TO STUDY SUPPLY CHAIN MANAGEMENT AND DEVELOP SOLUTIONS FOR REDUCING THE SUPPLY CHAIN COST OF LPG DISTRIBUTION IN PAKISTAN

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ABSTRACT

Today's economic downfall scenarios and competitive global business environment have offered challenge for maintaining the consumer prices. The consumer prices have become very important especially for those business products which involve large distribution of retailer or consumer goods movements. Now the cost of product is amongst the major challenges for the companies to survive in a competitive business environment.

The thesis includes an insight into the basics of the supply chain and the supply chain management for liquefied petroleum gas (LPG) distribution in Pakistan. The transportation cost is amongst the greater barrier for firm's profitability and increased consumer price especially in LPG distribution. The focus of study is made on the reduction of costs of LPG transportation/distribution for an LPG marketing company in Pakistan. It also includes a detailed study of LPG business in Pakistan.

The supply chain definitions, supply chain models, S.W.O.T., Principles of supply chain, just in time theories and transportation model (linear program model) have been used to reduce the supply chain cost.

An effort is made to make a new optimized model (or reduced cost model) in order to lower the consumer price, increase profitability, efficiency, effectiveness, customer satisfaction etc.

DEDICATED

TO

MY BELOVED FATHER.

Who at every stage encouraged me towards my success.

My Family Umer, Isra umer, Sadia, Saad, Qurat-ul-ain saad, Adil and Sara Sajjad.

My friend Imran Riaz for his help and support at all the stages of my study.

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CHAPTER –1

INTRODUCTION

1.1 General

The business climate of today's market has rapidly changed and it has become more competitive as ever in nature. In this competitive global economy, Supply Chain Management has emerged as the most important field for organizations and industries. SCM has become a necessity especially for downstream industry when it comes to deliver products at a competitive cost, better quality and in less time.

Supply Chain Management (SCM) as defined by Richard Hoppe is,

"The process of planning, organizing and controlling the flow of materials and services from supplier to end users."

This integrated approach incorporates suppliers, supply management, integrated logistics and operations. [1].

1.2 Background

In today's economic downfall scenario and competitive global business environment, the consumer prices have become very important especially for those business products which involve large distribution of retailer or consumer goods. The distribution cost per unit is expected to be high if the product size is large compared to its price or if the consumer/retailer price contains large transportation costs. The cost in the life cycle of the product (i.e. from raw form to factory, then to retailer and finally to the consumer) depends on healthier networks of operations, better transport services, stock controlling, information technology systems, etc.

Over the past few decades the cost of products have gone up due to increased labor rates, raw material cost, transportation cost, inflation etc. This has made the companies/corporations to think over their networks and make every effort to reduce cost so that the consumer price can be

made competitive and the profitability can be sustained in such global economic downfall.

In order to fight with the declining economies, increasing prices and decreasing sales, there is a need to review the networks of industries/organizations for their supply chain networks with the view to make their networks operate at optimum conditions and to reduce the over heads. This will result in reduced consumer price and this will also make the firms more profitable.

The thesis will focus on the supply chain network of Liquefied petroleum gas business in Pakistan. Liquefied petroleum gas (L.P.G.) is a consumer good and it is mainly consumed at domestic level and commercial level. It is used as alternative for natural gas on domestic level i.e. for cooking and heating purpose. The use on commercial level is in industrial processes e.g. welding, heat treatment, boiling etc. It is also used in automobiles as alternative source for petrol and Compressed Natural Gas (C.N.G.).

The sources of getting LPG are oil fields, oil refineries and gas fields. LPG is basically a bi-product of the following two processes.

- Gas/oil extraction process from gas/oil fields.
- Oil refining process from in oil refineries.

The supply chain of LPG involves two types of product transportation

a. Bulk Transportation. (Source to an LPG plant)
b. Bottled Transportation. (LPG Plant to end user in standard pressurized bottles called LPG cylinders)

The transportation cost in the supply chain network of LPG plays an important role in setting the consumer price which is highly competitive in Pakistan. As per the Oil and Gas regulatory authority of Pakistan there are more than 63 LPG marketing companies in Pakistan. One way of reducing the consumer cost of LPG is to reduce the transportation cost by

making optimized distances and optimized routing. The reduction in transportation cost can result in reduced consumer price, increased sales, better profitability of company and retailer, time efficiency etc.

1.3 Problem Statement

"Liquefied Petroleum Gas (LPG) business is a highly competitive business in Pakistan. The consumer cost for LPG (Liquefied petroleum Gas in cylinder form) is increasing day by day. The increase in cost is mainly due to the increase in transportation cost, operational cost, utilities costs, etc. This has resulted in low sales and also decreased the firm's profitability."

There has been hardly any study in Pakistan which has made a review of the LPG distribution/transportation network or the LPG supply chain network. Therefore there is a need to make a study with the aim to will discover the areas in the LPG supply chain network (especially transportation) from where money can be saved with the focus to reduce the consumer price and increase the firm's profitability.

Along with the cost saving in supply chain of an LPG company, an analysis of the company business strategy especially focusing to its supply chain will also be made.

1.4 Focus Areas for Cost Reduction in Supply Chain Network of LPG

Although there are many areas for cost reduction but this masters thesis will focus on the following

- Transportation cost analysis for LPG from LPG production sources to LPG customer area (or consumer area) via LPG filling facility (where the source product is changed into consumer product).
- Cost Analysis for present supply chain structure and discovering new areas of cost reduction while fulfilling the customer needs accurately and timely.

1.5 Target groups for the thesis

This thesis is targeted towards managers of LPG companies, distributors, transporters and retailers working in the supply chain network of an LPG marketing company. The other target groups are customers and people within the SCM network and/or consumer circle with an interest in logistics, cost reduction and supply chain management.

1.6 Research Objectives

The objective of this thesis is to make an analysis of the supply chain management system and apply the study to review the supply chain network for an LPG distribution/marketing company. An effort will be made to reduce the cost in the supply chain network and make a new optimized model (or reduced cost model) in order to lower the consumer price, increase profitability, efficiency, effectiveness, customer satisfaction etc.

The objective will be achieved by thorough analysis of past years data and using statistical techniques to project/forecast the future profitability. This will be compared with the reduced cost model and recommendations will be made accordingly.

1.7 Research Methodology

This study will focus to make an understanding of Supply Chain management and its effectiveness for industry especially focusing to find the critical areas of cost reduction in the supply chain network of an LPG marketing company in Pakistan.

The thesis will be completed as following.

- Literature review related to supply chain management, its principles and highlighting key areas where cost can be reduced.
- To study SWOT analysis and application to LPG distribution business for the company.
- To study the SCOR model and its use for measuring the performance

of supply chain network.

- To study Mckinsey 7s model and its application of its strategy element.
- To get an overview of the LPG business in Pakistan by studying the LPG supply chain, trends of LPG and its share in Pakistan energy consumption, usefulness of LPG and it future trends.
- To collect the past data related to LPG production and distribution in Pakistan (Punjab) and use statistical techniques for estimating the future trends of LPG business in Pakistan.
- Towards the end an effort will be made to recommend a reduced cost model (proposed supply chain model) for an LPG marketing company. This will be done by the application of SCM principles, SWOT analysis of the current LPG business for the LPG marketing company, Application of Mckensy 7s model, cost analysis for the transportation of LPG and by the application of transportation theory (Linear program model).
- Analysis of the proposed supply chain model for LPG distribution in terms of distance, cost and other features so that its feasibilty can be proved.
- Recommendations at local level, for Government of Pakistan and future research directions.

1.8 Thesis Structure

Chapter- one covers the back ground of the research work, problem statement, research methodology and the thesis structure.

Chapter- two focuses on the importance of the supply chain network. The origin of supply chain and supply chain management, developments in supply chain management, importance of supply chain management with examples, supply chain objectives and supply chain management goals.

Literature review in this chapter includes definitions of supply chain and supply chain management, the elements of the supply chain management, the seven Principles of the supply chain management, the S.C.O.R. model, S.W.O.T. analysis and McKinsey 7S model.

Chapter- three includes an introduction to Liquefied petroleum Gas (LPG), History of LPG in Pakistan, the uses of LPG, Pakistan energy consumption and LPG share, LPG business model in Pakistan, LPG supply chain in Pakistan, application of SWOT, Mckinsey 7s, analysis of transportational distances and Transportation cost analysis for LPG distribution of an LPG marketing company,

Application of the Transportation Model (As a Linear Program Model) for cost/distance optimization for current and proposed locations of LPG supply. In the end cost comparison of the proposed supply chain model and comparison of data is made.

Chapter- four includes the analysis and discussions regarding the thesis work. Distance and Cost Comparisons for LPG supply chain models are also discussed in this chapter.

Chapter- five includes recommendations for cost reduction at company's level, recommendations for Government of Pakistan and future research directions. The conclusion for the thesis has been made at the end of this chapter.

CHAPTER – 2

ORIGIN AND IMPORTANCE OF SUPPLY CHAIN MANAGEMENT-A LITERATURE REVIEW

2.1 Origin and Background of SCM

The supply chain techniques were thought to originate in 1950s in Japan which was later applied to car manufacturing industry. It is believed that the Japanese not only adopted the supply chain management technique in their industry but also worked for its wide spread.

In 1970s the organizations start thinking about cost reduction to increase their profitability. During 1980s there was a remarkable change in business all around the world when the organizations thought of low cost vs. high quality etc. This was the time when supply chain management grew up in the competitive global markets because the manufacturers were confronting the challenges of not only quality but also cost and efficiency. New product designs with low cost and better quality gain importance.

Supplier, manufacturer, retailer and consumer rely on one another so that what one of us does affects all of us. If my supplier makes a mistake, it may affect my customer and if my customer makes a mistake it may affect my supplier. If I make a mistake, it may affect both my customer and my supplier. [2].

These were the circumstances when the supply chain management start growing and later got its name in 1982.

The first mention of the term supply chain management was found in a paper published in 1982 in the US. [3].

The term “supply chain management” arose in 1980s and came into widespread use in the 1990s. Prior to that time, businesses used terms such as “logistics” and “operations management” instead. [4].

The subject of supply chain management remained popular till 1990s and it was used with different names like logistics, operations management etc. now a day this subject is given much more attention in almost every walk of life. The supply chain starts with the raw material, its transportation from supplier to industry where it is processed and then stored or transported in form of consumable goods or services to end user.

2.2 Developments in the Supply Chain Management

There have been several developments in the supply chain management through out its life span but we will focus on the era in which the "core competencies" concept was indulged in the supply chain management field.

This outsourcing and vendor partnerships not only mean the raw material or end product is outsourced but also outsourcing of services which the traditional business did not allow. Previously most of the services were provided in-house but due to global business competition, organizations need to increase the focus on their core business areas and develop their own competencies which can provide them with an edge in the competitive market. The logic behind this was that the company should increase focus on those activities in its supply chain which can provide a distinctive advantage and outsource everything else.

This transition made the companies to focus on their core business. E.g. if a company is dealing with cigarettes manufacturing, then that company needs not to focus on the transportation activity. I.e. the company should make partnership with vendors for their timely transportation of finished goods rather than spending their own time and money for this activity. This effort and time can be utilized in the production activity and can result in increased production.

2.3 Importance of Supply Chain Management

Napoleon a war master said several years ago that 'An army marches on its stomach.' [5].

This concept has greatly focused on the importance of supply chain management.

This means that the army can only move towards their targets if they are provided with food/services in efficient manner. I.e. the supply chain behind the movement of soldiers is important to win the war.

Supply chain management is considered to be an essential tool for organization or business success and customer satisfaction. The goal of any effective supply chain is to reduce inventory with the assumption that whenever any product is needed, it is available.

The importance of supply chain is reflected in almost every business e.g. manufacturing, transportation, production and distribution etc. Some of the features of supply chain management importance are as follows.

- Customer Satisfaction

  SCM can manage the customer demands in a better way by providing them with right product, in right quantity and at right time. More over better management of supply chain can easily address the problems related to customer's dissatisfaction. These problems can be further investigated to reach out their root cause. By eradicating the root cause the customer satisfaction and confidence on product or service can be increased.

- Principles of supply chain management

The seven principles of supply chain serve as guidelines for highlighting the critical issues involved in the organizational business that are major

cause for low profitability. These principles can help managers to fix the issues and make their firm more customer need oriented.

- Optimized Stocks

  The stocks can be kept at an optimum level so that the customer can find the stock available at location which is best suited. More stocks may involve more capital investment with low returns on investment while on the other hand stocks out situation may make the customer dissatisfied.

- Competitive Edge (Core Competencies)

  SCM provides the concept of core competencies because the global business competition has made the organizations to focus on their core business areas and develop their own competencies which can provide them with an edge in the competitive market. E.g. A car manufacturer makes a more light weight car body which consumes less fuel and gives more speed.

- Vendor Partnerships

  The new concept emerged from the supply chain management stress on vendor partnerships for those processes in the supply chain which are not core business areas for that organization. The logic behind this was that the company should increase focus on those activities which can provide a distinctive advantage and outsource everything else.

- Decreases Purchasing Cost.

The purchasing costs can be decreased by managing the demands and needs. Quick delivery of products can avoid holding expensive products which is dead investment till the time it is delivered.

- Decreases Production Cost

  Production department strongly depend on supply chains to deliver the materials as demanded i.e. just on time. Thus better supply chain management will result in low in-process inventory.

- Decrease Overall cost on product or service

  Better SC networks helps in managing the customer needs at the least total cost which can be achieved by timely managing the raw material, tailoring it to consumable form and delivering on time. Better forecasting in the supply chain may result in optimization of process which reduces the overall cost of product or service.

  Example – Dell computers manufacturer has outperformed the competition in terms of shareholders value growth from 1988-1996 using direct business models and build to order strategy i.e. using effective supply chain management. This helped Dell to keep smaller inventories in their factory and retail outlets which resulted in saving of millions of dollars. [6].

- Improve Financial Position

  Efficient management of supply chain management reduces the costs and increases the firm's financial position. The fixed asserts costs can be reduced by reducing the in process inventory cost in supply chain. The other reduction in cost can be made through optimized finished

stocks and transportation. E.g. Managing warehousing network in supply chain can result in six ware houses rather than ten.

Moreover the speed up process in the supply chain can result in lower time for the raw material to be converted in finished goods and finally reaching the customer. Thus a firm can furnish more orders in less time which increases cash flow.

- Better understanding of customer demands

An effective supply chain would understand the customer needs in a better way, which helps the organization in improving the product or service values. This further leads to technology driven competitive edge which is critical to business success.

- SCM improves Quality of life

    - Basic necessities of life such as food, water are strongly dependent on better supply chain management. Especially during natural disaster (Earthquakes, floods, hurricane etc) the importance of SC becomes more and more important for survival of human lives.
    - We are dependent on the supply chains for delivery of medicines and healthcare. This becomes more important for life saving drugs.
    - The utilities of life such as electricity/energy are delivered to homes through supply chains which are further used in cooking, refrigeration, air conditioning and other business related activities also.
    - Better supply chains reduce the end user price of products or services and it also improves the quality of product or service.

2.4 SCM Examples

Some of the excellent examples of utilizing the supply chain management for different organizations are as following.

1. Campbell Soup doubled its inventory turnover rate.
2. Hewlett-Packard cut desk-jet printer cost by75%.
3. Sport Obermeyer doubled profit and increased sales by 60% in two years.
4. National Bicycle increased its share from 5% to 29%. [7].
5. Wagmen's Supermarket Chains is a chain of supermarket in United States. It is also considered as leader in SCM in the grocery industry with about 37,000 employees. When a Wagman's spokesman was asked how many of its people work in its supply chain, he replied "37,000". The fact of matter is that most if not all of the people who work in any business organization are somehow involved with the supply chain and the overall success depends on these individual successes. [8].

2.5 The Supply Chain Objectives

The main objective of any Supply Chain is to get the customers satisfaction. Along with the customer satisfaction the components of the supply chain aim at increasing rather maximizing the profits of that organization.

Supply chain management has the objective to have the right products in the right quantities at the right time at minimal cost, a situation that would guarantee optimal service levels for the customer and optimal performance for the organizations as a whole and separately. [9].

