Chapter 6

Conclusion and Recommendation

6.1 Introduction

As Indian CGD companies don't have any gas storage facilities, it is obvious that in case of supply disruption from the main source CGD companies will face problem in catering to the demand for both CNG and PNG customers. Also, CGD companies will face problem in catering the fluctuating seasonal and peak load demand. CGD companies therefore need gas storage facilities so that they can avoid these problems and can work effectively without any flaw in operations. Apart from this, CGD companies can take the advantage when there is low price of natural gas by storing it and using it when there prices are high.

If geography of India is concerned there is a possibility of all the types of gas storage facilities in India which are already identified in the study as below -

- Underground gas storage- Depleted reservoirs
- Underground gas storage- Salt caverns
- Underground gas storage- Aquifers
- Aboveground gas storage- Gas holders
- Aboveground gas storage- LNG storage
- Storage in pipelines- Line pack
- Buried pipeline type gas holders

Some of the states that can have depleted reservoir type storage are Andhra Pradesh (KG basin), Assam, Gujarat, etc. While salt caverns can be constructed in Rajasthan, Aravalli and Eastern Ghats have a potential for Aquifers.

Above ground gas storage- Gas holder can be constructed as per the convenience i.e. in close proximity to the CGD companies along with consumer's market. LNG storage will be most feasible to construct near the port where the LNG cargo arrives. As India doesn't have any liquefaction facility, thus to store natural gas directly in liquefied form will be more economical as compared to liquefy the gas

and then storing it. For storage in line pack existing pipeline can be used, so that gas can be stored for short term by increasing the pressure inside the pipeline, the pipeline design is thus has to be taken into consideration .Buried pipeline type gas holders can also be used without any geographical constraint as it is used in Tokyo (Japan).

Now, as found in the study, CGD companies in India must address six factors namely, *Economic factors, Legal and techno operational factors, Geographic and political concern, Awareness and importance, Technical and labor skills, Environmental concerns*, to establish the conceptual framework of the establishment of gas storage facilities.

6.2 Identifying barriers and their mitigation

From the literature survey and expert analysis 29 variables were identified which have resulted into 6 factors which are:

- Economic
- Legal and techno operational
- Geographic and political
- Awareness and importance
- Technical and labor skills
- Environmental concerns.

The influence of these factors varies on the development of the conceptual framework for the gas storage of CGD companies.

The major barriers emerged from the study of these factors are:

- Technical and labor issues
- Land availability and acquisition issues
- Investment issue
- Environmental issue

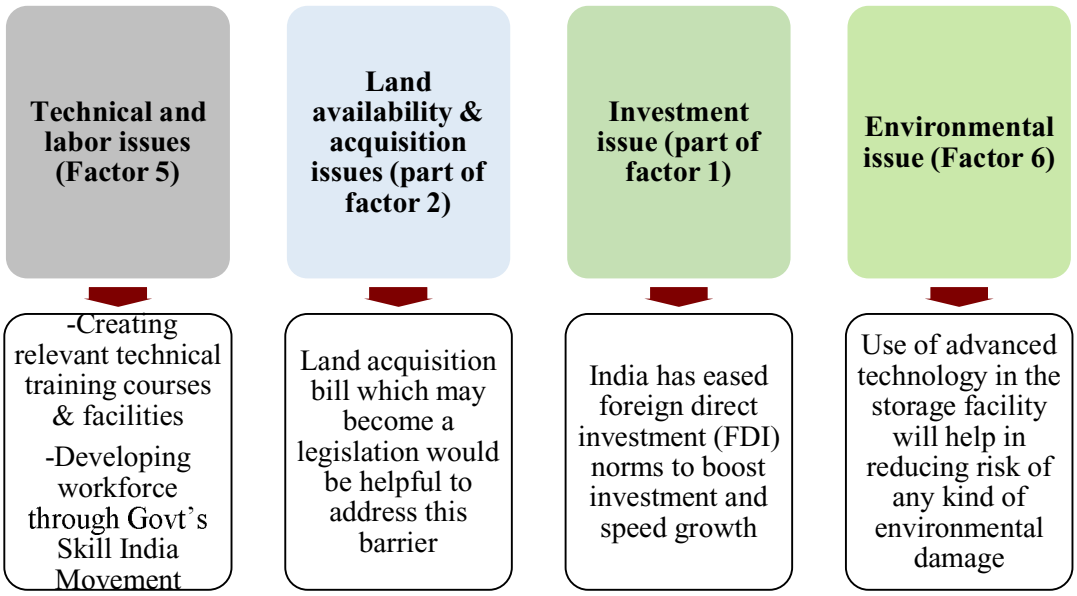


Figure- 6.1 Barriers and their mitigation

6.3 Conceptual Framework for establishment of Natural Gas Storage for CGD in India

Following are the basic parameters for developing a theoretical framework for the establishment of gas storage for city gas distribution in India:

- All Inputs from objective one and two are considered for the development of conceptual framework.

