       |
| Investment by MNCs                                   | 0.622                 |                       |                       |                       |                       |                       |
| Fluctuating seasonal and peak gas demand             | 0.74                  |                       |                       |                       |                       |                       |
| Alternative sources of gas                           | 0.691                 |                       |                       |                       |                       |                       |
| Disruption due to third party damage                 | 0.629                 |                       |                       |                       |                       |                       |
| Interruption in Trans National Pipeline              | 0.616                 |                       |                       |                       |                       |                       |
| Availability of skilled labor                        |                       |                       |                       |                       | 0.685                 |                       |
| Technology   |                       |                       |                       |                       | 0.777                 |                       |
| Storage Capacity                                     |                       | 0.693                 |                       |                       |                       |                       |



|                       |       |       |  |       |
|-----------------------|-------|-------|--|-------|
| Land requirement      | 0.755 |       |  |       |
| Land Availability     | 0.728 |       |  |       |
| Location              |       | 0.667 |  |       |
| Environment           |       |       |  | 0.691 |
| Safety                | 0.661 |       |  |       |
| Pipeline Design       | 0.693 |       |  |       |
| Natural Calamities    |       | 0.704 |  |       |
| War, terrorist attack |       | 0.741 |  |       |

### 5.3 Factors affecting the establishment of gas storage in CGD industry in India

*Table- 5.7 Factors affecting establishment of gas storage in CGD industry in India*

| S.NO | Factor | Factor Loading | Variables included in the factor  |
|------|--------|----------------|---|
|      |        | 0.732          | Support from government bodies and local gas authorities,   |
|      |        | 0.693          | Establishment of gas storage facilities by CGD companies will increase the Revenue generation of CGD companies                          |
|      |        | 0.737          | Gas storage will help in maintaining adequate level of price of gas at the time of gas price fluctuation.                               |
|      |        | 0.754          | Establishment of gas storage facility will add value to the customers' satisfaction by ensuring continuous availability of gas to them. |

|   |                            |       |  |
|---|----------------------------|-------|--|
| 1 | Economic Factors           | 0.676 | Developing gas storage facilities will help in creating employment opportunities.  |
|   |                            | 0.773 | Gas storage should be promoted considering the current and future supply and demand scenario of natural gas in India.                          |
|   |                            | 0.622 | International bodies like MNCs will invest in the establishment of gas storage facility in India.  |
|   |                            | 0.740 | Gas storage will help in catering fluctuating seasonal and peak gas demand.  |
|   |                            | 0.691 | Alternative sources of gas production in India like Shale Gas, CBM, Gas Hydrates etc. will increase the requirement of gas storage facilities. |
|   |                            | 0.629 | In case of any disruption in the pipeline like burst/leak/third party damages, gas storage will prove to be a viable option for storing gas.   |
|   |                            | 0.616 | In case of Interruption in trans-national pipelines in future due to geo political reasons, storage will prove to be very handy.               |
| 2 | Legal & Techno Operational | 0.693 | Storage capacity of gas storage is of primary concern  |
|   |                            | 0.755 | Land requirement will be a concern for the establishment of gas storage facilities.  |

|   |                                 |       |  |
|---|---------------------------------|-------|--|
|   |                                 | 0.728 | Land availability and acquisition can create a problem for establishment of gas storage facilities.  |
|   |                                 | 0.661 | Safety will be a concern while developing and operating gas storage facilities.  |
|   |                                 | 0.693 | If gas is stored in a pipeline, then the pipeline design should be optimized to sustain high pressure  |
| 3 | Geographic & political Concerns | 0.667 | Location of gas storage facility near the consumer market will play an important role.   |
|   |                                 | 0.704 | In case of natural calamities like hurricane, earthquakes etc. gas storage facilities will prove to be a good option for maintaining adequate level of gas supply. |
|   |                                 | 0.741 | In unforeseen conditions like war, terrorist attack etc. which may lead to disruption in supply, gas storage will play an important role.                          |
| 4 | Awareness & Importance          | 0.827 | People are aware about the CGD scenario in India.  |
|   |                                 | 0.695 | People acknowledge CNG & PNG as suitable replacement of conventional fuels.  |
|   |                                 | 0.611 | People are aware about the gas storage and the purpose it is solving worldwide.  |
|   |                                 | 0.685 | CGD companies can find adequate  |

|   |                          |       |   |
|---|--------------------------|-------|---|
| 5 | Technical & Labor Skills |       | technology in India for the establishment of gas storage.   |
|   |                          | 0.777 | There is an availability of skilled labor in India for construction, operation, maintenance and management of gas storage facilities. |
| 6 | Environmental Concerns   | 0.691 | Environment will be adversely affected by the establishment of gas storage facilities.  |