The supply chain also aims at enhancing the revenues by subtracting those processes or activities which do not give remarkable returns on investments or profits. Thus making the system optimized to achieve the

organization's success is the ultimate objective of the supply chain.

SCM objectives which support its effectiveness can be identified as following.

- Increase the output.
- Reduction of cycle time (To decrease bottle necking and increase the conversion process of customer's orders into finished goods or services)
- Reduction of inventories (Inventories may be raw material, in process inventory or the finished goods inventory)
- Improve the visibility of activities of supply chain. i.e. the demand, supply, in process activities, order fulfillment etc.
- Reduction of capital involved in the business.
- Improving the quality of finished products or services.

All these objectives are interrelated and the overall success of the supply chain depends on the individual component success. For example, If SCM aim at increased sales or throughput then it ultimately has to reduce the cycle time (time consumed from customer's order to finished product delivery as required). Thus the objectives of the supply chain ca n be set as a whole (on all the activities of the supply chain) and also at individual level (on each component or activity of supply chain). The individual level objectives can be tuned to achieve the overall objectives of the supply chain.

2.6 Supply Chain Management Goals

SCM aims at providing smooth and high velocity flow of materials in the whole chain of product or services along with the relevant information for making the supply chain more efficient. SCM plays a major role in reducing the total cost of supply chain. Such costs can be the raw material costs, transportation/shifting cost, facility development cost,

manufacturing costs, inventory cost etc

2.7 Definitions of Supply Chain

A typical supply chain is shown in the following figure. A supply chain consists of a stream of processes that involved the movement of material from the supplier to consumer through manufacturer/suppliers (factories, industries etc) and distribution centers (retailers etc). The manufacturer will covert the raw material into finished goods (consumable goods) as demanded by the end customer.

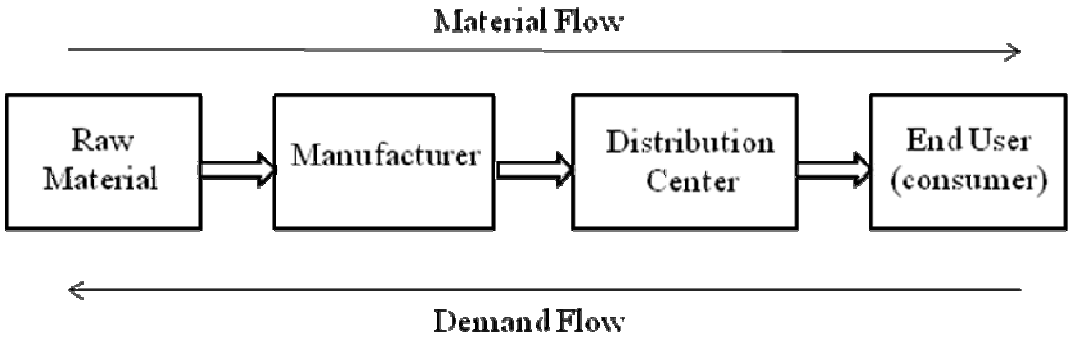

Figure 2.1 Typical Supply Chain

Following are some definitions of a supply chain:

1. "A supply chain is the alignment of firms that bring products or services to market." [10].
2. "A supply chain consists of all stages involved, directly or indirectly, in fulfilling a customer request. The supply chain not only includes the manufacturer and suppliers, but also transporters, warehouses, retailers, and customers themselves". [11].
3. "A supply chain is a network of facilities and distribution options that performs the functions of procurement of materials, transformation of these materials into intermediate and finished products, and the distribution of these finished products to customers."—from Ganeshan and Harrison . [12]

4. "The systemic, strategic coordination of the traditional business functions and the tactics across these business functions within a particular company and across businesses within the supply chain, for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole."—from Mentzer, DeWitt, Keebler,Min, Nix, Smith, and Zacharia. [13]
5. Supply Chain is a sequence of organizations – their facilities, functions and activities – that are involved in producing and delivering a product or service.

   Sequence begins with the basic suppliers of raw material and extends all the way to the final customer. Facilities include warehouses, factories, processing centers, retail outlets and offices. Functions and activities include forecasting, purchasing, inventory management, information management, quality assurance, scheduling, production, distribution, delivery and customer service. [14].

2.8 Definitions Of Supply Chain Management

The idea of Supply Chain Management (SCM) has been introduced in the end of 20th century. Supply Chain Management (SCM) is a strategic integrated customer and organization oriented management philosophy that focuses an increased sustainable performance and competitiveness for all partners within organizational arrangements called supply chain.

1. Simchi-Levi et al. define Supply Chain Management as follows: "Supply chain management is a set of approaches utilized to efficiently integrate suppliers, manufacturers, warehouses and stores, so that merchandise is produced and distributed at the right quantities, to the right locations, and at the right time, in order to minimize system-wide costs while satisfying service level requirements." [15].

2. “SCM is the management of a network of interconnected businesses involved in the ultimate provision of product and service packages required by end customer.” (Harland, 1996). [16]
3. Definition from the Council of Supply Chain Management Professionals.

   “Supply chain management encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third party service providers, and customers. In essence, supply chain management integrates supply and demand management within and across companies”. [17]
4. Supply chain strategy includes: “... two or more firms in a supply chain entering into a long-term agreement; ... the development of trust and commitment to the relationship; ... The integration of logistics activities involving the sharing of demand and sales data; ... the potential for a shift in the locus of control of the logistics process.” [18].
5. Supply chain management is “... an integrative philosophy to manage the total flow of a distribution channel from supplier to the ultimate user.” [19]
6. “Management is on the verge of a major breakthrough in understanding how industrial company success depends on the interactions between the flows of information, materials, money, manpower, and capital equipment. The way these five flow systems interlock to amplify one another and to cause change and fluctuation will form the basis for anticipating the effects of decisions, policies, organizational forms, and investment choices”. [20]

7. "The objective of managing the supply chain is to synchronize the requirements of the customer with the flow of materials from suppliers in order to effect a balance between what are often seen as conflicting goals of high customer service, low inventory management, and low unit cost." [21]

2.9 Elements of Supply Chain Management

Supply chain management involves coordinating activities across the chain. Central to this is taking customer demand and translating it into corresponding activities at each level of the supply chain.

Following table 2.1 reflects the elements of the supply chain and their related typical issues.

Table 2.1 Elements of SCM. [22]

S/No	Element	Typical Issues
1	Customers	Determining what product and/or services customer wants.
2	Forecasting	Predicting the quantity and time of customer demand.
3	Design	Incorporating Customers, wants, manufacturability and time to market.
4	Capacity Planning	Matching supply and Demand.
5	Processing	Controlling quality, Scheduling work.
6	Inventory	Meeting demand requirements while managing the cost of holding inventory.
7	Purchasing	Evaluating potential suppliers, supporting the need of operations on purchased goods and services.
8	Suppliers	Monitoring supplier quality, On-time delivery and flexibility; maintaining supplier relations.
9	Location	Determining the location of facilities.
10	Logistics	Deciding how to make the best move.

2.9.1 Explanation of the Elements of Supply Chain Management

The customer is the key driving element of the supply chain management. Usually marketing personnel are responsible for the demands of customer, as well as forecasting the quality as well as the time of product supply.

Product/Service design must match the customer demands considering the operations capabilities.

Processing is the core as it occurs in each part of the supply chain network. Major portion of this processing occurs at the portion which produces product/service for the final consumer. E.g. In mobile manufacturing there may be processing like purchasing of raw material, transportation, storage, conversion of raw form of material into consumer required form of product (Core area), packing, loading/unloading, transportation, etc. Inventory is a fastener in most supply chains. It needs not to be too much or too low. Because too much inventory will hide problems and it will require big capital investment, too small inventory may cause delays. Inventory needs to be just in time and having quality as demanded.

Purchasing links the organization with its suppliers. Purchasing department is involved in finding reliable suppliers, to do negotiations with suppliers which an plays important part in gaining confidence, make contracts with suppliers, evaluate suppliers etc.

Location factor is important in number of ways. It determines the transportation cost on raw material and finished goods, nearness to the resources as suppliers/market etc, delivery time of supplied items and finished goods to consumer may also depends upon location.

Logistics refers to movement of materials and information in the supply chain network. It includes movements of raw material, finished goods as well as managing utilities requirements like fuel, water etc.

2.10 S.W.O.T. Analysis

S.W.O.T. is an analysis tool that is useful in understanding and decision making for an organization in all the situations.

2.10.1 Introduction

S.W.O.T. is an abbreviation for Strengths, Weaknesses, Opportunities and Threats. It consists of four factors which have their own distinctiveness and also they have specific purpose. The following figure shows all the four factors of S.W.O.T.

Figure 2.2 S.W.O.T. Analysis [23].

The first two factors relates to internal factors (factors which are normally within the organization's control. e.g. Firms operational capabilities, inventory management, distribution network management etc) while the last two relates to External factors (normally deal with external environmental factors. E.g. may be political factors, economic factors etc) According to a Dr Otis Benepe:

> "S.W.O.T. analysis is a subjective assessment of data which is organized by the S.W.O.T. format into a logical order that helps understanding, presentation, discussion and decision-making". [24].

2.10.2 History/Origin of S.W.O.T

S.W.O.T. analysis aroused from Stanford Research Institute during 1960-1970. [25]. During that period firms and organizations were thinking

about the failure of their planning which lead to S.W.O.T. Different groups contributed to find out the factors for their business failures.

In the early sixties of 20th century an analysis named S.O.F.T (Satisfactory, Opportunity, Fault and Threat) made its existence. This analysis concluded that Satisfactory are all those things which keeps the present condition of firms in good position, things good for future were considered as an Opportunity, bad things for present condition of organizations was considered as Fault and bad in the future was considered to be a Threat for that organization.

In 1964 - Urick and Orr in Zurich Switzerland progressed in the research and changed the F to a W in the S.O.F.T. analysis and called it S.W.O.T. Analysis. [26].

2.10.3 Applications of S.W.O.T.

S.W.O.T. is an analysis tool being widely used by many business groups in different situations may be e.g. to evaluate the capabilities of an organization or business group. It is used in making strategic business planning process at different levels and different situations.

Besides the planning stage S.W.O.T. can be applied to identify root causes of a non-conformance and to provide new solutions/strategies to a business or organization

It is often not exposed to many employees as higher management or leaders of an organization are mostly involved in while making business decisions. Nevertheless, anyone who is trained and has good understanding of it, can perform a S.W.O.T. Analysis.

In general S.W.O.T. Analysis can provide the value added solution to the organization by the effective use of four factors may be in the following way.

- Strengths – Should be maintained and increased.

- Opportunities – Should be optimized and used in systematic way for business growth.
- Weaknesses – Needed to be removed by taking remedy actions.
- Threats – Counter measures should be taken to eliminate the threats

2.10.4 S.W.O.T. Factor's Explanation

The S.W.O.T. factors (External and internal) may include any of the following.

2.10.4.1 Strength and weakness

- Expertise of an organization in their business or operation.
- Access and availability of resources, asserts or people.
- Better Infrastructure availability or unavailability.
- Advantages or disadvantages over their competitors.
- Services and flexibility for customers.
- Quality over cost and time issues.
- Production / operational or Service efficiencies or inefficiencies.
- Better return on investments.
- Innovative aspects of an organization.
- Geographical situation.
- Accreditations and Certifications.
- Financial positions.

2.10.4.2 Threats and Opportunities

- Better Business Alliances for an organization or their competitor.

- Introduction of new Products and/or Services with better values and costs.
- Saturation market condition in a specific area.
- Developments in technology.
- Development in markets.
- Global influences on the business.
- New market trends.
- Business development or product development.
- New partnerships or hospitality agreements.
- Seasonal influences.
- External pressures may be legislative, environmental or political etc.
- Loss or gain of expert persons during some market strategy.

2.10.5 Performing S.W.O.T. Analysis

S.W.O.T. analysis involved the following steps.

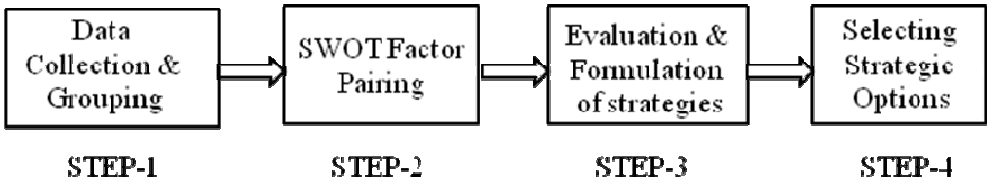

Figure 2.3 Steps in performing S.W.O.T. Analysis

- **Step-1 Data Collection and Grouping in Factors**

Data Collection regarding the four factors is an essential part of S.W.O.T. analysis. The information collected is expected to be more factual which would lead the solution of analysis to be realistic and reliable.

After the data collection phase is completed, it is then grouped in the four factors (Strengths, Weaknesses, Opportunities and Threats). This can be done individually or in a team.

- **Step-2 S.W.O.T. Factors Pairing**

After making the grouping of data in four factors, now the step is to pair those factors for strategic formulation in the following four categories.

1) Strengths / Opportunities Strategies (S.O. Strategy).
2) Strengths / Threats (ST Strategy)
3) Weaknesses / Opportunities Strategies (W.O. Strategy)
4) Weaknesses / Threats Strategies (W.T. Strategy)

- **Step-3Evaluation and Formulation of Strategies**

After the S.W.O.T factor pairing several strategic options are developed. A quick assessment of each of these strategies can be made to meet the business goals or objectives.

- **Step-4 Selecting Strategic Options**

Now the organization has come up with many strategic options and optimum options are to be implemented. This needs that the options need to be shortened may be by dropping some of them. To select more options is impractical.

2.10.6 Example of Performing S.W.O.T Analysis:

- **Step-1 (Data Collection)**

Let's take an example of using S.W.O.T. analysis for a cricket match. Before the game starts; both teams have different strategies but as the game proceeds there comes a difference in the condition of the game. Now is the time to evaluate the four factors, may be as follow.

Strength: Your team is good scoring form with few wickets in hand.

Weaknesses: One batsman is injured.

Opportunities: Pressure of losing the match has shifted towards the other team.

Threats: The required scoring rate is going high.

- **Step-2 (S.W.O.T. Factors Pairing)**

S/O Strategy: i.e. "Your team is good scoring form" and paired with your opportunities is "Pressure of losing the match has shifted towards the other team ".

W/O Strategy: i.e. "One batsman is injured" and paired with Opportunity i.e. "Pressure of losing the match has shifted towards the other team ".

- **Step-3 (Evaluation and Formulation of Strategies)**

In this step the management can take decisions after quick evaluation the above options. In the current example the team can go for

- S/O Strategy: With this situation the team can have the strategy to take some risks by scoring at a faster rate in order to win the game before the last over.
- W/O Strategy: With this situation your team can have strategy of playing defensively and reaching the target to win the game.

The other formulation of strategies (S.T. and W.T.) can be made in the same way.

- **Step-4 (Selecting Strategic Options)**

In this step the management can further work on the options and drop down the W.O strategy and go for S/O strategy. Here one can see that the S/O strategy (Offensive playing) and W/O strategy (Defensive playing) are not possible at one time.

2.10.7 Pros and cons of applying S.W.O.T.

S.W.O.T. Analysis tool seems pretty simple but it may offer many difficulties while applying in a real life practice. Following

2.10.7.1 PROS

- S.W.O.T. analysis can be used by big organizations as well as smaller groups and at any level.

- S.W.O.T. analysis contains factual data which leads to better understanding of external factors and internal capabilities of an organization or business.
- S.W.O.T. helps organization to make a competitive analysis of with other market players.
- Threats and opportunities may be evaluated to set new strategic planning for better position in a business environment.
- S.W.O.T. helps in setting new market position in new dimensions.
- S.W.O.T. helps in evaluation of weakness / threats, which may be prioritize and eradicated to prevent any loss.

