Model for marketing liquefied petroleum
gas in Nigeria

(Warri as a case study)

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ABSTRACT

Despite the huge national energy resources, many Nigerians do not have access to high quality, modern energy services. For those with access, energy supply lacks reliability, especially in the case of liquefied petroleum gas (LPG). Hence this research considers the possibility of enhancing the household use of LPG. It analyzes the factors affecting the current demand and supply. Salient features of the LPG supply and distribution system were also discussed.

On the basis of the existing situation, barriers of increasing LPG use, in particular, the problems regarding affordability, pricing, government policies, safety, transportation and distribution were analyzed and identified statistically using the chi-square statistical method as a tool.

Finally, on the basis of the challenges identified, suggestions and recommendations were made regarding the policies through which the problems could be overcome. Furthermore, a model was developed and tested for an effective marketing strategy of LPG in Warri Nigeria.
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LIST OF ACRONYMS

LPG:  Liquefied Petroleum Gas

ALCC:  Annualize Life Cycle Cost

C₃H₈:  Propane

C₄H₁₀:  Butane

NNPC:  Nigeria National Petroleum Company

PPMC:  Product and Pipeline Marketing Company

NGL:  National Gas Liquid

DOF:  Degree of Freedom

OPEC:  Organization of petroleum exporting countries.

APPENDIXES
CHAPTER ONE

1.0

BACKGROUND TO THE STUDY

INTRODUCTION

Nigeria ranks high among countries of oil producers both on world level and among the OPEC eleven. (LPG workshop, Abuja Dec. 11, 2003). It is therefore, paradoxical that the supply of all petroleum products is erratic and has declined sharply in the recent past mostly in Warri (Nigeria).

In Nigeria and Warri in particular about 75% of the people live in homes where alternative fuels are used for cooking instead of fuel gas (Liquefied Petroleum Gas, LPG or electricity (electric cookers) (LPG workshop, Abuja Dec. 11, 2003). These alternative fuels, which are crude in nature, are, wood from falling trees, charcoal, coal, crop residues and animal dung. These fuels have adverse effect on those directly involved in its usage, through inhaling of smokes, carbon, fumes and stench which result from its usage, and also on the community, through the ambient pollution from simultaneous cook-fires and land degradation in the cases where fire wood is gathered in an unsustainable manner. (Rachel Carson 1962)

The use of this alternative fuel has also resulted in blindness, brain damage, kidney disease, convulsion, and cancer which will also lead to death. (Rachel Carson 1962) Furthermore it causes elevated blood pressure levels, which are related to hypertension and cardiovascular disease, particularly strokes, heart attacks and premature deaths. (Rachel Carson 1962)

Children are also not left out of this crude alternative fuel usage, and because they have lower immunity, they are so susceptible to systemic and neurological injuries, including lowered IQs, reading and learning disabilities, impaired hearing, reduced attention span, hyperactivity, behavioral problems and interface with growth. (Rachel Carson 1962)
1.1 WHY LPG?

LPG, like all fossil fuels is a non renewable source of energy. The development of LPG begins in the crude oil fields and it ends with the storage of liquid gas. The main components of LPG are hydrocarbons containing three or four carbon atoms. The normal components of LPG thus, are propane (C₃ H₈) and butane (C₄ H₁₀). Small concentrations of other hydrocarbons may also be present depending on the source of the LPG and how it has been produced.

LPG is a gas at atmospheric pressure and normal ambient temperature, but it can be liquefied when moderate pressure is applied or when the temperature is sufficiently reduced. It can be easily condensed, packaged, stored and utilized, which makes it an ideal energy source for a wide range of applications. Normally the gas is stored in liquid form under pressure in a steel container, cylinder or tank. The pressure inside the container will depend on the type of LPG (commercial butane or propane) and the outside temperature. It is typically purchased in cylinders of various sizes: 2.5kg, 6kg, 12kg, and 16kg, up to 50kg.

LPG is many times more efficient, less detrimental to health and is much easier to use for cooking than other sources of energy.