## 5.4 Discussion on Factors

After the analysis the six factors that have emerged out are as follows:

### 5.4.1 Economic factors

This factor encompasses 11 aspects out of 29 aspects as mentioned in the questionnaire. The different aspects are as follows:

- (i) Support from government bodies and local gas authorities (Question number 4 in the questionnaire).
- (ii) Establishment of gas storage facilities by CGD companies will increase the Revenue generation of CGD companies (Question number 5 in the questionnaire).
- (iii) Gas storage will help in maintaining adequate level of price of gas at the time of gas price fluctuation (Question number 6 in the questionnaire).

- (iv) Establishment of gas storage facility will add value to the customers' satisfaction by ensuring continuous availability of gas to them (Question number 7 in the questionnaire).
- (v) Developing gas storage facilities will help in creating employment opportunities (Question number 8 in the questionnaire).
- (vi) Gas storage should be promoted considering the current and future supply and demand scenario of natural gas in India (Question number 10 in the questionnaire).
- (vii) International bodies like MNCs will invest in the establishment of gas storage facility in India (Question number 11 in the questionnaire).
- (viii) Gas storage will help in catering fluctuating seasonal and peak gas demand (Question number 12 in the questionnaire).
- (ix) Alternative sources of gas production in India like Shale Gas, CBM, Gas Hydrates etc. will increase the requirement of gas storage facilities (Question number 13 in the questionnaire).
- (x) In case of any disruption in the pipeline like burst/leak/third party damages, gas storage will prove to be a viable option for storing gas (Question number 15 in the questionnaire).
- (xi) In case of Interruption in trans-national pipelines in future due to geo political reasons, storage will prove to be very handy (Question number 16 in the questionnaire).

This factor covers the economic aspect of gas storage in CGD business in India. The focus is on different economic aspects like the government aspect i.e.

whether government will support the gas storage activities or not in India along with regional authority supports, financial aspect i.e. revenue generation and price fluctuation effect on storage, Customer satisfaction, employment opportunities etc. The economic factor also encompasses the supply and demand scenario of natural gas i.e. how the supply is lagging behind demand and how storage will act as a bridge so as to overcome the gap between supply and demand. Further the economic factor also covers the aspect of international player's investment in storage projects for CGD along with the need for storage while keeping in mind the growth of alternative fuels like CBM, Shale Gas etc. in the future coming time. Lastly but not the least the economic factor also encompasses the geo political reasons which leads to disruption in gas supply and in this scenario how storage will help in maintaining continuous supply of gas.

#### **5.4.2 Legal & Techno Operational**

This factor encompasses 5 aspects out of 29 aspects as mentioned in the questionnaire. These aspects are as follows:

- (i) Storage capacity of gas storage is of primary concern (Question number 21 in the questionnaire).
- (ii) Land requirement will be a concern for the establishment of gas storage facilities (Question number 22 in the questionnaire).
- (iii) Land availability and acquisition can create a problem for establishment of gas storage facilities (Question number 23 in the questionnaire).
- (iv) Safety will be a concern while developing and operating gas storage facilities (Question number 26 in the questionnaire).

- (v) If gas is stored in a pipeline, then the pipeline design should be optimized to sustain high pressure (Question number 27 in the questionnaire).

India is a developing nation and in today's time land availability and acquisition is one of the major problems faced by any new project. Legal factor includes the land availability and requirement issues related to gas storage for city gas distribution in India. So as to overcome with this issue the underground vertical line pack storage is the method which is promoted and this requires the least space for creating gas storage as compared to other types of gas storages available. Techno factors include the Storage capacity and pipeline design variables. These two aspects greatly determine how much gas can be stored and delivered at a particular period of time. The operational part includes the safety aspect during the construction of the gas storage facilities.