2.10.7.2 CONS

- Collection of data may not be updated because the S.W.O.T. team may take some previous events for make new decisions.
- Members may have different opinions as per their understanding of S.W.O.T. process.
- People may include their own opinions rather that facts.
- Details, reasoning and justification are often not included in the S.W.O.T. table which may lead to difficulty in understanding.
- Flexibility: S.W.O.T. can be used in a variety of situations so it is flexible but on the other hand it can lead to a number of abnormalities.
- S.W.O.T. may consume lot of time and energy.
- All the elements in one factor may not carry equal attention because some elements in a factor may be controversial than others. e.g. Threat A may be more crucial than threat B or threat C.
- S.W.O.T. can oversimplify the situation may be because of placing the elements in categories in which they may not fit.

2.11 The Seven Principles Of The Supply Chain Management

The seven principles of supply chain management emerged in 1997, these

were written by experts from the respected Logistics practice of Andersen Consulting (now Accenture), "The Seven Principles of Supply Chain Management," laid out a clear and compelling case for excellence in supply chain management. The insights provided here remain remarkably fresh ten years later. [27]

These principles focus towards all the activities across the supply chain to create values for the customers and to make the organization more profitable. These principles serve as guidelines for highlighting the critical issues involved in the organizational supply chain processes that are major cause for low profitability. These principles can help managers to fix the issues and make their firm more customer need oriented.

2.11.1 Principle-1: Customer Segmentation (Need based segmentation of customers)

"Segment customers based on the service needs of distinct groups and adapt the supply chain to serve these segments profitably".

The customers needed to be segmented based on their particular requirements and the supply chain is to be made according to these distinct groups. The target in this case would be to maximize the sales and to increase profitability. E.g. Supply of drinking water to certain customers based on their need may be at a particular location rather than retailer. In this scenario the supply may be adapted in such a way that the needs of the specified group of customers are fulfilled on time and with decreased cost.

2.11.2 Principle-2: Customize the logistics network to the service requirements and profitability of customer segments

In this principle it is focused that the organization's logistics network needed to be designed as per the requirements of the customers. I.e. the logistics network must fulfill the needs of fast orders (may be of small quantity of stocks and segmented areas) and larger or bulk orders. For this purpose the warehousing and supply networks needs essential working so that the customer orders are fulfilled on time and the supply network must also be optimized to lower costs. Mostly the organizations have a pre-designed logistics network which is as assumed to fulfill the needs of all the customers but as the customers are segmented that pre-designed network may be less useful in meeting their needs. So the study of logistics network as per the service requirements is essential to optimize the use of resources but it needs real-time and robust decision making.

2.11.3 Principle-3: Listen to market signals and align demand planning accordingly across the supply chain, ensuring consistent forecasts and optimal resource allocation.

Forecasting has been an essential tool for the organizations business but traditional ways of forecasting is bit cumbersome as multiple departments forecast for the same final product in their own ways. E.g. the manufacturing department of a certain organization may focus its energies in making a smooth operational for a specific quantity of output while at the same time the sales department may forecast to assume larger sales by giving discounts on the product. In such case the manufacturing and sales forecast of the consumable quantity required may mismatch. This functional forecast of the organizations sometimes is also not attuned with the supply chain network, however good it may be.

Now a days organizations have realized to put planning that is supported

by different departments and also involve all the links of supply chain i.e. from the supplier's supplier to the customer's customer. The motto is to lower the inventory level in such a way that the resource utilization is optimized i.e. the inventory level is maintained at the lower possible but to fulfill the customer requirements. The curve for the customer needs and the organization production suppliers must be smooth and overlapping.

2.11.4 Principle-4: Differentiate product closer to the customer and speed conversion across the supply chain.

The organization's supply chain network needs to be aligned with the optimum production on need basis of the customer. The manufacturers should decrease the lead times in production and strive for planned production as per needed by the customer.

Traditionally the manufacturers have stocked the products to cater for the forecasting errors and to meet their production targets. This sometimes consumes lot of resources which are not aligned with the customer's demand and also it consumes lot of time.

As time is money and loss of time is loss of money so the organizations must strengthen their abilities focused on the market signals/demands by compressing their lead times along the supply chain network and they should also speed up their conversion process of finished goods (or manufacturing) as per the needs of the customer. This may also be called as just-in-time manufacturing. This approach pushes the critical processes closer to the actual demand and increases the manufacturer's flexibility to respond the customer's demand. It may be called as the increases the flexibility of production decision is kept close to the moment of

occurrence of demand.

2.11.5 Principle-5: Manage sources of supply strategically to reduce the total cost of owning materials and services.

The time of converting the raw material into finished good and transfer of the finished goods to retailers or customers must be kept to the minimum. In other words the raw materials must be stocked only as per the demand of the finished products. This requires efficient and reliable suppliers. If the raw material is stocked in more quantity and the speed of conversion to finished goods is less due to the customer's demands, then the cost of extra material stocked in the company (which is not converted into final form due to low demand) is a loss for the organization. In other words large lots may reduce the unit cost but if they are not reflected in sales, it is a loss of time and resources. The other view of this picture may be that manufacturer stocks more finished goods than actual demands which also locks money and resources, infect these resources can be put to profitable tasks rather than to stock them.

This fact is traditionally considered bit difficult because the risk factors are involved. The risk may be the less speed to fulfill to customers need due to lack of raw material. For this the best approach may be to keep strategic relationship with suppliers, long-term supply contracts or to integrate vertically so that the just-in-time approach may be followed.

2.11.6 Principle-6: Develop a supply chain-wide technology strategy that supports multiple levels of decision making and gives a clear view of the flow of products, services, and information.

The traditional supply chain systems need to be redesigned with flexible

and enterprise-wide systems. If the outcome of the latest technological systems with many aspects of data don't supports real time decisions for an organization then it may be useless. The system must be flexible to support an efficient supply chain strategy. I.e. it should give a clear cut picture of the needs verses production may be for short term, long term or medium term perspectives.

The technological systems must have the following characteristics.

- The system must assist in planning and decision making supported by demands and production efficiencies and resource allocation for their optimum utilization.
- The system must be enterprise-wide and able to share information with the supply chain channel partners to achieve mutual targets.
- Handle orders in efficient way. May be electronic handling of transactions, orders and payments from customer to supplier.
- Must be supportive to make strategic planning for fulfilling of the customer demands.
- Helpful in decision making for just-in-time inventories. i.e. lower stocks but fulfill the demands.

2.11.7 Principle-7: Adopt channel-spanning performance measures to gauge collective success in reaching the end-user effectively and efficiently.

Channel-spanning performance measures can be implemented in a successful way if the technology supports tracking and control in a timely manner. Measures must be adopted not only to control the supply chain network but also to calculate the performance. This may be done to each and every link of the supply chain network that may include production, service, supply, financial matters etc.

The performance measures should fulfill the following.

- Order fulfillment measurement: The orders are fulfilled as demanded by the customers.
- Pricing: The pricing of the orders should be measured for correct entry so that it may not affect the end performance.
- Measure of real cost of supply chain and compare it with the actual one.
- Costing needs to be activity based costing in order to save money in unnecessary activities.
- Measure of the warehousing costs.
- Tracing and Control of the supply chain activities.

2.12 SCOR Model

2.12.1 Background

In 1996, two Boston-based consulting firms: Pittiglio Rabin Todd & McGrath and AMR Research decided to develop a standard approach to analysis and describe all the aspects of supply chain processes. The outcome was the SCOR. [36].

The objective of this model was to address the issues regarding the supply chain, to measure the performance of the supply chain and identify improvement opportunities. SCOR was developed with the view to make it applicable for all the industries with global as well as local environments.

2.12.2 Introduction of the SCOR

This model was developed to elaborate the organizational business processes which are associated with the customer's demand as well as satisfaction.

The model is based on three pillars or foundations

1. Process Modeling.
2. Performance Measurement.
3. Best Practices.

2.12.3 Process Modeling

Supply chains can be described by using process modeling building blocks, SCOR model can be helpful to describe simple as well as complex supply chains through the use of common set of definitions.

SCOR model contains the following five management processes.

1. Plan
2. Source
3. Make
4. Deliver
5. Return

The following figure 2.4 shows these five processes.

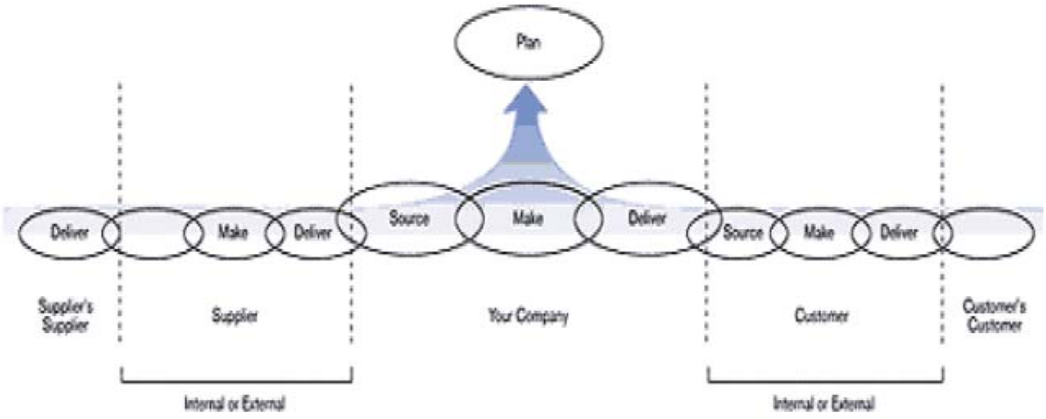

Figure 2.4 Five major management processes in SCOR model. [37].

The figure 2.4 represents the supply chain from the supplier's supplier to the customer's customer. Three main areas of the figure are Supplier, Company or organization and the customer. SCOR assuming that all supply chain processes can be subdivide into one of five general subtypes: Plan, Source, Make, Deliver, and Return. So the figure sub-divides the supplier, customer and the organization operations into the

general subtypes.

2.12.4 Explanation of five Processes

- **Plan**

The planning process is of prime importance because the efficiency of all other process is strongly dependent on the planning. This process manages the balance between the supply and demand requirements. Further it optimizes the resources with regard to requirements. This is also responsible for the flow of information regarding the plans to all members of the supply chain so that they can coordinate and update themselves accordingly.

- **Source**

After an establishment of plans, this looks into the suppliers for their evaluation and selection. This also manages the optimum stock levels of the raw material in order to meet the customer needs. Other than this, the following are also managed

  - Supplier's performance
  - Data collection and data management
  - Information pertaining to inventory management
  - Capital assets, policies for import/export.

- **Make**

This process is used to schedule the operational activities which also include quality assurance of finished goods, testing, packing etc. I also manage production issues, performance data, production/operations networks and their facilities etc.

- **Deliver**

In this process the routing for delivery of finished goods is made which includes transportation, warehousing. The customer satisfaction is achieved by timely delivery of the goods as well as delivery in good

condition.

- **Return**

This process contains the management activities regarding the return of exceeding or defective raw material, verification of its status, return schedule or repair.

2.12.5 Levels of SCOR Model

The five management processes in SCOR model are put into three levels in order to analyze a company's supply chain. These levels have been described in the following figure and explained below.

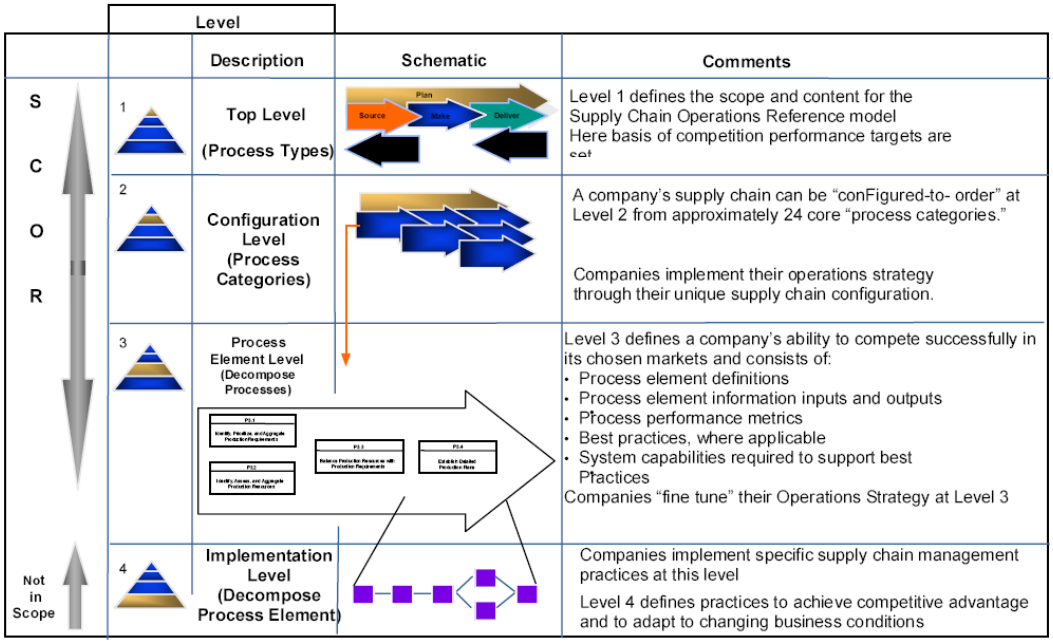

Figure 2.5 Levels of SCOR. [38].

SCOR model do not explains the details of the business process and the activities involved in them rather it explains the relation ship between those processes. The key assumption for SCOR is that work force training, quality of product o process, information technology systems, admin related issues are assumed to be basic support process for this model.

- **SCOR level 1**

This level defines the scope of SCOR model for that organization and it is usually performed by the top decision makers. At this level the company builds up basic fundamental strategic decisions. E.g. If the Level-1 of SCOR model relates to the 'make' process then Analysis focus will be concentrated on those processes that relate to the manufacturing or value addition process. The same is the case for deliver, source and return process.

- **SCOR level 2**

At this step the companies shape their supply chains and decide that which type or scenario is applied to the process selected in the level 1. This may be understood by the following example.

Example: In level 1 'make' process is selected. Now there are three sub types (Level – 2)or scenarios for 'make' process that may be M1, M2 or M3. The M1, M2 and M3 are SCOR model's syntax in which the alphabet represents the process (M represents make, S represents source, R represents return, D represents deliver etc). The numerical value (1, 2, 3 etc) represents the scenario or type. The syntax is described in the following example.

- M1 – refers to "Make build to stock"
- M2 – refers to "Make build to Orders" (Products/services are manufactured as per customer's order)
- M3 – refers to "Make engineer to order"

The same can be used with the plan, source, deliver and return processes. E.g for Plan it may be P1, P2 or P3, For Source it may be S1, S2 or S3 etc.

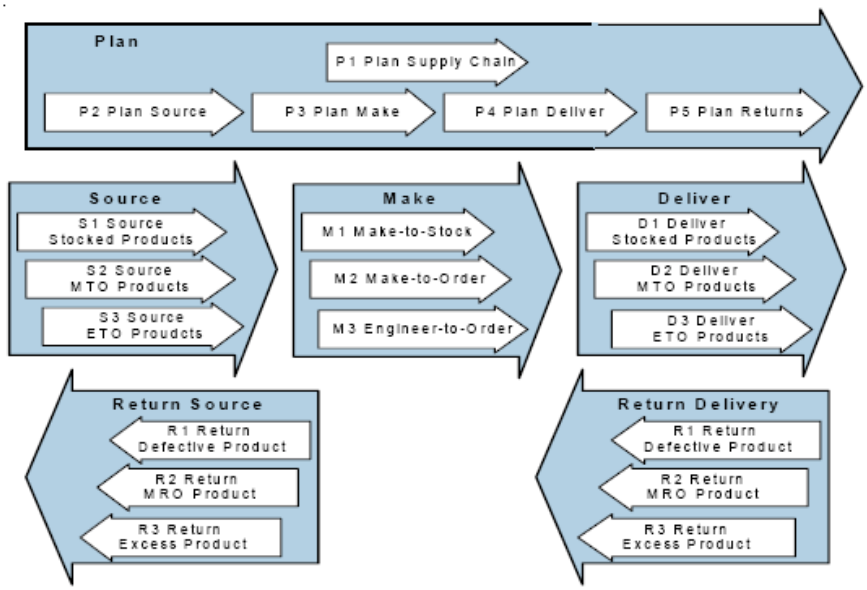

Figure 2.6 SCOR Level 1 processes and Level 2 subtypes. [39].