- The framework will integrate regulators and policy makers i.e. GOI, PNGRB on one hand and Stakeholders i.e. CGD companies on the other.

- The CGD companies need to align with foreign players with the help of mergers/joint ventures etc. so as to absorb technology and skilled labor for the establishment of gas storage.

- The CGD companies need to learn from global experiences.

- The academia need to support the CGD companies through skill development and knowledge sharing.

- A market study needs to be carried out by the CGD companies so as to analyze the supply and demand scenario of gas, project feasibility, HSSE and investment required in the project.

- Government need to take steps so as to fast track the legal formalities required for the establishment of gas storage facilities in India.

- Government should notify the Gas Storage Policy and it should allow global participation of MNCs/IOCs/CGD Companies etc.

- A body needs to be framed out for data acquisition and location determination in collaboration with the CGD companies.

- Another body needs to be framed out by the Government for clearance related to land acquisition, environment etc.

- A bidding/approval body needs to be framed out so that the board of directors of different companies can come for approval/bidding for gas storage establishment.

Focus Group Methodology for Development of Conceptual Framework:-

Research Methodology for Objective-2:-

Qualitative Research was used for the purpose of development of conceptual framework.

In-depth semi structured interview with experts were conducted using the Focus Group technique which is explained below:

The interview was recorded, transcribed and fed into software **Atlas TI** that provided a suggestive framework based on the output of transcribed conversation. The Transcribed conversation is attached as **Appendix – E**. The steps followed are given as follows:-

1. Expert Group based on Judgment Sample consisting of
    a. Natural Gas Transmission Experts
    b. CGD Marketing & Technical Experts
    c. Regulatory Expert
    d. Safety Expert
2. Semi Structured Interviews with the expert group
3. Transcribe the recorded interview
4. Coding with Atlas TI software
5. Suggestive Framework based on Atlas TI output