### **5.4.3 Geographic & Political Concern**

This factor encompasses 3 aspects out of 29 aspects as mentioned in the questionnaire. These aspects are as follows:

- (i) Location of gas storage facility near the consumer market will play an important role (Question number 24 in the questionnaire).
- (ii) In case of natural calamities like hurricane, earthquakes etc. gas storage facilities will prove to be a good option for maintaining adequate level of gas supply (Question number 28 in the questionnaire).
- (iii) In unforeseen conditions like war, terrorist attack etc. which may lead to disruption in supply, gas storage will play an important role (Question number 29 in the questionnaire).

The demand of gas in India is increasing day by day and so as to cope up with this demand it has now become essential that the storage facilities should be constructed near to the consumer market so that at times of peak demand the extra gas required can be extracted from the storage so as to fulfill the consumer demand and when there is less requirement of gas additional gas can be stored. The geographic factor has covered this aspect whereas political aspects covers variable like when there is an attack or war there are chances that gas supply could be disturbed, so in this scenario again gas storage could be used as a good option for maintaining adequate level of supply.

#### **5.4.4 Awareness & Importance**

This factor encompasses three aspects out of twenty nine aspects as mentioned in the questionnaire. These aspects are as follows:

- (i) Respondents were aware about the CGD scenario in India (Question number 1 in the questionnaire).
- (ii) Respondents acknowledged CNG & PNG as suitable replacement of conventional fuels (Question number 2 in the questionnaire).
- (iii) Respondents were aware about the gas storage and the purpose it is solving worldwide (Question number 3 in the questionnaire).

Without the proper awareness and without acknowledging the importance of gas storage, it is very unlikely that some of the people whose support will be needed in establishing the gas storage will get convince. As most of the people are reluctant to new things by nature hence prior to the gas storage it is necessary to get to know the basic questions regarding the awareness of people about the CGD scenario in India, as without awareness it will be difficult for a person to understand the importance of gas storage in present and future scenario. Another variable included here is 'alternate fuels', which is asked in the questionnaire as



whether people acknowledges CNG and PNG as suitable replacement of conventional fuel or not. Developing gas storage for CGD companies' importance will augment if people are willing to shift away from conventional fuel in the future. Because large scale storage will help in increasing the natural gas supply and consequently the increase in CNG and PNG supply by CGD companies. Hence the three variables i.e. Awareness of CGD scenario, alternate fuels and importance are described in this factor as 'Awareness and Importance'.

#### **5.4.5 Technical & Labor Skills**

This factor encompasses two aspects out of twenty nine as mentioned in the questionnaire. These aspects are as follows:

- (i) CGD companies can find adequate technology in India for the establishment of gas storage (Question number 17 in the questionnaire).
- (ii) There is an availability of skilled labor in India for construction, operation, maintenance and management of gas storage facilities (Question number 18 in the questionnaire).

This factor includes the two variables namely, technology and availability of skilled labor. Technology is very much required for establishing storage facilities. With the help of technology one can increase the efficiency, decrease the chances of failure and increase the feasibility of the project. Apart from technology, availability of skilled labor is also a major variable which will impact the establishment of gas storage facilities. One major question is whether it is available in India or not. As India doesn't have any prior experience in establishing gas storage facilities. It can be inferred that shortage of skilled labor in India for the construction might be faced in case of operation, maintenance and

management of gas storage facilities. Foreign support for both technology and workforce might be required, as they are having prior experience and their gas storage facilities are currently operational.

#### **5.4.6 Environmental Concerns**

This factor encompasses one aspect given as:

- (i) Environment will be adversely affected by the establishment of gas storage facilities (Question number 25 in the questionnaire).

There are many environmental issues that are going on like air pollution, water pollution, water scarcity, poor waste management, land/soil degradation etc. Thus it is of paramount importance to check whether environment will be adversely affected by the establishment of gas storage facilities or not. And also if environment will be adversely affected than how severe would the impact on the environment would be. In this regard, experience of different countries in building gas storage facilities should be utilized.