- **SCOR level 3**

This level defines the further sub process or business activities or tasks that belong to each of the Level 2. E.g. M2 (Make build to order) is selected in level 2 then in level 3 the further categorization of M2 is done as M2.01, M2.02, M2.03, etc.

M2.01 - Refers to "M2 – Schedule Production activities"

M2.02 - Refers to "M2 – Issue Product"

M2.03 – Refers to "M2 – Produce / Test"

M2.04 – Refers to "M2 – Packing"

The other processes may be represented in the same manner as described above. E.g. for Source S2 (Source – build to order) it may be S2.01, S2.02, etc,

2.12.6 Performance Measurement

The performance of the supply chain through SCOR model can be measured by the use of key indicators of SCOR model. These performance indicators have been derived through the experience and

contribution of the council member.

In the performance measurement the SCOR metrics are placed hierarchically with Level 1 metrics at the top then level 2 and level 3. Level 1 metrics do not necessarily relate to SCOR Level 1 process (plan, source etc) and Level 1 Metrics are primary high level measures, these are the measure of the organization in achieving their targets and goals. The metrics are used in combination with performance attributes (which are the characteristics of the supply chain. Just like the physical characteristics of any solid object i.e. height, weight etc). Example of performance attributes are shown in the following figure.

	Performance Attribute	Performance Attribute Definition	Level 1 Metric
Customer Facing Attributes	Supply Chain Delivery Reliability	The performance of the supply chain in delivering: the correct product, to the correct place, at the correct time, in the correct condition and packaging, in the correct quantity, with the correct documentation, to the correct customer.	Delivery Performance
			Fill Rates
			Perfect Order Fulfillment
	Supply Chain Responsiveness	The velocity at which a supply chain provides products to the customer.	Order Fulfillment Lead Times
	Supply Chain Flexibility	The agility of a supply chain in responding to marketplace changes to gain or maintain competitive advantage.	Supply Chain Response Time
			Production Flexibility
Internal Facing Attributes	Supply Chain Costs	The costs associated with operating the supply chain.	Cost of Goods Sold
			Total Supply Chain Management Costs
			Value-Added Productivity
			Warranty / Returns Processing Costs
	Supply Chain Asset Management Efficiency	The effectiveness of an organization in managing assets to support demand satisfaction. This includes the management of all assets: fixed and working capital.	Cash-to-Cash Cycle Time
			Inventory Days of Supply
			Asset Turns

Figure 2.7 SCOR Performance Attributes and Level 1 Metric. [40]

The level 2 calculations (Lower level calculations) are generally associated with a narrower subset of processes. Level 1 calculations are made form the level 2 (lower level calculations), so level 2 calculations are made first.

2.12.7 Best Practices

After measuring the performance of the supply chain operations and gap identification, the next step is to make analysis of the gaps and to take improvement steps against those gaps.

The supply chain council members have made over 430 executable practices for this purposes which are based on their experience and study. The SCOR model defines a best practice as a current, structured, proven and repeatable (they have been proven in several environments) method for making a positive impact on desired operational results. [41].

2.12.8 Weaknesses and limitations of the SCOR Model

- SCOR model is still in evolutionary phase and there has been several changes made in it such as the 'return' process has been introduced in it.
- The model elements can have particular degree of uncertainty under specific environment which is not cater for in this model.
- This model does not explain every business process and activity with in the supply chain, rather it assumes them to in fundamental form.
- The work force training, human resource, quality assurance and IT has been left at the stake of the organizations which may deviate the results of improvement activities.

In general SCOR can help organizations to improve their supply chain efficiencies by identifying the inefficiencies and suggesting remedies.

2.13 McKinsey 7-S Model

2.13.1 Introduction

This model is named after the work done by a consulting company named Mckinsey in 1980s. This is a diagnostic model which looks at seven components of an organization and their interrelation. These seven

components are structure, strategy, systems, skills, style, staff and shared values. As all these components starts with “S” so this model is often called Mckinsey 7-S Model.

This model has been applied to analyze more than 70 large organizations. [42].

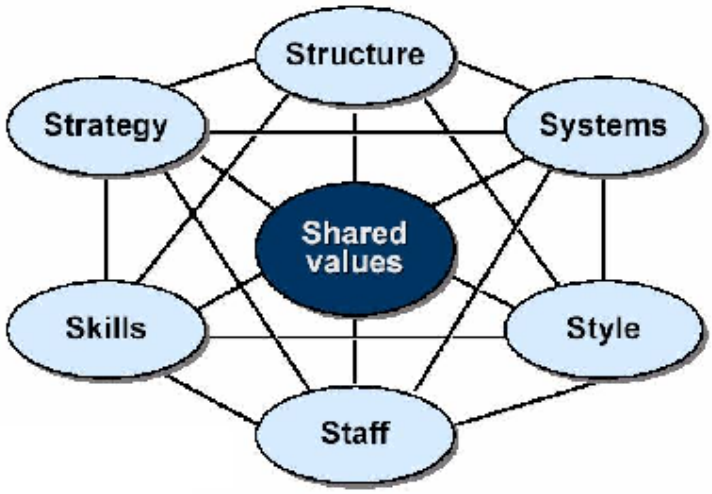

Figure 2.8 McKinsey 7-S Model [43]

2.13.2 Description of Fig

The above figure has been designed as per the McKinsey model. This shows the all the 7 components of this model and it also shows their interdependency.

There are also other variables in the organizations but these seven variables have been considered of prime importance for the organization workers. [44].

2.13.3 Key Benefits of 7-S Model

- Effective way to diagnose i.e. to identify key areas of benefit for organization.
- Provides better understanding of organization in seven key areas.
- Provide guidance and course of conduct for organizational change;

- Provides rational and also emotional constituents with their interrelation to get the organizational objectives.

2.13.4 7-S Model – Application for Successful Organization

7-S model may be applied to path the organization towards success. For this, the organization work on all the 7‘s’. These needs to be aligned in such a way that each ‘s’ reinforce the other ‘s’. It is quite difficult to get the organizational success by working on few of the 7‘s’, the aim should be to work on all and find the driving factors among them. E.g. an organization can find its goals by developing a strong structure implement more effective system and strategies and work on the development of staff, their skills, culture and values. It is not possible to bring new systems without developing the staff.

2.13.5 Classification of 7 Components

The seven elements are normally classified as soft and hard elements.

2.13.5.1 Soft Elements

The soft elements of 7-S model are skills, style and staff and shared values. These elements require much effort to understand as compared to the hard elements as these elements are continuously developing with in the organization and these are strongly depended on the people of that organization. These elements can be analyzed by a close study with in the organization may be by conducting interviews of the people working in that organization.

Moreover it is also difficult to bring change in these elements and managing that change is also very difficult. e.g. an organization structure

(hard element) is bit easier to change rather than to bring change in the style/culture of the people.

2.13.5.2 Hard Elements

The hard elements are strategy, structure and systems. These elements can be identified easily in any organization. The data regarding these elements is tangible like business plans, policies, organization chart etc. strategy, structure and systems

2.13.6 Description of 7 Components

2.13.6.1 Strategy

The strategy is the planning done by an organization to meet the needs as per the changes that exist in the external environment.

The strategy consists of action plans required for the organization may be in any of the following three conditions.

1. Current position of the organization (may be compared to its competitors)
2. Future position of organization (May be after one or more years as per the firms objectives)
3. The time required to achieve the organizations future goals.

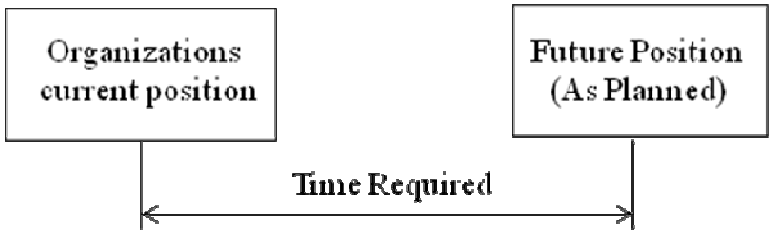

Figure 2.9 Strategies - McKinsey 7-S

Strategy is designed to transform the firm from the present position to the new position described by objectives, subject to constraints of the capabilities or the potential. [45]

2.13.6.2 Structure

The structure refers to the organizations skeleton often called as Organizational structure. This organization structure is made according to the business objectives and it is also shapes the minimum requirement for an organization to operate and achieve its objectives.

The traditional way involves structuring in a hierarchical way which contains many divisions and departments. These departments and divisions are assigned specific tasks and it also shows the reporting of each group. The structure is quite wide at the bottom which reduces as it goes upwards.

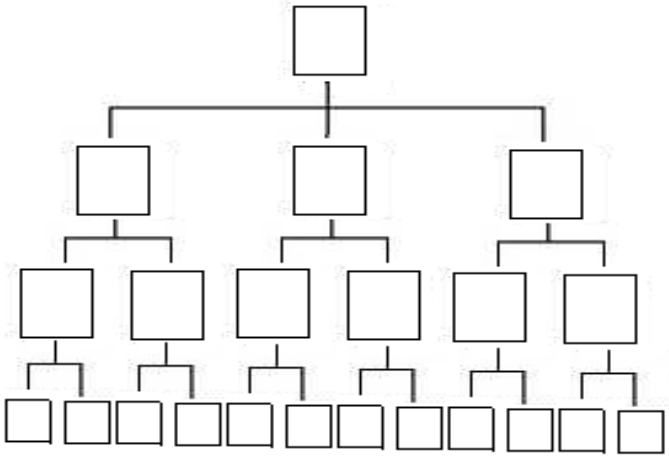

Figure 2.10 Traditional Organizational Structures

The organization structure may follow many different styles which depend upon the organizations objectives and culture. The typical success factors while developing the structures may be following.

- Reporting needs to be decentralized.
- Response needs to be rapid.
- Reliability of structure
- Reporting (Needs to be permanent)
- Flat hierarchy

Flat Structures This is modern trend for organizational structure with the idea of empowering employees. I.e. the trained employees/workers needs more direct reporting so that they can be directly involved in the decision making process rather than following by more supervisors and managers. It leads to better relationship between managers and workers which further leads to better team performance, better communication of organizations objectives and it also lowers the cost as some supervisors or managers have been reduced in it.

These structures are mostly limited to small organizations.

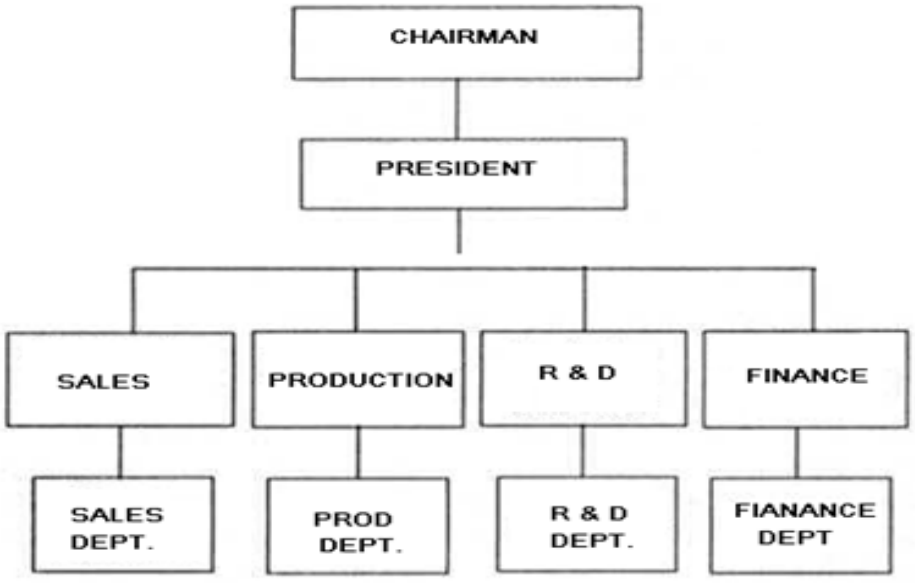

Figure 2.11 Flat Structure of Organization

2.13.6.3 Systems

All the organizations have some processes to implement their strategy. These systems are essential part of any organization and they need to be followed strictly.

Example: An organization may have quality control system that may include checking of finished product before handing over to the customer. It may also include invoicing procedure for selling of goods etc.

The decision making in systems is very importance. Organizations are working to make their systems and processes simpler and user friendly by use of technology which reduces the time and risk in decision making process.

2.13.6.4 Style/Culture:

The style or culture is a distinct characteristic for an organization which depicts several things like the communication style followed by managers or staff, leisure time spending, interaction among people working for that organization.

The culture/style for organizations needs to be more open and friendly so that different people can feel freedom to use their approaches in reaching the organization goals.

The style/culture consists of two components:

- **Organizational Culture** These are the dominant values which build up over time among the people of that organization. Example may be the presentation style of staff to the customers, vendors etc.

- **Management Style** It shows what managers do than what they say, how they focus their attentions etc

2.13.6.5 Staff

All the organization consists of a number of people doing different jobs in order to reach the organization goals and objectives. These people work in different groups and units with their specific duties. E.g. people in organization may be related to finance, human resource department, I.T., transport, Supply chain etc.

2.13.6.6 Skills

Organizations try to look for qualified staff and work on their trainings to reach the operations or performance excellencies. The basis edge for an organization would be to make their people more and more competitive for their business. It's also very important for the organizations to make them inspire for their organization and make them understand for the reward/award of efficient works.

2.13.6.7 **Shared Values**

The shared values are the common guidelines for an organization, these common values may be to achieve high profits, upgrade the technological facilities, to save money in declining economic scenario etc. These values make the employees to drive towards common goals for achieving the business success and also work for team efforts. These values should be very strong for any organization otherwise they may lead towards personal goals rather than organization goals.

2.13.7 Using the 7S Model

7S model covers about all major parts of an organization required to

make analysis and also to highlight the areas of key benefit for that organization. This model helps in getting the information about the organization in pretty systematic way as it highlights seven crucial factors for organization's success. In order to use this tool following simpler steps may be followed.

- Gather information regarding the organization. May be through interviews, news, reports etc.
- Categorize and put those factors under the seven elements as described by the model.
- Analyze these elements to highlight the areas of improvement.

2.13.8 Limitation of 7-S Model

- External environment: The external environment is not mentioned in the McKinsey 7S Framework, although the authors do acknowledge that other variables exist and that they depict only the most crucial variables in the model. While alluded to in their discussion of the model, the notion of performance or effectiveness is not made explicit in the model.
- One major disadvantage is that when one of the parts is changed, all parts change because they are all interrelated.

CHAPTER – 3

SUPPLY CHAIN APPLICATION TO AN LPG MARKETING COMPANY IN PAKISTAN – A CASE STUDY

3.1 LPG – An Introduction

Liquefied petroleum gas is most commonly known as LPG. LPG consists of two gases called propane and butane. LPG also exists naturally in the oil and gas fields from where it is extracted through refining process. It is also extracted as a bi-product of oil refining process.

LPG is a gas a normal temperature and pressure but it becomes liquid on application of small amount of pressure. This characteristic of LPG has made it more popular because of the ease and efficiency in transportation. It is transported as liquid in pressurized containers. LPG is stored in pressurized vessels (in bulk form) and also in small or medium sized cylinders for use at domestic or commercial level.

3.2 History of LPG in Pakistan

In Pakistan LPG is produced from crude oil refining industry and the gas fields. At the start LPG industry was fully controlled by the government bodies. Imports were not allowed and the only dependency was on the LPG produced within the country. The pricing was also controlled by the government which was later authorized to the producers of LPG in Pakistan in 2001. Later in 2001 government allowed imports because the local production could not meet the country needs.

The LPG government policy for LPG production and distribution was published in 2006 with the objective to increase the LPG supplies, ensuring the minimum safety standards and making its supply chain more efficient/effective especially in the LPG starved areas of Pakistan.