The snapshot of coding of focus group interview is shown below:-

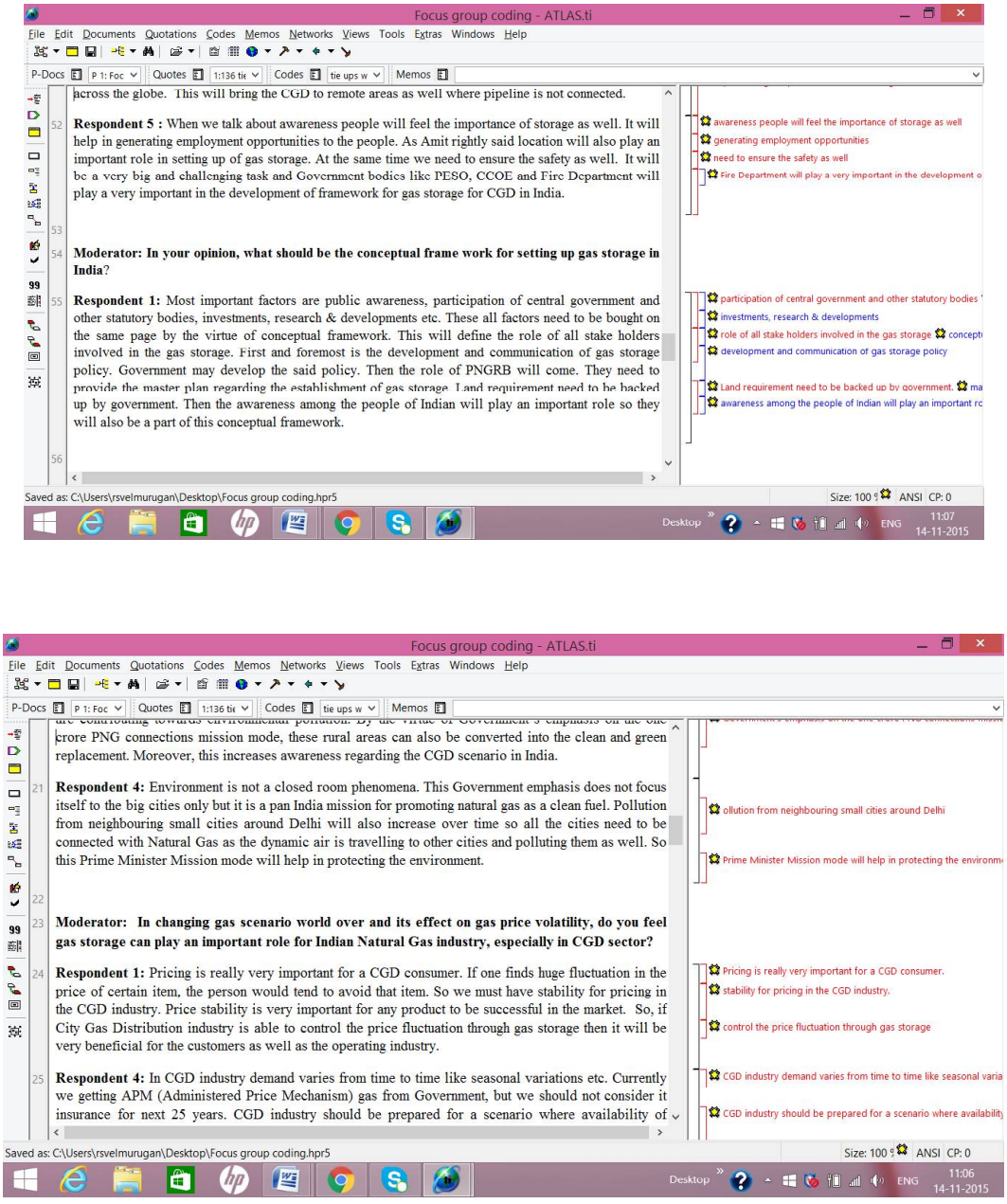


Figure- 6.2 Snapshots of coding of focus group interview

The transcribed coding provided certain keywords and parameters which were instrumental in the formulation of conceptual framework. These keywords and

parameters were utilized in the development of conceptual framework. The output of Atlas TI is as below:-