#### **5.5 Barriers in the establishment of gas storage in CGD Business in India**

From the six factors that have been emerged, all the factors will have a significant influence in development of gas storage facilities by CGD companies, but from these factors some of the factors and variables need special emphasis as they will act as a barrier if not addressed properly.

- Technical and labor issues (Factor 5)
- Land availability and acquisition issues (part of factor 2)
- Investment issue (part of factor 1)
- Environmental issue (Factor 6)

## **5.6 Addressing the barriers**

### **5.6.1 Technical and labor issues**

Gas storage facilities (Underground, above ground, LNG storage, Line pack etc.) are present in the countries like U.S, Russia, Germany, U.K., Japan etc. It is well known that how much technologically sound these countries are. Talking about India, the country lacks in technology in many fields. One basic example can be, India is having reserves of Shale gas, Gas hydrates and CBM, but don't have adequate technology to take the advantage of these sources of natural gas, and also the policies are such that foreign companies are reluctant to participate in NELP rounds. If the foreign company comes it will also bring the technology in India, hence the entry of foreign firms should be made smooth.

In storage technologies like cryogenic tanks, pipeline which can sustain high pressure, gas holders with large capacities, conducting seismic surveys for finding the suitable location for establishing underground gas storage facilities etc. plays an important role. Thus, taking service of other technologically around countries will help in addressing these issues.

And as far as the labor issues are concerned India does have a shortage of skilled workforce, as currently approx. 1.5 lac people are employed in oil and gas sector in India. Also, there are less number of institutes which gives knowledge of specific oil and gas industry, thus even for some of the work force gas storage can be a challenging issue. Skilled labor and technology are interrelated issues as skilled labor is required for effective use of technology.

Thus, in a nutshell, technical and labor barriers can be mitigated properly if the experience of successful gas storage facilities of different countries is studied properly and referred from this study whenever required.

### **5.6.2 Land availability and acquisition issues**

Land availability can prove to be a barrier for the establishment of gas storage facility in India, as India is a densely populated country (with more than 120 crore population) hence getting land will be a challenging task.

Although for the development of depleted reservoir type underground gas storage facility, land availability might not prove to be a barrier as for depleted reservoir land is already available and all that needs to be done is storing the gas. But for the storage facilities like Gas holders, LNG storage etc. land availability will be an important concern, as CGD companies operates mainly in densely populated cities like Delhi, Mumbai etc. CGD company would want to establish the gas storage in the close proximity to the consumer's market thus finding a land in such populated areas will be a challenging task. Also, the cost of land required for establishment of storage facility will also be a concern.

In land acquisition, companies might face legal problems and also land acquisition is a political sensitive issue especially for industries. Political parties sometimes creates an issue out of nowhere just to manipulate the people to benefit its political status, they sometimes instill the fear in the minds of people that if the land is acquired then it might have negative impacts. Thus in this case people sometimes protest against the land acquisition by the companies and thus companies face problems. This can also happen in the case of CGD companies.

Apart from this, legal issues may also prove to be a barrier for the establishment of gas storage facilities by CGD companies as several clearances are required to clear the legal formalities in India. Hence it can be a time consuming process.

Although with the new government in center the land acquisition policies are made easy for the industries so that it can free up the procedural bottlenecks.

The issues can be mitigated by doing the proper study before finalizing the land for the development of gas storage facilities, and also doing the PESTLE analysis of that particular area where the land is identified, before taking the next step.

### **5.6.3 Investment issue**

Investment will also play a major role in successful development of the gas storage facilities, Investment will be directly proportional to the type of storage, capacity requirement for storage and the land needed. Investment from different players like MNC's, domestic players, government etc. will augment the successful establishment of the gas storage facility.

To involve different players for investment some of the points that should be taken into considerations are:

- Create the awareness about the project in various investors, highlighting the pros in the investment in the project.
- CGD companies should highlight their performance.

Investors should feel safe investing in the gas storage projects. Government is also formulating policies which will enhance the foreign participation in future.