The LPG share in Pakistan's energy consumption was about 1% for the year 1996-97 but this was almost doubled in 2006-07. [46]. The LPG share in total energy consumption is very less yet the industry is

growing (by volume) at an elevated rate. The increase in volume of product is due to the increase in local production and the import of LPG from other countries. The demand for LPG has increased more than the increase in its production.

Currently there is shortfall of about 150,000 MT per year between the supply (local and imported) and demand of LPG in Pakistan. [47].

3.3 Uses of LPG

LPG has the following uses in Pakistan,

- **Domestic**

  LPG is used mainly in the natural gas starved areas of Pakistan for cooking and heating purposes. The main areas of Pakistan include northern areas, some areas of Punjab, Sindh and Baluchistan.

- **Commercial**

  It is used in hotels and restaurants where natural gas is not available. Main uses are cooking and heating.

- **Automotive**

  LPG is a excellent fuel for automobiles commonly called as auto gas. It is uses in rickshaws, taxis, motor bikes etc. The LPG kit can be easily installed in the petrol run vehicles. So in Pakistan there is no auto gas station but government is working to make policies for auto gas sector investment.

- **Industrial**

  The industrial use is cutting, heating etc. It is also used for metal processing works like cutting of sheet metal, welding process etc.

3.4 Pakistan Energy Consumption and LPG Trends in Pakistan

As the thesis is focusing on the supply chain management of LPG, we will look at the demand and consumption of LPG in the previous years for Pakistan.

The supplies of energy for Pakistan include natural gas, oil, LPG, coal,

hydro-and nuclear electricity. The LPG share for total energy consumed in 2007-08 is about 2% i.e. 0.620 MTOE.

The total production of LPG in Pakistan for 2006 was almost 1600 tons/day. [48]

The total consumption in year 2006-07 was 648,572 MT which included locally produced LPG and imported LPG. [49]

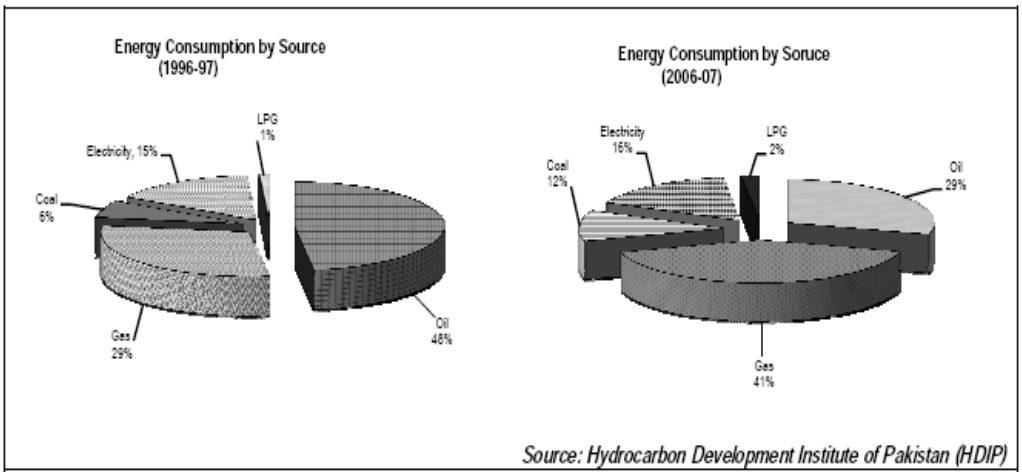

Figure 3.1 LPG share in Pakistan energy Consumption. [50]

The above figure shows that the liquefied petroleum gas (LPG) consumption in 2006-07 was double the value of LPG consumption in 1996-97. The growing demand of LPG increased at a very fast rate in 2006-07. As the production capacity was low, so LPG has to be imported and during 2006-07, there was largest import of LPG i.e. 64000 MT. [51]

3.5 LPG Demand Forecast for Pakistan (Year 2020)

The demand of LPG in Pakistan is growing at an elevated pace in Pakistan. The increase in demand is most prominent in the domestic, commercial and transport sector. Though the progress in transport has not gained acceleration due to government policies yet there has been tremendous increase in its use for automobiles. The following graph shows the demand of LPG up to the year 2020.

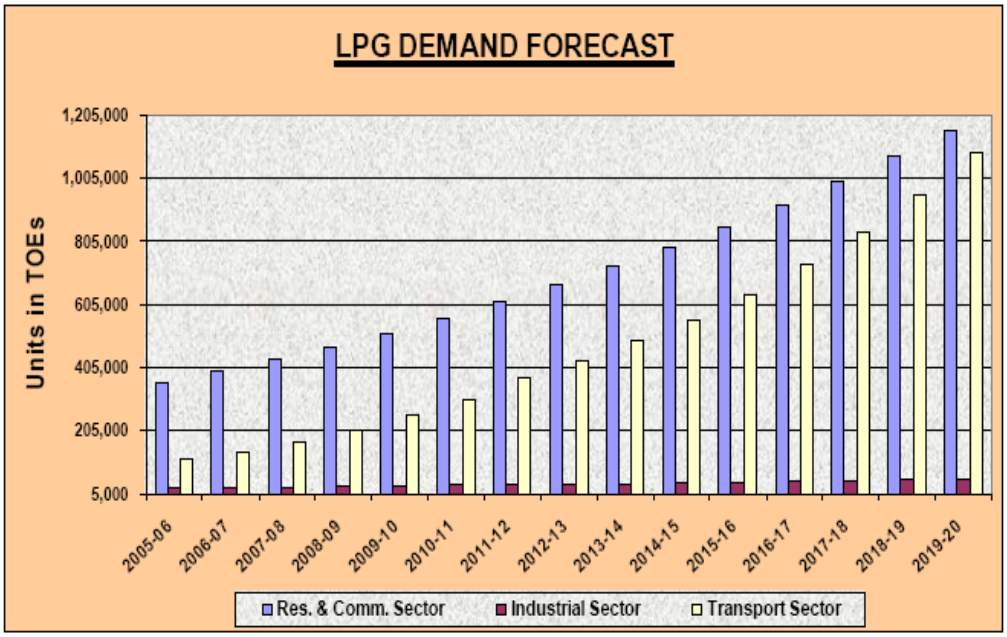

Figure 3.2 LPG Demand Forecast – 2020. [52].

3.5.1 LPG Growth and Shortfall in 2020 for Pakistan

Since the introduction of LPG in Pakistan, the production of LPG in Pakistan has increased but on the other hand the LPG demand has increased more than the increase in its production. This has resulted in shortfall of LPG between its supply and demand.

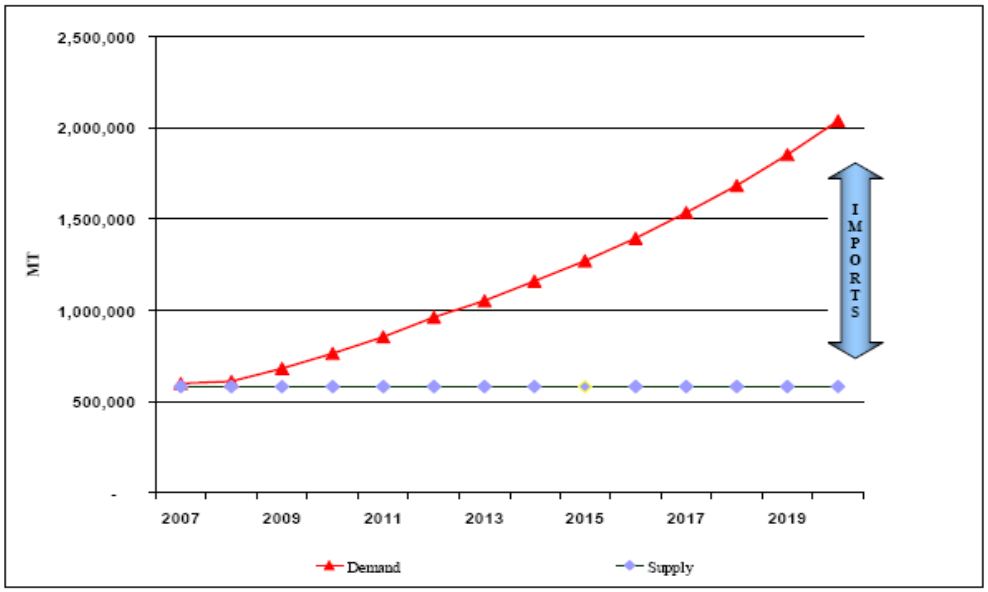

Figure 3.3 LPG Growths and Shortfall in 2020 for Pakistan. [53].

3.5.2 LPG Imports

The production of LPG in Pakistan is not sufficient to meet the current needs, so LPG is also imported in country through different marketing companies under government licenses. The imported gas is costly than the locally produced LPG because it contains base price, taxes, excise duties, transportation and handling costs.

During 2006-07 the LPG imported from other countries was about 64,000 MT by different LPG marketing companies under government licenses. [54]

3.6 LPG Business Model in Pakistan

Before getting an insight into the cost reduction for an LPG marketing company, it is essential to look into the current business model for an LPG marketing company and its supply chain from the LPG producer to the LPG end user.

This LPG business model mirrors the companies who do business of LPG by taking LPG from source, store it, fill it in small cylinders and finally dispatch to the distributors to meet the consumer needs.

3.6.1 Infrastructure

The infrastructure defines the LPG facility, sales and operational areas. These may include a remote storage/filling plant or import/export terminal near a port. The infrastructure may include a testing unit for LPG cylinders.

3.6.2 LPG Storage Unit

The storage defines the capacity of an LPG plant i.e. if a plant has a storage capacity of 200 metric tons of LPG then that plant will be 200 metric tons capacity. LPG is stored in pressurized vessels

which are available in different shapes as per standards. There are other alternatives like cavern and refrigerated storage of LPG.

3.6.3 Logistics

The logistics for LPG includes the means of transportation of bulk supplies (from LPG production source to LPG storage plant) and transportation of filled cylinders supplies (From LPG filling plant to LPG distributors/retailers). The LPG in bulk form can be shifted by using trucks or LPG bowsers which are available in different sizes. LPG is also transported through pipe lines. The imports usually follow transportation through ships. For bulk supplies of LPG, special types of LPG bowsers are needed.

3.6.4 LPG Filling Plant

The LPG filling plant is connected to the LPG storage plant. The LPG filling plant is the area where the stored LPG is transferred in small cylinders for use at homes, shops, industries etc. These cylinders are shifted through logistics i.e. by use of trucks. These trucks are sometimes designed especially to take LPG cylinders else simple trucks may be used.

3.6.5 Others

The other items included in the LPG business model are the requirement for LPG cylinders. The requirement for LPG cylinders depends on the capacity of plant and the number of distributors/users.

The LPG cylinders are imported from other countries and also built with in the country. The LPG marketing companies gives the cylinder to customer on payment of one time security

deposits. After that the customer can exchange the empty cylinders with the filled cylinders on payment of filled LPG price.

Fire fighting units are considered as an essential part for LPG business (whether it is an LPG plant, retailer, distributor, end user etc).

3.7 LPG Supply Chain in Pakistan

The LPG supply chain (for a cylinder filling business) includes the following:

3.7.1 LPG Production

Oil Refinery, Gas Fields, and Foreign producers for imported LPG. The LPG producer sale the LPG only to designated customers as per the allocation of share or quota. Previously the price was set by Government of Pakistan but now a day the producers set the prices as their own.

3.7.2 LPG Storage/Filling Plants

These plants are owned by LPG marketing companies. The storage of LPG is in fixed LPG vessels of different capacities. The LPG Filling plants include machines which may be automatic, semi-automatic and manual types.

3.7.3 LPG Transportation

Trucks, Ships for imported LPG and LPG pipe lines. The transportation of LPG has major impact in the end user or consumer price.

Some LPG marketing companies own their fleet for LPG transportations otherwise there are transport contractors available which may be hire by the LPG marketing companies. Some of the

famous marketing companies are Perfect Transport Network (PTN) pvt. Limited, Crescent carriers (pvt) limited etc.

3.7.4 LPG Distribution

Mostly the marketing companies have partners for their LPG distribution in cylinders form. Some companies in Pakistan have their own distribution centers.

The distributor sends the consumable LPG to the users which may be domestic user or industrial/commercial users.

3.8 Facts related to LPG Transportation

Before making the location analysis the following facts must be understood for any LPG marketing business.

3.8.1 Two types of transportation are involved in shifting the LPG product from LPG supply source to end user.

- Bulk Transport. (From Source to Company's LPG Facility through pipe line or tank trucks)
- Bottled Transportation (From Company's LPG facility to distributor's sales point. This is made in form of different capacities of LPG cylinders supplied through trucks)

3.8.2 Bulk Supplies of LPG (i.e. through pipe line and tank trucks) is much more feasible than bottled supply (supply of LPG in form of LPG cylinders).

This is because of the fact that in bottled supply lower volumes and more weights are involved and it is easier to achieve the economies of scales in bulk supply rather than bottled supply.

3.8.3 The consumer price for LPG highly depends on the nearness or farness of the LPG facility as the consumer price is directly proportional to the distance from the source.

3.9 Business Overview of the LPG Marketing Company

The company under review is a US based and fifth-largest energy company in the world with its business in 180 countries. It is engaged in every aspect of the oil and natural gas industry, including exploration and production; refining, marketing and transportation; chemicals manufacturing and sales; and power generation.

In Pakistan the company deals in fuels, lubricants, CNG and LPG. The LPG business consists of five LPG plants located at different areas of Pakistan. For this master thesis, the LPG facility located near Rawalpindi (Punjab, Pakistan) has been studied.

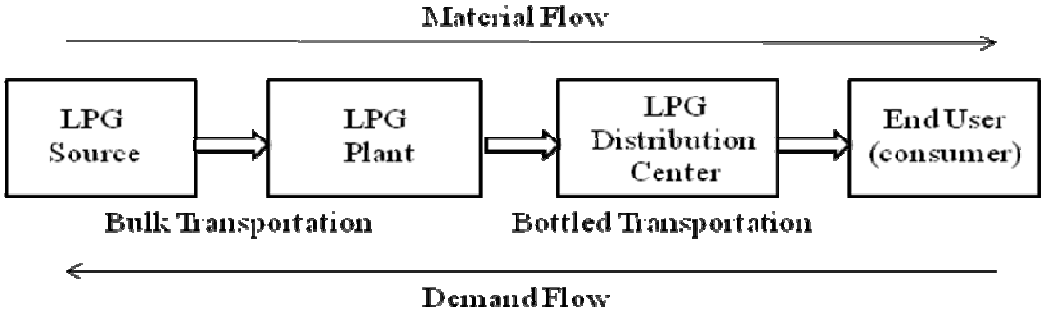

Figure 3.4 LPG Supply chain

The current location (near Rawalpindi) for company's LPG facility seems not very viable as it was in the past because of the increase in transportation costs of bulk and bottled supply of LPG.

The following are the two scenarios of the company's business in past and present.

3.9.1 Business Scenario (Till 1998)

The location analysis before setting this facility was made mainly because of the following factors.

- There was a big LPG source which was situated in the vicinity of this facility (About 2 km from the facility). The company was getting its LPG share through pipe line which is a cheaper transportation mode than transportation through LPG tank trucks.

- The other LPG sources were also located at a feasible distance from the company's facility.

- More distributors/retailers of company were located in central Punjab region and northern areas of Pakistan. These areas have an easy access to this location.

3.9.2 Current Business Scenario (From 1998 to date)

The current condition is that the nearby sources of LPG have depleted naturally and the company lost its share. Then the company moved to the other resources which are situated at distance of approx. 540 Km and 250 Km from the current location.

- The distributors /retailers of the Company are almost the same. The transportation of LPG (From source to company's facility) shifted from the cheaper source (pipe line supply) to relatively costly source. i.e. transportation through LPG tank trucks. This has resulted in overall decrease of earnings.