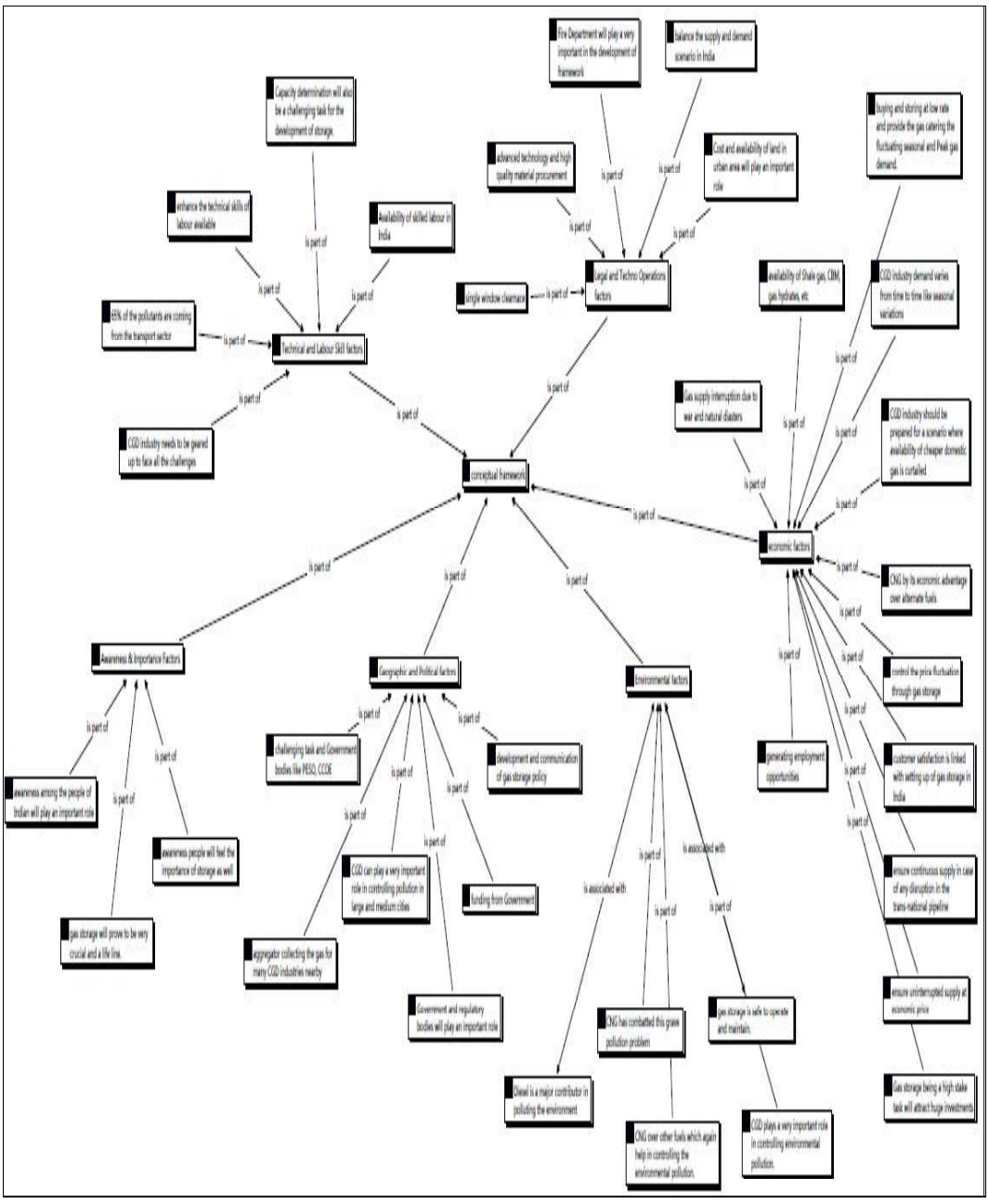


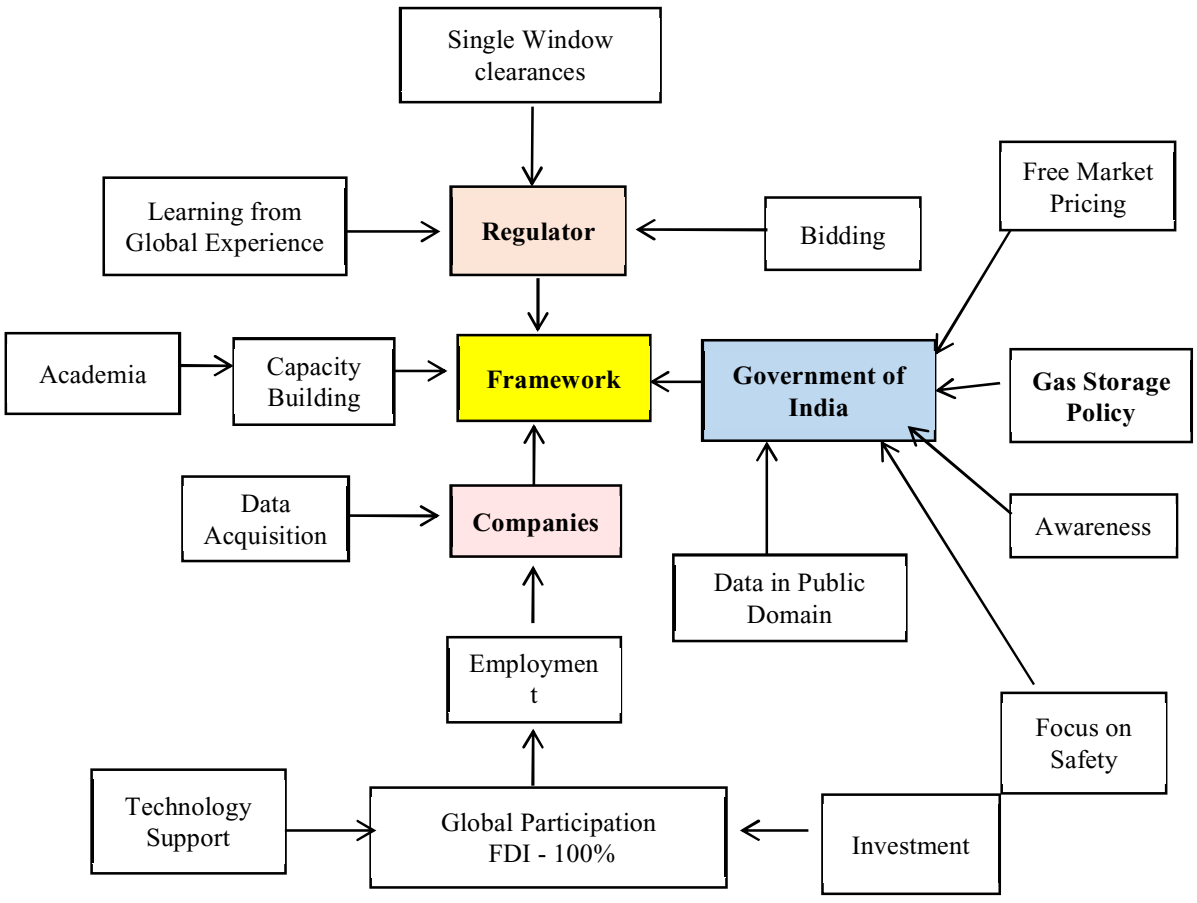
Figure- 6.3 Network view of codes with Labels