### **5.6.4 Environmental issue**

Environmental concern will be a barrier in the establishment of gas storage facility. There can be various ways that environment can be adversely affected depending on the type of storage, thus environmental agencies might raise the questions regarding the feasibility of the project as per the environmental context whether the gas storage facility will increase the water pollution, land degradation, air pollution etc.

To mitigate the environmental issue, site selection of the project is very important. Advanced technology used in the storage facility will also help in reducing the risk of any kind of environmental damage. Steps should be taken so that the gas leakage incidents can be minimized in the storage facilities i.e. all norms and standards should be followed strictly.

### 5.7 Analysis of Qualitative Response in the Questionnaire

In the questionnaire, 29 questions were of quantitative nature but 2 questions were of qualitative nature and open ended. As qualitative questions were optional, therefore some of the respondents gave their valuable inputs and sum of the respondents refrained from giving any response to the qualitative questions.

The two questions were:

Q1- As per your opinion which type of storage is more feasible for Indian CGD industry. (More than one option can be selected)

- Underground gas storage- Depleted reservoirs
- Underground gas storage- Salt Caverns
- Underground gas storage- Aquifers
- Above ground gas storage- Gas holders
- Above ground gas storage- LNG storage
- Storage in pipeline- Line pack
- Buried pipeline type gasholders
- Other (please specify)
- Can't say

Q2- In your opinion, why gas storage is necessary for CGD companies in India?

.....  
.....

For open ended Question 1, overwhelming responses were received, as out of 395 respondents 390 gave their answer, as more than one option could be selected, these numbers as shown in the table below and the percentage breakup is shown in the pie chart.

Table- 5.8 Response Analysis for qualitative questions

| Type of storage                              | Responses  |
|--|------------|
| Underground gas storage- Depleted reservoirs | 143        |
| Underground gas storage- Salt Caverns        | 68         |
| Underground gas storage- Aquifers            | 58         |
| Above ground gas storage- Gas holders        | 75         |
| Above ground gas storage- LNG storage        | 164        |
| Storage in pipeline- Line pack               | 96         |
| Buried pipeline type gasholders              | 53         |
| Other (please specify)                       | 5          |
| Can't say                                    | 34         |
| <b>Total</b>                                 | <b>696</b> |

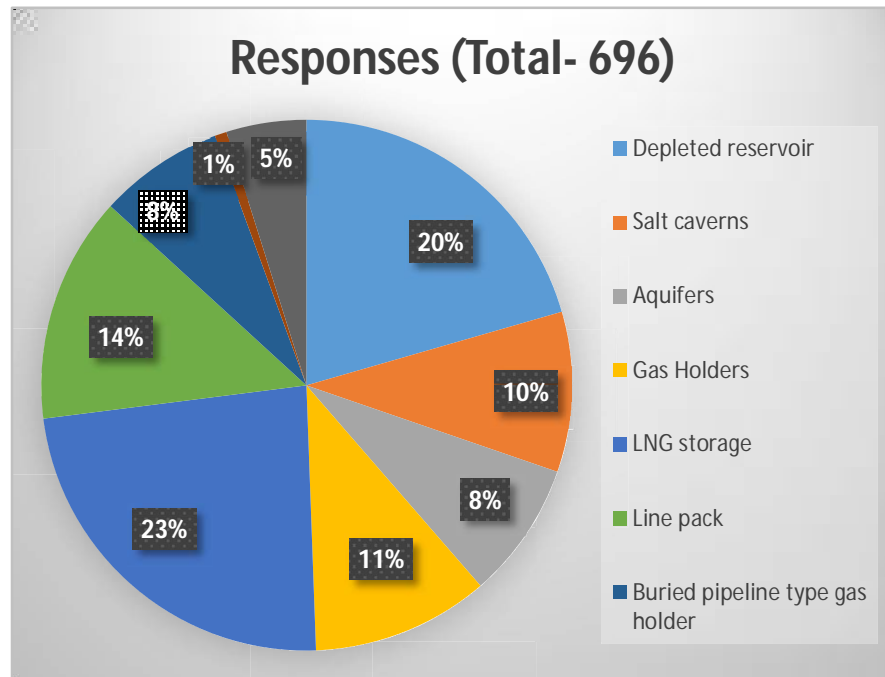


Figure- 5.2 Response Analysis for qualitative questions (%)

It is therefore concluded that 23% of the respondents feels that LNG storage will be more feasible for CGD industry. LNG storage is followed by Depleted reservoir (20%), Line Pack (14%), Gas holders (11%), Salt caverns (10%), Aquifers (8%), and Buried pipeline type gas holders (8%).