- The company is also losing market share in the regions of Punjab like Lahore, Gujranwala, Sialkot, Shekupura, Sargodha region etc. because the distributors of this region have to pay more transportation costs (because of the farness of the company's current LPG facility) as compared to the other marketing companies which have their LPG filling plants situated near to these locations. This results in forcing the customers to keep his profit margins lower in order to survive in a competitive market environment. The reduced profits can make the distributors to shift their business to other marketing company which will be a loss for this company.

3.10 SWOT Analysis – Application to LPG Marketing Company

The aim to apply SWOT analysis is to improve the supply chain management of LPG distribution for LPG marketing company so that a strategy can be developed for reduction in supply chain cost. The analysis of strengths\, weakness, opportunities and threats are greatly helpful in developing strategy for improving the LPG distribution for LPG marketing company.

3.10.1 Strengths

- Company **meets the Government requirements** (Oil and Gas Regularity Authority (OGRA)) for design, safety and pricing of the product.
- LPG **demand in Pakistan is very high** because of the natural gas shortage in many areas of Pakistan especially in the northern areas, Kashmir region and in other areas of Pakistan.
- **Quality Consideration:** The LPG Distribution Company is well known for its quality consideration regarding the product, processes, environment, safety and health. (ISO 9001-2000, ISO-14000 OHSAS, OEMS - Operational Excellence Management System)
- **Most of the competitors are local** and they do not have managed system for product distribution and order fulfillment.
- Company has very **high safety standards** for controlling losses and maintaining safe environment for work.
- **Company owned fleet** for product transfer from source to company facility which reduces the risk of strikes from the transporters.
- **Company owned testing unit** for quality control over product receiving and selling to customers.

- **Customer/Distributor training programs** for Company helps in maintaining the safety and reliability of product. Moreover they are also helpful in improving the consumer needs and demands.

3.10.2 Weaknesses

- **Higher Costs –** Company's LPG operation involves higher safety and operational standards which the local players do not keep so the per unit cost is very low as compared to Company. As the final product price has to be kept at completive level which decreases the company profitability.
- **No recent supply chain review** has been conducted for improvement in the supply chain costs.
- **Site Location:** The current site location is far off from the source as well as for the customers of central Punjab region. As the product has to travel more distance, so the transportation cost adds up to the consumer price and cuts down the company's profit margins.
- **Local Competitors:** Most of the competitors are local players which do not keep higher or even minimum safety standard hence they operate at lower costs as compared to company.
- **Communication Gaps:** There are communication gaps between the distributors and company management.

  These communication gaps offer hindrance in understanding the customer/consumer needs which results in dry out position for distributor.

3.10.3 Opportunities

- **Sales Increase by reviewing the supply chain network –** The LPG supply chain has not been reviewed. A review of this can result in reduction of supply chain costs. This can be helpful in

keeping a competitive cost in a highly business environment and it would also help in increasing the profits.

- **Sales increase – Auto gas –** Company owned sales station for refined oil at prime location of cities and towns can be used for the sales of LPG to automotives.
- **Government Regulations (OGRA) are met.** The company is meeting all the regulation as per the GOP requirements. This is helpful in the current scenario because of the restrictions from Government of Pakistan (OGRA) as the government is enforcing the local (non-standard) players for investment in meeting the minimum safety requirements.
- **Safety sense of people** – the safety sense of people are helpful in going for the standard products. The company's safety standards are higher than the local competitors which are beneficial for this.
- **Outsourcing besides the core business activities –** Outsourcing the non-core activities like transportation (use for bulk transfer of LPG) can add value towards decrease of capital involved and make core competencies more efficient.
- **Improve communication networks for understanding the customer's needs –** The customer's needs can be fully understood by making strong communication system. This can help in making the demand and supply accuracy. Moreover the product availably as per consumer needs can be ensured by this.
- **Enhance business to bulk supplies -** The company is not supplying any bulk product to customers where as some of the big competitors like Pro-Gas and SHV (pvt) limited are supplying bulk product to its customers.

3.10.4 Threats

- **Highly competitive business environment –** The LPG business in Pakistan is highly competitive with more than seventy LPG marketing companies.
- **Local players –** The highly competitive LPG business in Pakistan involves mostly local companies which operate at very low cost because of their lower operational and safety standards. Whereas Comany has very high safety and operational standards which involve larger costs and makes the consumer price more competitive in market.
- **Government quota system –** The LPG business in Pakistan is strictly quota based because of the limited production in Pakistan. Moreover the demand of LPG is more than its production so the Government has to make allocation for the production and also for the distribution of product in different areas of Pakistan.
- **Government laws/regulations/policies** - the Government policies in case of LPG are changing from time to time which creates difficulties for the marketing companies in developing their strategies.
- **Political Influence –** The environment of favoritism in allocation of quota for the LPG can create difficulties for the LPG distribution business.
- **Weak controls over Smuggled Product –** The smuggled product from Iran and other countries is of lower cost and it is available even in the areas of Central Punjab. The local companies use this product and sell at lower price which makes difficulties for other marketing companies. Also it reduces the sales.

3.11 SCOR – Application to LPG Marketing company

The SCOR model provides best tools to measure, examine and optimize supply chains. This thesis has focused on the preliminary work towards developing a method for assessing the impact of transportation cost (or supply chain cost) on LPG distribution business for a LPG marketing company in Pakistan. The supply chain operations model (SCOR) can be used to work out the improvements in a SCOR performance attribute or level I metric given that a set of best practices is implemented with a specific transportation solution. Performance indicators for LPG distribution business can be sorted out to find the optimum solution for the business.

SCOR may help in examining and analyzing the information from business partners along the supply chain. The real-time business intelligence requirement can be used for collection and analysis of information. The mapping process helps to make the relationship between partners, suppliers and customers. The SCOR model is about five key management processes: planning, procurement, organization, delivery and return. Each of these processes can be studied at three levels. The first level is strategic, the second level maps to determine exactly what is happening within each area. The third level focuses on the operational level of areas.

SCOR do not tell exactly what to change but it maps the areas where the weaknesses lie. It is then necessary to make specific adjustments are appropriate for this particular channel.

3.12 McKinsey 7-S Model – Application to LPG Marketing Company

The McKinsey 7-S model provides useful information for developing a strategy which can help the organization to improve its strengths and move to a new better position. In this thesis research the ‘strategy’ element of McKinsey 7-S model is applied for the LPG distribution business of the LPG marketing company in the Punjab region of Pakistan.

3.11.1 Concept of Strategy for LPG marketing company

The 'strategy' in Mckinsey 7S model is reflects the concept that the LPG distribution company's customers should be facilitated from a source which is at optimum distance from the product receipt point (product source) as well as product supply point (consumer area), this may result in reduction of costs involved in transportation of product. (Bulk transportation as well as bottled transportation of LPG)

This strategy is understandable, considering the current condition of the economy (global financial crisis), the increasing operational costs, supply chain costs and the high business competition in market.

3.11.2 Explanation of Strategy for LPG distribution

The SWOT analysis (section 3.10) of the LPG distribution business reflects that the company needs to

- Improve or retain its strengths and over the weaknesses.
- Avail the opportunities by keeping mitigation plans for threats.

So a strategy needs to be made which can help in getting success for the company business. The following section 3.12 shows the analysis for the company business and the strategic options for getting business profitability.

3.13 Analysis of Company's Previous and current business Scenarios

The previous and current scenarios of the company business (Section 3.9) portrays that the depletion of nearby LPG source has made the company to move to other LPG source which is located at far distance.

Now the company wants to find some alternative means in its supply chain which can reduce the LPG transportation cost (In bulk and in bottled/cylinder form). At the same time the company wants to retain its current customers /retailers. The following may be some of options.

3.13.1 Option#1

"Relocation of the company's current LPG facility nearest to the LPG

source. This may reduce the transportation cost of bulk product supply from product source to LPG facility."

3.13.2 Option#2

"Relocation of the company's current LPG facility nearest to the LPG customer or consumer area. This may reduce the transportation cost of bottled (LPG in cylinders) product supply from LPG facility to LPG customers."

3.13.3 Option#3

"Rail Carry of product for cheaper transportation".

3.13.4 Option#4

"As LPG Price directly proportional to transportation cost, some alternative routing of LPG transportation should be work out to reduce the distance travelled by the product, so reduction in transportation cost (bulk and bottled supplies) can be achieved"

3.13.5 Explanation of Options

The option#1 and option#2 involve two costs; the first cost is the cost of transportation from source to company's facility and the second cost is the cost of transportation from company's facility to the consumer areas. Most of the company's distributor's are located in the northern areas and central Punjab region. The movement of the facility nearer the LPG source (Near Multan region) will result in increased distances for the northern areas distributors and also for the some of central Punjab region distributors. There is a risk that the far away distributors may shift to some other company which is located at more feasible distance to the customers.

Moreover the cost of moving the LPG facility is very high which involves larger capitals. Also the source of LPG is quota based and in future if the company fails to make agreement with the LPG supplier /producer then this may result in bigger loss to company's business. The company also

seems not interested in involving capitals for relocation of its facility.

The option#3 is also not feasible as the LPG rail carriage facility is not available in Pakistan. The option#4 seems feasible as this do not involves larger capitals. The customers of a different area may be analyzed for optimum distances and may be shifted to some other LPG facility through mutual agreement with some other company.

Following two distances needs to be analyses

1. Distance of Bulk product transportation
2. Distance of bottled transportation to the Company's distributors.

This needs a study on the company's distributors as per area and LPG supplies to those distributors. Based on the LPG sales concentrated area, the LPG customers may be grouped and some of these may be shifted from company's facility to some other company's facility.

3.14 Limitations of Study

The option # 4 (alternate routing for reduction in distance and cost of transportation) will be analyzed with the following limitations.

- The Company's business will be analyzed only for the Central Punjab region and for those areas where LPG supply is higher.
- The current management structure is assumed to be enough for handling any new activity.
- The data for LPG transported to distributors has been analyzed for the year 2009-10 but with current LPG transportation rates. These current transportation rates have been taken from the LPG transportation companies.

- The distances (from source to LPG facility and from LPG facility to distributor's sales point) have been taken from transport companies, LPG distributors, Pakistan road maps etc.

- The losses in LPG transportation are negligible i.e. the quantity of LPG supplied in bottled form by the company to the LPG distributors is same as LPG supplied in Bulk form from the LPG source to the company.

3.15 Review of Central Punjab Areas LPG Business for Company

The supply chain of the company's LPG marketing business in Punjab region starts from the source of LPG supply i.e. Pak Arab Refinery, Mehmoodkot. LPG is supplied in bulk form in LPG tank trucks 25 Metric Tons and 08 Metric Tons. This product is stored at the company's current LPG facility. The storage facility is located at a distance of approximately 540 Km from the source of LPG. The bulk product is stored at this area which is further transferred to small containers (LPG cylinders of 11.8 Kg, 15Kg and 45.4 Kg capacities) and delivered to different areas of Pakistan through LPG distributors in bottled form transportation. The distributors are located in different cities/towns of this region.

The following two types of transportation are involved in shifting the LPG from source to end user.

- Bulk Transport. (From Source to Company's LPG Facility)

- Bottled Transportation (From Company's LPG facility to distributors situated at different areas of Pakistan)

The bulk transportation of LPG is cheaper than the Bottled transportation because in bottled or cylinder transportation lower volume and more weights are involved compared to bulk transportation where economies of scales can be achieved.

- **Assumption**

While doing this study an assumption has been made that that the current LPG facility is not feasible for the central Punjab region and the distributors of this region should be shifted to a new facility (proposed facility) which can result in reduction of transportation cost.

In order to make the above assumption correct, the following two analyses are required for comparisons of current LPG facility and proposed LPG facility for the company.

- Distance Analysis
- Proposed location Cost Analysis.

3.16 Proposed LPG Supply Chain Model For the LPG Marketing Company

This model involves the following changes in the current business model of the company.

- Shifting of Central Punjab region distributors from the current LPG facility to a new proposed supply facility.
- Supply of Bulk product (LPG) to the new proposed supply facility as per the demand of the shifted distributors.
- Management of the proposed supply facility through mutual agreements and/or some time named as hospitality agreements.

3.17 Proposed LPG Supply Location

The proposed facility has been selected in the central Punjab region near to Lahore. The selection has been made by considering availability of such facility near to the under consideration regions of central Punjab. Moreover this LPG facility is already providing such facility to other companies.

This facility is responsible for

- Filling of LPG product in distributor cylinders in a timely manner.
- Meeting the minimum HES/Requirement of the company.

The proposed facility charges the customer with LPG filling rates as amount per metric ton of LPG filled in cylinders. The current LPG filling rates were taken from the proposed facility which is used in the proposed location cost analysis.

3.18 Analysis of Distance for LPG Transportation

The product life cycle starts from the LPG source, then it comes to LPG plant where it is filled in LPG cylinders (bottled form) and then transported to the LPG distributor sales points in bottled form. The sales points are located at different areas of the region as per the demand of LPG in that area.

For the LPG transportation cost analysis twenty distributors of the LPG marketing company have been selected. The selection of the twenty distributors has been made as per their monthly LPG sales and top twenty distributors were selected.

The transportation cost will be estimated from the source of LPG supply to LPG marketing company facility (in bulk form) and then to the LPG distributor (in bottled form).

3.18.1 Assumption

While making the distance and cost calculations, it is assumed that the losses in LPG transportation are negligible. So the product delivered to the LPG distributors (in bottled form) by the LPG Company will be same as the product supplied from the LPG source to company's LPG plant.

Formula for estimation of total distance covered by the product (LPG)

If

A= Total distance from LPG source to LPG plant (in bulk form)

B= Total distance from LPG plant to LPG distributor sales point (In bottled form)

Then,

Total distance covered by the Product (LPG) - D = A + B ---------- (a)

Table 3.1 LPG Supply chain - Analysis of Distances

Analysis of Distance for LPG Distribution							
Region	Total No. Of Customers	Distance from Current LPG Facility [Km]	Distance from Proposed LPG Facility [Km]	Distance of Current LPG Facility from Source (Bulk Supply)	Distance of Proposed LPG Facility from Source (Bulk Supply)	Total Distance Covered by Product Via Current LPG Facility	Total Distance Covered by Product Via Proposed LPG Facility
		B1	**B2**	**A1**	**A2**	**D1= B1 +A1**	**D2 = B2 + A2**
Sargodha	14	255	185	534	315	789	500
Silanwali	2	275	205	534	315	809	520
Lahore	5	360	25	534	315	894	340
Shek-u-Pura	2	320	60	534	315	854	375
Gujranwala	3	305	85	534	315	839	400
Gujrat	3	325	65	534	315	859	380
Jhelum	1	185	159	534	315	719	474
M.B.Din	2	240	140	534	315	774	455
Patoki	1	450	110	534	315	984	425
Okara	2	390	135	534	315	924	450
L.Musa	1	315	95	534	315	849	410
Hafizabad	1	285	165	534	315	819	480
Sialkot	3	305	80	534	315	839	395
Jhang	3	325	207	534	315	859	522
TOTAL	**43**					**11,811**	**6,126**

3.18.2 Results

Difference b/w D1 & D2 from above data = 5685 Km.

This is the reduction in distance travelled by the LPG product from source to end customer by using proposed business model for company. The benefits of reduced distances are reduction in transport cost, increased time efficiency, less operational liability of the company, reduced road exposure which reduces motor vehicle accidents etc.

3.19 Cost Analysis for LPG Transportation

The costs involved in delivering the product from LPG source to LPG distributor via the proposed source and via the current source are

- Transportation Cost (Bulk supply).
- Transportation Cost (Bottled Supply).
- LPG Cylinder Filling Cost of Proposed Facility. (Per Metric Ton of LPG filled)

3.16.1 Formula for estimation of Transportation cost of the product (LPG)

If

T= Product transferred to Distributor per month

Note: As per the assumption, the total product supplied to LPG distributor is same as the total product supplied from LPG source to LPG plant or it can be stated as the total product purchased by the LPG Company is equal to total product sold by the LPG Company to LPG distributors.