The conceptual framework developed based on the outputs of Focus Group discussion and further deliberation is as shown below:-

6.4 Suggestive Framework based on Atlas TI software output:-

Following frame work has been suggested based on the data generated through focus semi-structured interview and by processing the same by using Atlas TI software.

Figure- 6.4 Suggestive Framework



6.5 Interpretation of the Conceptual Framework

Various stakeholders and their roles are deliberated as:-

1. **Regulator**
    a. Learn from global experience- Studies need be carried out regarding the success and failures of already established natural gas storages from all across the globe.
    b. The regulatory environment should be such that it promote fast track clearances for gas storage facilities establishment in India
    c. PNGRB should conduct bidding for fair play.
2. **MoP&NG**
    a. MoP&NG need to gather data from public domain and make awareness about the establishment of gas storage for city gas distribution in India.
    b. Formation of gas storage policy by MoP&NG will be of paramount importance for the implementation of gas storage projects and there should be no barriers for FDI.
    c. Focus on HSE should be given top most priority.
    d. Free market pricing regime should be promoted for attracting major and minor players in gas industry.

3. **Companies**
    a. Companies should carry out feasibility studies of natural gas storage by acquiring appropriate data through surveys.
    b. Indian Oil and Gas companies should develop healthy linkages with major global players in order to acquire technical, labor and financial support for the execution of the plan.
    c. Establishment of gas storage will lead to economic development of India with major increase in employment generation.

4. **Academia**
    a. R&D to be carried out so as to adapt with the changing technologies and reduce various cost associated with gas storage. For example: Operating cost, Maintenance cost etc.
    b. For the maximization of capacity building, Academia will play a major role for skill development.

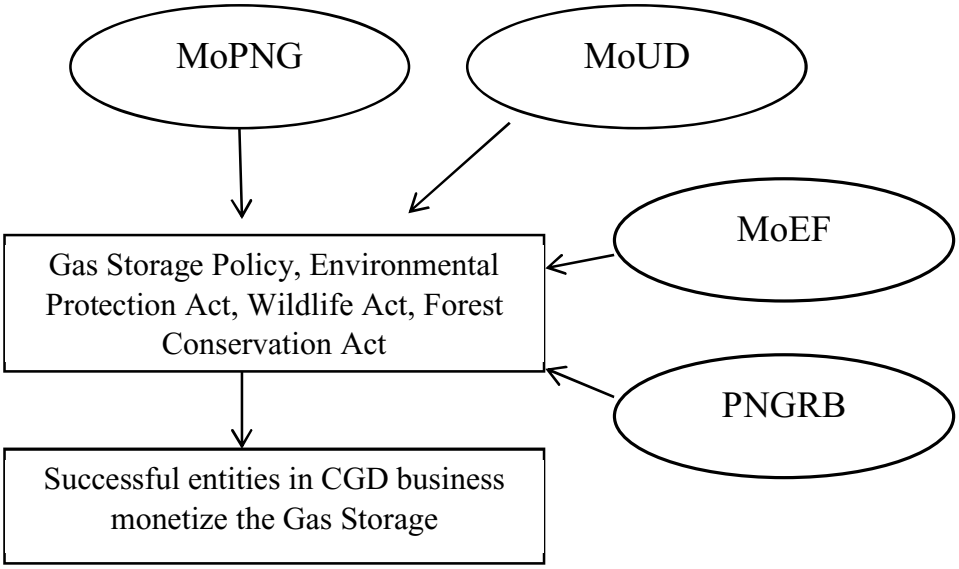


Figure- 6.5 Monetizing Gas Storage in India Schematic

Following will be the major parameters to be kept in mind while implementing the framework:-