Second question was a descriptive type question in which respondents were asked about their opinions regarding why gas storage is necessary for CGD companies in India, for this question out of 395 respondents, 220 respondents gave their opinions whereas 175 respondents choose not to answer.

Some valuable opinions received are listed below; some of them are worth pondering:

- To maintain the supply and demand.
- To take care of price fluctuations in future.
- To provide employment opportunities.
- With the help of gas storage, CGD companies can plan an additional revenue area by trading the gas with other CGD companies/Industries when demand is high.
- Customer's satisfaction.
- Premium can be charged on the supply of stored gas, thus it will help in additional revenue generation of CGD companies.
- India's indigenous production and reserves are low, thus making storage necessary.
- Balancing of flow in pipeline system.
- Arbitrage.
- For economic development of the country.
- Uninterrupted development of gas market.
- To reduce the transportation charges, if gas is needed on an ad-hoc basis.
- To overcome the need of conventional fuel, thus contributing in cleaner environment.
- For a sustainable CGD business.



- To maintain uninterrupted gas supply to their valuable customers at reasonable price.
- Hedging financial risks arising out of fluctuation in gas prices.
- It will be helpful in avoiding opportunity loss arising on account of non-utilization of cheaper gas.
- For maintaining contractual balance, as any imbalance situation might result in penalty.
- Will help in avoiding the conflicts related to supply at the CNG stations.
- In many countries, the household needs are fulfilled by piped gas i.e. hot water, heating etc. same can be promoted in India too, as with the help of storage the dependency on other sources will be reduced.
- Saving of electricity and fuel for compressors for continuous running.
- To subside the issue of under drawl and over drawl of gas from gas supplies, i.e. prevention of penalty from the gas supplying company.
- Currently, long term LNG prices are high as compared to spot LNG prices.
- By storing gas at pressure, compression cost at stations can be reduced.

Apart from these, some respondents showed some criticism also for the gas storage necessity for CGD Company. Some worth mentioning points are:

- Main concern should be on the network integrity rather than the gas storage. As without proper network integrity storage will not be of much use.
- Economics for setting up the storage facility will be a big concern.
- Gas storage for CGD may not be a feasible option as, historically transmission pipeline failures are rare. However failure within CGD is very high, moreover land availability will be a huge concern which is associated with financial viability.
- Storage in large amount will be very difficult and challenging.

To conclude, the majority of the respondents seem very optimistic regarding the establishment of gas storage facility by CGD companies, and majority of them are acknowledging the fact that it will be very beneficial in term of supply and demand imbalance and will prove to be very handy in gas price fluctuations etc. This analysis indicated that 164 numbers i.e. 23% respondents have given their first choice as LNG above ground gas storage. Second choice accorded is for Deleted reservoirs type underground gas storage- by 143 numbers i.e. 20% respondents.

### **5.8 Concluding Remark**

With the help of extensive literature survey and experts opinion, 29 variables have been identified that would affect the establishment of gas storage for city gas distribution in India. A detailed questionnaire was prepared on 7-Point Likert Scale and administered to 395 respondents who belonged to different categories (Upstream, Midstream, Downstream, Consultancy, Service providers and Academia). Further the respondents were both from public sector companies and private sector companies. The survey was carried out in two ways. (i)The questionnaire was uploaded on Google docs and was sent via email to various experts in the industry. (ii) A hardcopy of the questionnaire was given to the expert people for their opinion. After getting the responses of the questionnaire the responses were factor determined using Principle Component Analysis Method (PCA) by using SPSS 16.0 Software. By using Factor Analysis six major factors emerged from the analysis. These are:

- Economic Factors
- Legal & Techno Operational
- Geographic &Political Concerns
- Awareness & Importance
- Technical & Labor Skills
- Environmental concerns