F = Transport Rate of LPG in Bulk form (Per Ton of LPG – Per Kilometer)

G = Transport Rate of LPG in Bottled form (Per Ton of LPG – Per Kilometer)

Then,

If, C = Transportation Cost of Product,

Then

C = T (A x F) + T (B x G)

Or

C = T [(A x F) + (B x G)] ---------- (b)

The formula (a) and Formula (b) will be used in the analysis of the cost calculations for the company's current business model and the company's proposed business model.

3.16.2 Formula for estimation of Total cost of the product (LPG) for Proposed Facility

The total cost for proposed facility may be calculated as follows.

If, C3 = LPG Filling cost of the proposed facility

C2 = LPG transport cost via proposed facility

Then

Total Cost of Proposed facility C4 = C2 + C3----------(c)

Table 3.2 Cost Analysis for Proposed LPG Supply Facility

Cost Analysis for Proposed LPG Facility									
Distributors Region	Total No. Of Customers	Product per Month Delivered to Distributor [Metric Tons]	Distance from Current LPG Facility [Km]	Distance from Proposed LPG Facility [Km]	Distance of Current LPG Facility from Source (Bulk Supply)	Distance of Proposed LPG Facility from Source (Bulk Supply)	Total Transport Cost of Product Via Current LPG Facility	Total Transport Cost of Product Via Proposed LPG Facility	LPG Filling Cost Per Metric Ton for Proposed Facility
		T	B1	B2	A1	A2	C 1= T x [(B1xG) + (A1xF)]	C 2= T x [(B2xG) + (A2xF)]	C3 = E x T
Sargodha	14	78.2	255	185	534	315	959,232	641,553	273,700
Silanwali	2	15.9	275	205	534	315	203,940	139,348	55,650
Lahore	5	94.6	360	25	534	315	1,438,525	352,290	331,100
Sheh-u-Pura	2	19.3	320	60	534	315	271,868	90,787	67,550
Gujranwala	3	64.5	305	85	534	315	881,483	348,558	225,750
Gujrat	3	17.6	325	65	534	315	250,385	85,254	61,600
Jhelum	1	6.5	185	159	534	315	66,992	48,594	22,750
M.B.Din	2	19.6	240	140	534	315	232,189	136,102	68,600
Patoki	1	8.3	450	110	534	315	147,129	50,663	29,050
Okara	2	15.3	390	135	534	315	245,510	104,101	53,550
L.Musa	1	14.2	315	95	534	315	198,039	80,713	49,700
Hafizabad	1	12.6	285	165	534	315	165,141	96,314	44,100
Sialkot	3	17.9	305	80	534	315	244,629	94,226	62,650
Jhang	3	44.6	325	207	534	315	634,497	393,372	156,100
Total	**43**	**429.1**					5,939,558	2,661,876	1,501,850

3.16.3 Results of Proposed Facility Cost Analysis

Using formula (c) for calculating total cost of proposed facility

Total Cost of proposed facility C4 = C2 + C3

Since C2 = 2661,876 and C3 = 1501,850

Then

C4 = 2661,876 + 1501,850

C4 = 4163,726

3.16.4 Difference in cost of current and proposed facility (C5)

C5 = Total cost of proposed facility – Transportation cost of current facility

Or

C5 = C4 – C1

Since C4 = 4136,726 and C1 = 5939,558, Then

C5 = 4136,726 – 5939,558

C5 = -1775832

Since the result is in negative hence the proposed model for company's LPG business can result in saving of Rs-1775832/- per month or approximately eighteen hundred thousand /month.

3.20 Transportation Models and Linear Programming

The transportation problem is one of the subclasses of linear programming problem. [55]

3.17.1 Objective of Transportation Model

The transportation model aims at supplying various quantities stored or produced at various origins in such a way that the total transportation is minimized while the destination requirements are also fulfilled.

3.17.2 Explanation

Whenever there is a physical movement of goods from one point (source) to the other point (destination) through different distribution channels (wholesalers, retailers, distributors etc.), there is a need to optimize the cost of transportation with the aim to increase the sales and enhance the profitability. Transportation models provide an optimal solution for a transportation problem in which a product produced or stored at different

factories / plants can be transported to a number of demand locations.

3.17.3 Mathematical Model of Transportation Problem (linear programming problem)

Mathematically a transportation problem is a special linear programming problem in which the objective function is to minimize the cost of transportation subjected to the demand and supply constraints. [56]

The formulation of a Linear Program Model consists of the following.

- **Variables Definition**

  All the variables that are involved in the problem are defined with alphabets. E.g.

  'Pi' – is the number of source locations for supplying any product.

  'Cij'- is the cost of moving a unit from 'i' location to 'j' destination.

  'Xij'- Quantity supplied from 'i' location to 'j' destination.

- **Objective Function**

  It is the value which is being optimized i.e. minimized or maximized. E.g. 'Z' is objective function to minimize the total cost of transporting 'X' quantity to demand destination then.

  $$\text{Objective Function: Minimize } Z = C_{ij}X_{ij}$$

- **Constraints**

  (Supply and Demand): These are derived from the specs of a problem. E.g. A constraint may be the minimum quantity of product supplied to a distributor.

- **Decision Variable**

  The variables whose optimal values are to be found are called decision variables. E.g. If there are two supply locations then our

decision variable would be the quantity 'X_{ij}' i.e. how much quantity to be supplied from each location to achieve the optimum cost or distance.

3.17.4 Problem Formulation For LPG Distribution (As A Linear Programming Model)

The following is the LPG supply chain model which is to be optimized for transportation i.e. to find the minimum distance for transportation while keeping the demand of the distributors fulfilled to satisfactory level.

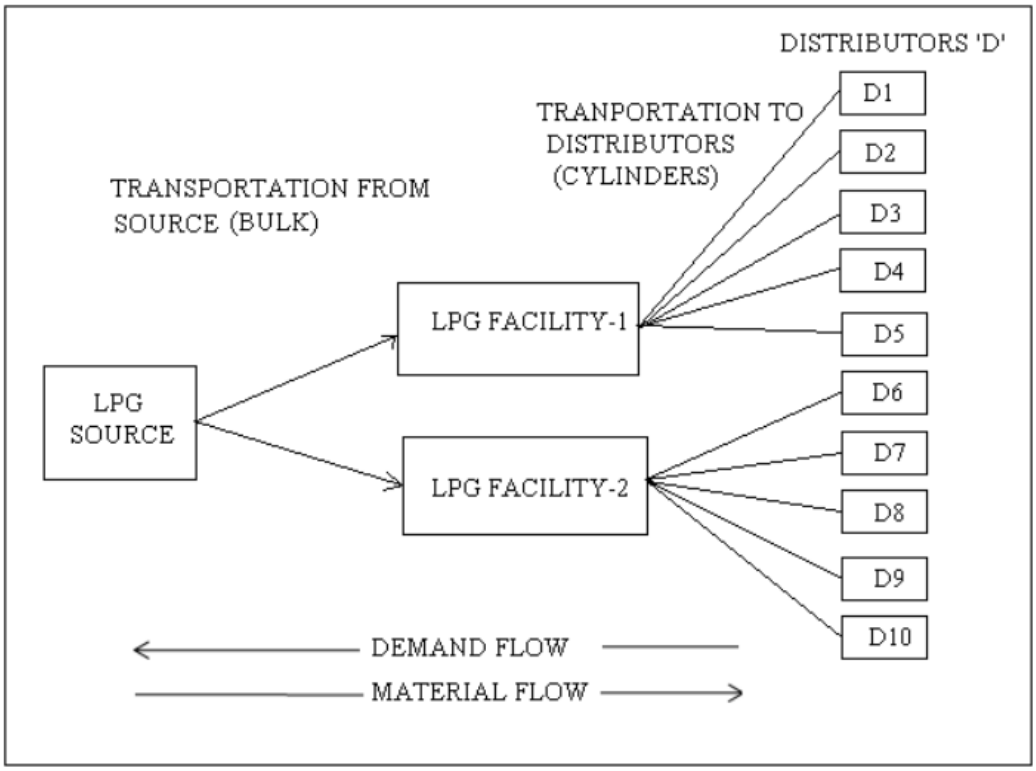

Figure 3.5 LPG Supply chain Model

- **STEP–1 Definition of Variables**

  1> S_{ij} -- Denotes the LPG source from where the LPG is transferred in small cylinders of different capacities to distributors. (Currently two LPG sources are identified for this problem)

2> X_{ij} – Denotes the quantity of product (LPG in Metric Tons) supplied to distributors 'j' from source 'i'.

3> C_{ij} – Denotes the cost per ton for transportation of LPG from LPG source 'i' to LPG distributors 'j'.

4> D – Denotes the distributors or end customers to whom the source supplies the LPG in cylinder form.

5> i= 1,2,…..,n and j = 1,2,….,n

- **STEP–2 Objective-function 'Z'**

  The objection function 'Z' can be represented as:

Minimize $Z = C_{ij} X_{ij}$ (i.e. cost of shipping 'X' quantity of LPG from plant to distributor)

- **STEP–3 Constraints Definition**

Following are the constraints for the formulation of LPG distribution problem.

Note: It is assumed that Supply = Demand

Supply Constraints

Supply constraint defines the capacities of the LPG plants in metric tons per month basis.

$$\sum X_{1,j} <= 500$$

$$\sum X_{2,j} <= 450$$

Demand Constraints

Quantity supplied from plant 'i' to distributor 'j' >= Quantity demanded by the distributor 'j'

Note: Quantity Supplied/Delivered is in Metric Tons per Month

$$X_{1,1} + X_{2,1} >= 78.2$$

$$X_{1,2} + X_{2,2} >= 15.9$$

$$X_{1,3} + X_{2,3} >= 94.6$$

$$X_{1,4} + X_{2,4} >= 19.3$$

$$X_{1,5} + X_{2,5} >= 64.5$$

$$X_{1,6} + X_{2,6} >= 17.6$$

$$X_{1,7} + X_{2,7} >= 6.5$$

$$X_{1,8} + X_{2,8} >= 19.6$$

$$X_{1,9} + X_{2,9} >= 8.3$$

$$X_{1,10} + X_{2,10} >= 15.3$$

$$X_{1,11} + X_{2,11} >= 14.2$$

$$X_{1,12} + X_{2,12} >= 12.6$$

$$X_{1,13} + X_{2,13} >= 17.9$$

$$X_{1,14} + X_{2,14} >= 44.6$$

$$X_{1,15} + X_{2,15} >= 6.5$$

$$X_{1,16} + X_{2,16} >= 6$$

$$X_{1,17} + X_{2,17} >= 7.5$$

$$X_{1,18} + X_{2,18} >= 6.5$$

- **STEP–4 Solution**

The following table shows the cost of transportation C_{ij} from source 'i' to the distributor 'j' (in thousands of PKR).

S1 -- is the current LPG facility having capacity 500 MT (shown at the right end of table)

S2 – is the proposed LPG location having capacity 450 MT (shown at the right end of table)

Note: The solution has been made for total 49 customers. These customers have been populated as per their location. E.g. 'Sargodha' in

the following table represents 14 different customers located in this region. The distances for these distributors have been approximated to optimum.

3.17.5 Data Input Value for Solution

The following table shows the input values for linear program model.

Table 3.3 LPG Transportation Cost from Source to Distributor

	Sargodha	Silanwali	Lahore	Sheh-u-Pura	Gujranwala	Gujrat	Jhelum	M.B.Din	Patoki	Okara	L.Musa	Hafizabad	Sialkot	Jhang	Kahuta	Chakwal	Rawalpindi	Mianwali	**Plant Capacity Per Month**
S1	12.2	12.8	15.2	14.0	13.6	14.2	10.3	11.8	17.7	16.0	13.9	13.1	13.6	14.2	8.2	9.3	7.2	9.6	**500**
S2	11.7	12.2	7.2	8.2	8.9	8.3	10.9	10.4	9.6	10.3	9.2	11.1	8.7	12.3	15.1	14.3	15.5	16.4	**450**
Demand	78.2	15.9	94.6	19.3	64.5	17.6	6.5	19.6	8.3	15.3	14.2	12.6	17.9	44.6	6.5	6	7.5	6.5	

3.17.5.1 Explanation of Table Inputs

Row 1 = LPG Distributors or Supply Locations. The last column shows the capacities of both LPG supply locations (per month and per metric tons)

Row 2 = Cost (per Metric Tons per Month – in thousands of PKR) of LPG transportation from Plant 1 or Supply location ‘S1’ to distributor.

Row 3 = Cost (per Metric Tons per Month– in thousands of PKR) of LPG transportation from Plant 2 or Supply location ‘S2’ to distributor.

Row 4 = Demand per Month ‘d’ for LPG Distributors (in Metric Tons).

3.17.5.2 Constraints for Data Inputs

The following table 3.4 shows the constraints for input values for linear

program model.

Table 3.4 Constraint Inputs for Linear Program Model

	Sargodha	Silanwali	Lahore	Sheh-u-Pura	Gujranwala	Gujrat	Jhelum	M.B.Din	Patoki	Okara	L.Musa	Hafizabad	Sialkot	Jhang	Kahuta	Chakwal	Rawalpindi	Mianwali
S1	$X_{1,1}$	$X_{1,2}$	$X_{1,3}$	$X_{1,4}$	$X_{1,5}$	$X_{1,6}$	$X_{1,7}$	$X_{1,8}$	$X_{1,9}$	$X_{1,10}$	$X_{1,11}$	$X_{1,12}$	$X_{1,13}$	$X_{1,14}$	$X_{1,15}$	$X_{1,16}$	$X_{1,17}$	$X_{1,18}$
S2	$X_{2,1}$	$X_{2,2}$	$X_{2,3}$	$X_{2,4}$	$X_{2,5}$	$X_{2,6}$	$X_{2,7}$	$X_{2,8}$	$X_{2,9}$	$X_{2,10}$	$X_{2,11}$	$X_{2,12}$	$X_{2,13}$	$X_{2,14}$	$X_{2,15}$	$X_{2,16}$	$X_{2,17}$	$X_{2,18}$
	>=	>=	>=	>=	>=	>=	>=	>=	>=	>=	>=	>=	>=	>=	>=	>=	>=	>=
Demand	d1	d2	d3	d4	d5	d6	d7	d8	d9	d10	d11	d12	d13	d14	d15	d16	d17	d18

- **Supply Constraints:**

  $X_{1,1} + X_{2,1} >= d1,$

  $X_{1,2} + X_{2,2} >= d1$ up to $X_{1,18} + X_{2,18} >= d8$

  Note: the values for Demand (d1, d2 …. d18) are displayed in Row 4 of Table 4.3.

- **Demand Constraints:**

  $X_{1,1} + X_{1,2} \ldots\ldots\ldots + X_{1,18} <= 500$ and

  $X_{2,1} + X_{2,2} \ldots\ldots\ldots + X_{2,18} <= 450$

3.17.6 Results of Linear Program Model for Data Inputs

The following table 3.5 shows the results of the linear program model for input values including the constraints.

Table 3.5 Results for Data Inputs

	Sargodha	Silanwali	Lahore	Sheh-u-Pura	Gujranwala	Gujrat	Jhelum	M.B.Din	Patoki	Okara	L.Musa	Hafizabad	Sialkot	Jhang	Kahuta	Chakwal	Rawalpindi	Mianwali
S1	0	0	0	0	0	0	7	0	0	0	0	0	0	0	7	6	8	7
S2	78	16	95	19	65	18	0	20	8	15	14	13	18	45	0	0	0	0

The results show the product routing from the supply location ‘S1’ and the proposed supply location ‘S2’. It is clear that the only five customer regions are to be entertained from the current facility in order to optimize for the cost of transportation. The rest of customers are to be entertained from proposed location ‘S2’.

The table 3.5 shows the results of liner Program Model for the LPG distribution problem. The quantities against S1 and S2 are the values for decision variable X (i.e. amount of LPG supplied to distributor from each location in metric tons).

The results Shows the following:

1> Jhelum, Kahuta, Chakwal, Rawalpindi and Mianwali region distributors should be supplied product from plant 1 or S1 (Current Location).

2> Rests of the customers are to be fed from the other location S2 (Proposed location).

The proposal for the new location (For Punjab regions customers) has greatly contributed towards reduction in the transportation distance travelled by the product (LPG).