6.5.1 Captive Market for Gas Storage in CGD Business in India

India is a gas importing country. The demand of gas in India is increasing day by day and so as to fulfill this demand there is limited supply. It can be concluded that as long as there will be a gap between supply and demand of natural gas there will be a scope of gas storage in Indian context as gas storage can be used to cater seasonal and peak demand. Talking about the City Gas Distribution scenario, currently the CGD

network in India has no storage availability, hence if any unforeseen situation arises where there is disruption in the main transmission pipeline of gas due to any reasons like technical, environmental, political etc. then the whole CGD network will come to a halt due to non-availability of gas. In this context again gas storage will play a very important role as gas can be extracted from storage so as to fulfill the consumer needs.

6.5.2 Arbitrage

Gas industry is an industry where price fluctuations are common. Gas storage will play a very important role in storing gas when the prices are low and selling gas when the prices are high. India is an importer of gas so storage will prove to be very fruitful option in the coming time. Further the CGD companies can store gas during the non-peak times and deliver it later when the demand increases. Currently in India a government agency is formed namely Indian Strategic Petroleum Reserves limited (ISPRL) which manages the strategic storage of crude oil in locations like Visakhapatnam, Mangalore, Padur etc. This step has been taken keeping in mind the future oil scenario in India. It can be inferred that gas storage options should also be considered as the use of gas in India by various sectors especially city gas distribution is increasing day by day.

6.5.3 Flexibility

By using gas storage facilities short and long term flexibility can be achieved by the gas operating companies especially by city gas distribution companies. Base load storages like depleted reservoirs of oil and gas can be used to store large volume of gas and cater seasonal demand on the other hand peak load requirements can be fulfilled with facilities like aquifers, salt caverns etc. because these have high injection and withdrawal rates.

6.5.4 Maintenance

If any pipeline or plant unit needs to go under maintenance gas storage will be a good option for storing gas which is available. In the absence of gas storage, the gas needs to be flared out when the pipelines or plant unit go under maintenance in most of the cases. Thus Gas Storage will help in reducing cost and at the same time accumulating gas for future use.

6.5.5 Land requirement & availability issues

For building gas storage facilities for city gas distribution companies, it is essential that the facility is near to the market. Acquiring land in densely populated area will be a problem however with the implementation of the Land Acquisition Act 2013, and the new ordinance made by the BJP Government to the act in 2015 will help in acquisition of land easily as compared to earlier times. The compensation plan for land acquisition is four times the market price for rural areas and two times the market price for urban areas. Further different state government bodies of state like Gujarat, Andhra Pradesh, Himachal and Haryana etc. are also giving a helpful hand to companies for acquiring of land for economic growth of the nation.

6.5.6 Gas Storage options for India

As learnt from the global experience different gas distribution companies all across the globe are using different gas storage facilities for storing gas as per their needs. In United States, Russia and Europe the companies are generally using Underground storage facilities and LNG storage facilities for catering their demand. The reason behind this is that they have enough natural underground formations available. Japan is making the use of vertically buried pipe type gas holders for storing gas. The reason being that they have very densely populated areas and building storage above ground will also increase the environment concerns. Australia, China,

Korea etc. are also making the use of underground, above ground and LNG storage facilities for gas storage. Seeing all these aspects and then considering India there are different options available for storage as per the locations. There is possibility of construction of underground gas storage facilities in regions like Gujarat, Rajasthan, KG basin etc. while in densely populated areas like metropolitan cities vertically buried pipe type gasholders and line packs can be used for storing gas.

6.5.7 Consumer Satisfaction

Gas storage will also emerge as a good option for achieving consumer satisfaction. The main consumers of a city gas distribution companies are CNG, PNG, Commercial and Industrial. So as to achieve and maintain consumer satisfaction it is essential that proper supply of gas is present as per the consumer needs all the time. So as to achieve this gas storage can be used as a source of gas when there is shortage of gas.

6.5.8 Access to Technology and Services

As gas storage is a new concept in India and till now there is no storage set up for city gas distribution companies, India is lagging in the technology of gas storage. For the construction of gas storages technology and services needs to be imported from foreign countries like United States, Germany, France, China, japan etc. As India is having good political relations with most of these countries who have expertise in the establishment of gas storage, importing technology and services from foreign countries will not be a very big concern.

6.5.9 Environmental Concerns

Environmental concerns like gas leakage from storage, gas leakage while injection and withdrawal from the storage etc. can be minimized with the help of latest technology and materials available for storage construction.

Materials with high tensile and compressive strength are being used for the construction of storage facilities like LNG above and underground storage tanks, line pack etc.

6.5.10 Revenue Generation

Gas storage will not only help the companies in maintaining adequate supply but will also help in increasing the revenues of the companies. Not only CGD companies but companies involved in upstream, midstream and downstream can also benefit with the help of gas storage. Companies can store the gas in storage at time of reduced gas prices and can sell the gas later when the price increases.

6.5.11 Develop and communicate the Gas Storage Policy

A proper gas storage policy needs to be developed and at the same time it is also required to be communicated so that people are aware about the gas storage concept and companies can show their interest in this business.

6.5.12 Fast Track Legal Formalities

For promoting and developing gas storage facilities in India it is essential that legal aspects like land availability and acquisition issues etc. needs to be dealt at a speedy pace. This is essential because these aspects take too much time for approval in current scenario and due to which projects get delayed a lot. Hence for speedy establishment of gas storage facilities in India it is essential to have such a legal framework which can give decisions at a speedy pace.

6.5.13 Extracting data

All the data should be extracted from the CGD companies of all the countries that are having the storage facilities like U.S, Germany, Russia, U.K, Japan etc. A detailed study can be conducted to avoid the mistakes which they have made in the past learning from their experience.

This will help us a lot in establishment of gas storage facilities.

6.5.14 Decide possible locations of gas storage in India

Deciding location is very important if to establish the gas storage facility especially underground type. As all the locations can't support the development of underground gas storage, hence detailed study of geography of India or nearby location of a CGD company should be conducted so that the underground gas storage option can be identified. If developing underground storage is not feasible, then depending upon the location requirement other options like line pack, gas holders, buried pipeline type gas holders can be pursued.

6.5.15 Technology

At present time there are no gas storage facilities available in India, so it can be assumed that there is no experience either in the construction of gas storage facilities. Hence it becomes essential to develop sound political relations with other countries like U.S., China, Japan, Germany, France, United Kingdom etc. who are having expertise in the construction of gas storage facilities so that there is no problem in importing the technology from their country to India.

6.5.16 Infrastructure Development

It is essential that the gas storage facilities are constructed near the market and for doing this proper infrastructure needs to be laid down. The

infrastructure needs to be created keeping in mind the environmental aspect and the safety aspect. Pipelines need to be laid down with proper connectivity with source, storage and the consumer.

6.5.17 Training

As India doesn't have any prior experience in natural gas storage establishment, hence training programs of individuals should be conducted so that they can become aware of the terminologies, operations, maintenance, and management etc. of gas storage facility. Also if needed real time training in existing facilities can prove to be very fruitful in the overall learning experience and to develop the required skillset. This can be done by sending individuals in different companies that are operating gas storage facilities worldwide.

6.5.18 Research and Development (R&D)

CGD companies that want to establish gas storage facility should also formulate research and development department so that any future brown field expansion within the storage facility can be done. Also R&D will be beneficial for the consistent focus on improving the technologies and to improve the overall efficiency of the facility.

6.6 Theoretical Premises

Various theories like Stakeholder theory, Theory of Constraint (TOC), Resource value based theory (RVBT) etc. were studied to deliberate the theoretical premise for this study. After due deliberation, it is observed that **Stakeholder's theory** is the most relevant for this study.

Stakeholder theory suggests that the purpose of a business is to create as much value as possible for stakeholders.

The various stakeholders and their roles are deliberated as:-

Suppliers: Major suppliers will be international companies in gas storage, since India is not having adequate technology and material for the establishment of gas storage.

Shareholders: Establishment of gas storage will lead to wealth maximization and profit maximization of shareholders as the demand of gas in India is increasing which in turn means more gas business.

Workers: As gas storage is a new technology in India, workers need to be provided with adequate training so that they can handle the facility.

Consumer: Consumer will be benefitted the most with the establishment of gas storage facilities for CGD as they will receive uninterrupted supply at affordable prices that is value for money.