CHAPTER–4

ANALYSIS AND DISCUSSIONS

4.1 General

This thesis study has evaluated the effectiveness of cost saving in the supply chain model for LPG distribution. The problem for reduction in supply chain cost has been greatly resolved by the analysis of current supply chain model and by discovering new supply chain model while keeping the customer demands 100% fulfilled.

The comparison of the current supply chain model and proposed supply chain model for LPG distribution has shown tremendous improvements. The results of the proposed supply chain model are significantly better in terms of cost savings, distance reduction, time saving etc.

The proposal for the new location (For Punjab regions customers of the company) has greatly contributed towards reduction in the transportation distance of the product and hence the cost is also reduced which is a straightforward addition to company's profitability. Following comparisons from the study will show that the current supply chain model is not

4.2 Comparison In Terms of Distance (For Current Supply Chain Model and Proposed Supply Chain Model for the Company)

The transportation cost greatly affects the customer price in LPG. The distance travelled by the product from source to distributor directly increases the customer or consumer price. The comparison of the current supply chain model and the proposed supply chain model has shown decrease in the distance and hence the transportation cost of the product.

The following table 4.1 compares the distance travelled by the product from source to distributors via current supply chain model and via the proposed supply chain model. This distance involves

- Bulk transportation. Distance travelled by LPG from LPG source to LPG filling plant.
- Bottled transportation. Distance travelled by LPG from LPG plant to LPG distributors.

The distributors are represented as D1, D2, D3…D14 and the distances are shown (in kilometers) for each customer.

Table 4.1 Distance Comparison of Current and Proposed Supply Chain Model (Kilometers)

Distributors	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14
Current S.C. Model	789	809	894	854	839	859	719	774	984	924	849	819	839	859
Proposed S.C. Model	500	520	340	375	400	380	474	455	425	450	410	480	395	522

The table 4.1 reflects that the proposed supply chain model involves less transportation for the same quantity of product supply. This following figure 4.1 shows the graphical results for the comparison of distances as in table 4.1.

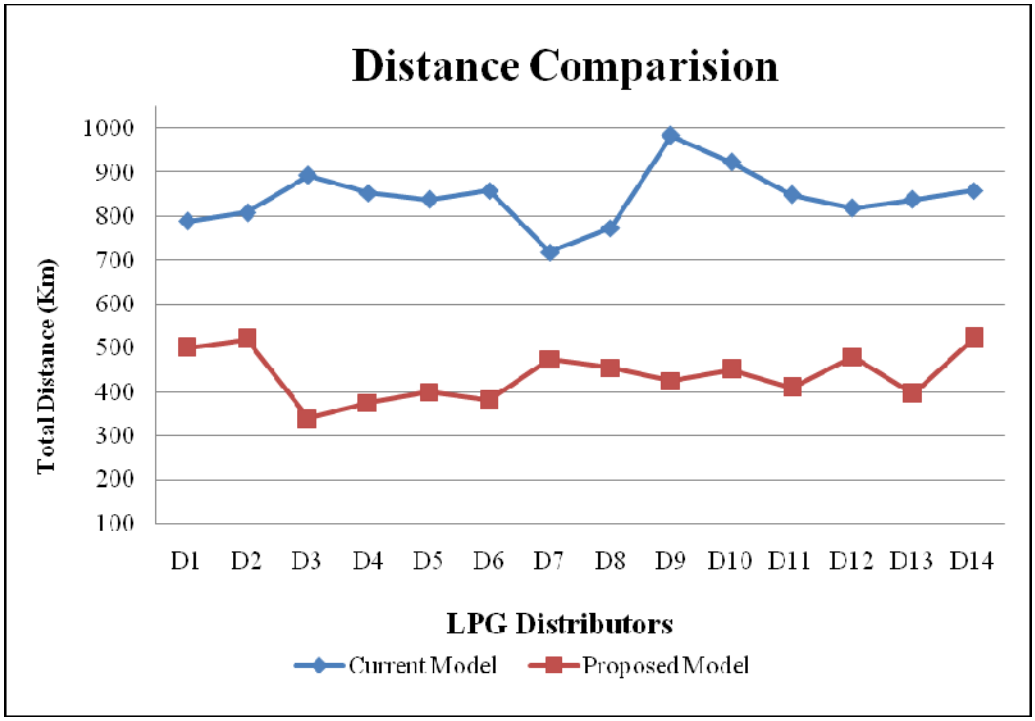

Figure 4.1 Distance Comparison of Current and Proposed Supply Chain Model

The following table 4.2 shows the sum of total distance travelled by the product for one trip from source to distribution point or supply point. This distance is the sum of individual distances for the LPF distributors. (D1, D2, D3…..D14).

The table 4.2 shows that there is 52% reduction in the distance travelled by the product from source to end customer through LPG facility. This reduction in distance can greatly contribute to the cost of transportation for the product.

Table 4.2 Distance Comparison (One trip per distributor)

Distance Per Trip Per Distributor (Km)		Distance Reduction
Current Model	Proposed Model	
11,811	6,126	52%

4.3 Comparison In Terms of Transportation Cost (For Current Supply Chain Model and Proposed Supply Chain Model for the Company)

The transportation cost for the product is directly proportional to the distance. Any reduction in distance will reduce the transportation cost. The cost comparison of the current supply chain model and the proposed supply chain model has shown decrease in cost because of the decrease in distance travelled by the product.

The following table 4.3 compares the cost of the product supply from source to distributors via the current supply facility and via proposed supply facility. The cost also includes the additional costs for the proposed facility which includes operational cost and management cost.

Table 4.3 Cost Comparison of Current and Proposed Supply Chain LPG Model (Thousands of PKR per Month)

Distributors	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	D13	D14
Current Model	959	204	1439	272	881	250	67	232	147	246	198	165	245	634
Proposed Model	915	195	683	158	574	147	71	205	80	158	130	140	157	549

The table 4.3 reflects that the proposed supply chain model involves less cost per month for the same quantity of product supply. This following figure 4.2 shows the graphical results for the comparison of distances as in table 4.3.

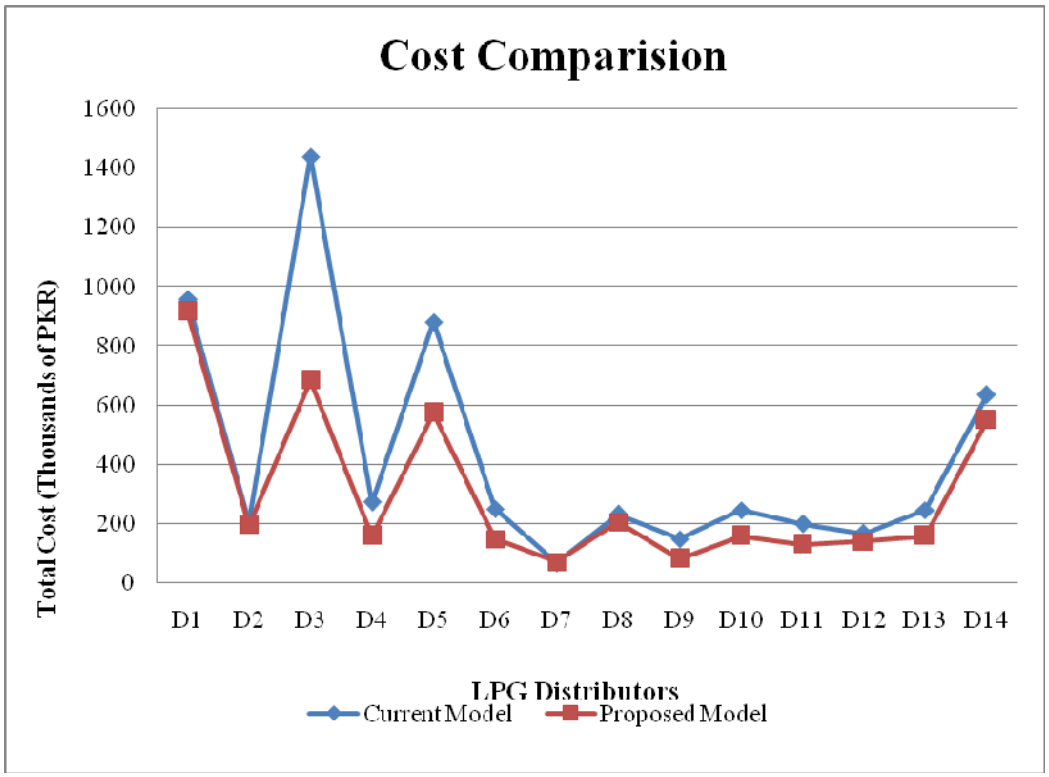

Figure 4.2 Cost Comparison of Current and Proposed Supply Chain LPG Model

The following table 4.4 shows the sum of total cost per month of the product supply for all the distributors D1, D2, D3…..D14.

Table 4.4 Cost Comparison (Per Month)

Cost Per Month (PKR)		Difference / Cost Saving (PKR/Month)	Annual Cost Saving (PKR)	Cost Reduction
Current Model	Proposed Model			
5,939,000	4,162,000	1,777,000	21,324,000	29.9 %

The table 4.4 shows that there is 29.9 % reduction in the cost of product supplied from the current supply chain model and the proposed supply chain model. This reduction in transportation cost is a straight forward benefit towards supply chain cost reduction.

4.4 Other Features of Proposed Supply Chain Model

- **Customer Satisfaction**

  The proposed supply chain model involves less distance travelled by the product and lesser costs. The customer demands can be fulfilled aptly.

- **Efficient Time Management**

  As the proposed supply chain model involves lesser distance than the current model, so the transportation time from the source to distributer is greatly reduced.

- **Less over all capital involved**

  Table 4.4 shows that overall 29.9% capital amount per month can be saved for the same quantity of product supply to the distributors. This decrease in overall capital can increase the financial positions to great extent.

- **Increase in Sales**

  As there is cost reduction in proposed model (as shown in table 4.4), so any discount given to the customer can greatly increase the customer's satisfaction level.

- **Less road exposure – Health Environment and Safety Improvement**

  Lesser distances involve lesser road exposure of the product transportation. The road exposure offers many risks and hazards which are reduced by the proposed supply chain model.

- **Risk Reduction**

  The risks involved in product transportation and capital invested can be greatly reduced by the proposed supply chain model.

CHAPTER – 5

RECOMMENDATIONS AND CONCLUSIONS

5.1 Recommendations for LPG Distribution Company

- As there is 52% reduction in distance and 29.9% reductions in cost for the proposed supply chain model compared to the current supply chain model, so the company should move to the proposed supply chain model.
- As the company is highly HES (Health, Environment and Safety) sensitive company and the proposed model involves lesser risks and hazards, so the proposed LPG supply chain model is more effective to be adopted rather than current model.
- The cost savings (Around 1,777,000 PKR/month) should be used in optimum way to enhance the business setup for the organization. It may be in terms of discount for customers, invested in other business promotion activities etc.

5.2 Recommendations for Government of Pakistan

- **Optimum Product Routing**

  Since the LPG demand is more than the LPG supplied, so the optimum routing is not very haphazard in the country. The following may be the reasons

  - Though Government of Pakistan has set policy for the northern areas but it is not strictly followed by the suppliers especially in the seasons of more demand. It should be controlled and monitored.
  - The suppliers are not provided with a plan to optimize the product movement in different areas of country, so some areas of khabir Pakhtun Kuan (Previous name NWFP) and Azad Kashmir remains lack of product supply.

- **Quota Based System Limitations**

  The LPG distribution from producer is a quota based system. The quota needs to be allocated for areas of need rather than personal affiliations. The quota is sold from the one person to a marketing company and then to distributor and finally to the consumer which results in increased consumer prices.

- **Producer/Supplier Price Setting**

  The producer price setting follows the international market rule even for local production and it is at the stake of the producer. The Government should make formula for price setting at local level so that the consumer may get maximum benefit of the country resources.

- **Consumer Price Controlling.**

  There is almost no control or check at consumer price. During summer season of low demand, the competition controls the prices but the prices become worst in winter season when the demand shoots higher than the supply. The consumer has to pay higher prices for purchase. It should be controlled at consumer end i.e. at distributor level.

- **Regulation Regarding Product Composition**

  Normally LPG is supplied at 60:40 (Propane: Butane), it works well under normal weather condition but in the areas where weather is very cold (Below 0 Degree Celsius), this product composition don't works well. The consumer uses unsafe means to extract gas out of the cylinder i.e. they burn fire under the cylinder which is very risky and may result in blasts.

  The government should provide increased propane ratio of LPG (i.e. 80% above) for the cold weather areas.

- **Demand meeting Through Imports – 2020 Needs**

  The demand in the year 2020 would reach more than 5000 tons/day while the current LPG supply is around 1700 tons/day (including

imported LPG and locally produced LPG) and the current demand is more than 2000 tons/day.

Government should take measures to enhance the production of LPG at local level by discovering new sources and also work on the imports of LPG from near by countries like Iran.

5.3 Recommendations for Academics/Future Research Directions

- This thesis work has focused on transportation cost reduction in supply chain. **Supply Chain Optimization for other Factors** can be done to further increase the firm's profitability.
- **High Safety and Operational Standards for LPG business in Pakistan** requires larger capitals. How this ca be a strength in present culture of Pakistan where people keep low safety sense which is a risk especially in case of LPG usage at homes.
- **Generic Supply Chain Model** for other distribution business like water, food items, soap, electrical items etc.
- **Application of Porter's Model** for highlighting the affect of five forces on LPG business in Pakistan.
- **Demand /Supply balancing** for the current years and for year 2020 through local and imported resources.
- **Highlight new sources of LPG production for Pakistan**. E.g. LPG extraction from natural gas, some oil refining or extraction units do not contain LPG extraction plants etc.
- Build a **model for optimum routing of LPG in Pakistan** so that minimum supply chain cost is involved and hence the capital.
- **Formulate the price setting** for LPG at producer level and consumer level.

5.4 Conclusions

Liquefied Petroleum Gas (LPG) is very vital for its existence because the energy needs in the coming years will greatly depend on it. It is extracted from crude oil, gas fields and oil fields. At normal conditions it is a gas but it is stored and transported as liquid which greatly reduces the transportation cost.

It is considered not only a domestic fuel but also an industrial and commercial fuel. The LPG shortfall between supply and demand is around 150,000 Metric Tons per year between the supply (local and imported) and demand of LPG in Pakistan. [57]

The LPG share for total energy consumed for Pakistan in 2007-08 is about 2%. [58]

The increasing consideration given to Liquefied Petroleum Gas is not only a momentary fad or fashion but a requirement to meet the country needs in better energy utilization.

The cost cutting in the supply chain optimization helps in reducing the consumer price as well as increasing the profitability of organization in the competitive market.

The distribution of Liquefied petroleum gas from source to consumer through LPG filling plants involves bulk transportation (From Source to LPG plant) and bottled transportation (From LPG plant to distributors or consumers). The bulk transportation is cheaper than bottled transportation because of its weights to volume ratio. So an optimum limit needs to be identified for bulk product travelling and bottled product travelling. This depends on the location of distribution units.

Identification has also been made for the alternative supply locations (on mutual contract basis or hospitality agreement basis) so that the transportation cost can be reduced which can greatly impact the consumer price and firms profitability. Transportation model has been applied as

linear program model to evaluate the optimum distance analysis for proposed LPG supply location. An attempted has been made to overcome the gaps in the supply chain of an LPG marketing company. A new supply chain model has been proposed with a new supply location which has resulted in decreased transportation of bulk product supply as well as bottled product supply. The total reduction in distance covered by the product from source to customer is 52% and the total cost savings compared to the current supply chain model is 29.9%. The cost of 2.3 million PKR per year can be saved by following the proposed supply chain model which directly adds profit to the firm.

Useful recommendations for the LPG distribution company, Government of Pakistan and for academics (future research directions) have been provided in this study.

This study is useful not only for any LPG distribution company in Pakistan but also it can be applied to other consumer or industrial goods distribution e.g. distribution of food products, dairy items, water, medicines, electrical items, cement, soap, etc. The crux is to evaluate and optimize the supply chain without disturbing the consumer needs.

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