Local community: Local communities will get employment opportunities along with regional area development which will ultimately lead to economic growth. Further, for the establishment of gas storage for CGD companies stakeholders will play major role

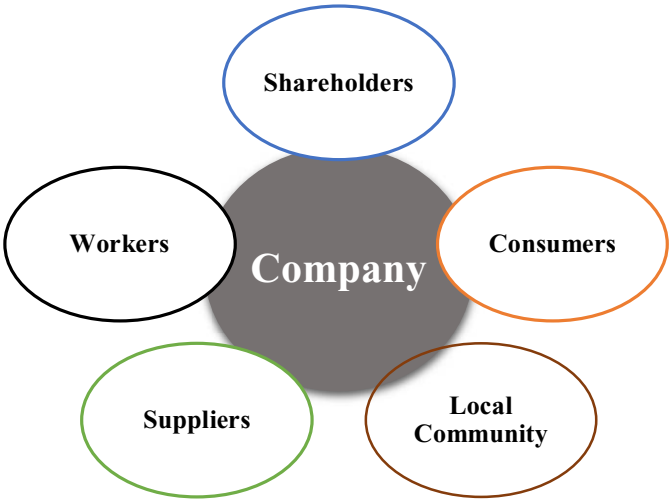


Figure- 6.6 Theoretical Premises – Schematic

CGD companies and the Government of India are two major constituents of the framework. Government of India comprises of PNGRB (Petroleum and Natural Gas Regulatory Board) which in turn act as a regulator for CGD companies in India. Action plan will therefore include all the actionable points for all these entities.

- Government of India has to take following actions:
  - Swift clearance of legal formalities like land acquisition etc.
  - Give directions to PNGRB to form gas storage policy.

- PNGRB has to take following actions:
  - Formulate a gas storage policy, keeping in mind the current policies of other countries. Which in turn should provide the data regarding gas storage; provide possible locations of gas storage etc.
  - Conduct Bidding rounds (or give approvals) for allocating the specific land for gas storage.
- CGD company has to take following actions:
  - Make a merger/ JV with foreign players so as to absorb the technology and skilled labor related to natural gas storage.
  - Study worldwide CGD companies and their gas storage facilities and take a note from their experience.
  - Study the domestic market, which will include the demand and supply analysis, project feasibility study (i.e. which type of gas storage will be more feasible), Investment required in the project, HSSE issues.
  - Make collaboration with oil and gas sector's academia so that the CGD companies will get informative inputs and workforce as well.
  - Board of directors should make decisions regarding participating in bidding or taking an approval for the establishment of gas storage facility.

6.7 Limitations of the Study

Presently there is very little official data available in India on natural gas storage facilities. No gas storage facility till now has been established in India hence the study is limited to global scenario of natural gas storage and in global scenario the countries taken are limited. The identification of the variables are dependent on the global scenario and the different reports analyzed on gas storage.

Sample size has been determined with the help of Yamane Formula and the results obtained are specific to the derived sample size. Analytical tool i.e. Factor analysis has been used so as to determine the factors.

Till now no work has been done on the establishment of gas storage in India and very less literature is available. In this research learning from global scenario has been incorporated and efforts have been done so as to implement the learning in Indian Scenario.

6.8 Future Scope of the Study

Other Scholars can carry out a detailed study of the factors identified in this research and can make use of other analytical tools which can give much more realistic and exact probability of the contribution of each factor in the establishment of gas storage facilities in India.

Scholars can also go forward and do detail analysis of different type of gas storage options available and the feasibility of these options in Indian scenario. Further by doing more extensive literature survey scholars can add more variables which might have been missed out in this study.

6.9 Concluding remarks

The study has taken into consideration the view of experts in gas industry, available literature, role of energy in economic growth, structure and composition of natural gas industry in India and abroad. The study has clearly established the need and benefits of developing natural gas storage facilities for CGD companies

in India. Six major factors were identified through this study having both positive and negative influence in the establishment of gas storage facilities by CGD companies in India. These factors are listed below:

- Economic
- Legal and techno operational
- Geographic and political
- Awareness and importance
- Technical and labor skills
- Environmental concerns.

These factors were studied in depth and further analysis of these factors revealed that we need to battle out the following four major barriers in the establishment of gas storage:

- Technical and labor issues
- Land availability and acquisition issues
- Investment issue
- Environmental issue

These barriers need to be addressed properly to make sure establishment of gas storage facilities for CGD companies in India.

The study has also made an attempt to develop a conceptual framework to facilitate establishment of gas storage facilities for CGD companies in India. Through conceptual framework an effort has been made to outline suggestive role of various stakeholders that will play key role in the development of gas storage facilities for CGD in India. It would be pertinent to mention here that though each stakeholder has its own set of activities, all the stakeholders need to work in tandem to achieve the objective

Hence, it can be concluded that the present research study has achieved its objectives.