The harmful effect of traditional fuel use such as fire wood, coal, and animal dung on health has been proved in several regional studies. For example a study of 58,768 individuals from 10,265 rural households of 118 villages in three north Indian states (Parikh et al..2003) found correlation between the incidence of respiratory ailments and use of traditional based fuels, exacerbated by factors such as kitchen location and limited ventilation.

A World Bank study of 59,000 children (aged 0-4) in the south eastern state of Andhra Pradesh reported substantial reduction in child mortality through the use of cleaner fuels, in comparison with wood, dung and coal (World Bank, WB 2002).

Since the task of collecting and processing of most forms of biomass usually fall on women, the availability of alternative cooking fuels would reduce this drudgery and enable them to divert their time and energy to other pursuits.
Further, a detailed study of household stoves (smith et al. 2002) has concluded that the biomass stoves in common use burn, with relatively low efficiency, while emitting products of incomplete combustion.

Between kerosene and LPG, the latter is preferable, on the basis of the environmental impacts of the entire fuel cycle (extraction of petroleum and natural gas, processing, transport and distribution), and cooking (Jungblunt, 1995).

Annualized life cycle costs (ALCCs) may be used for comparison of the commonly used fuel/stoves. ALCC includes both initial costs (stove prices and any other capital costs) and operating costs, which vary with the fuel requirement (depending on the energy content of the fuel and stove efficiency) and the prices. When ALCCs are compared, LPG is not as expensive an option as is initially perceived, because the larger initial investment is compensated for by the longer life of the equipment and the higher fuel efficiency (Jungblunt, 1995). LPG can therefore be recommended both for its higher efficiency and lower environmental impact than the alternatives, even without inputting an economic value to the avoided human labour and time saving. More so Nigeria, particularly Warri has a good reserve of both crude oil and natural gas. (LPG workshop, Abuja Dec. 11, 2003)

1.2 CURRENT STATE OF LPG INDUSTRY IN WARRI (NIGERIA)

At present, the LPG industry comprises the players in the marketing and distribution chain: traders and shippers, road haulage contractors and manufactures/vendors of LPG cylinders, tanks, appliances, and ancillary equipment. Neither the refineries (despite their key role as suppliers) nor the gas processors can be described as seriously engaged with the LPG industry. Active participation of several producers in the LPG workshop indicates renewed interest in the domestic market and is a positive outcome of the market study (LPG workshop, Abuja Dec. 11, 2003).

Historically the domestic market enjoyed low naira-dominated wholesale (that is ex-refinery) prices combined with official price control at the retail level. It could not sustain the international market prices for imported LPG, which was required to make good the supply shortfall from the refineries, main while all LPG produced from
gas processing was solely for export. Imported kerosene was stabilized and the LPG / kerosene differential became wider at the retail level (WB/WLPGA, 2001). A decade of unrealistic price and margin control followed by a decade of limited, uncertain supply, together with a breakdown in good business practices, have left the LPG industry in a seriously weakened condition.

The LPG market is highly fragmented with few large national business and many small, local operators. Final selling prices are effectively set by an ineffective regulated, informal sector. One major company- ‘Shell’ withdrew from the market, others have closed and the survivors tend to be ticking over, at best. The remaining cylinder manufacturer receives few orders and is facing closure. (LPG workshop, Abuja Dec. 11, 2003). Crucially, cylinders appear not to be maintained correctly and leaking valves are common, putting consumers and wider public at risk. LPG transport is often in dilapidated trucks, many purchased second hand cylinders which often gets worn out. Ship owners and traders attempting to supply the market have mostly withdrawn after incurring large financial losses. The decline in LPG sales have allowed marketers to withdraw some defective and out of test cylinders from service and so avoid the cost of repair / replacement but, generally the cylinders in circulation are not in very good condition. (LPG workshop, Abuja Dec. 11, 2003).

1.3 CHALLENGES TO INCREASED DOMESTIC USE OF LPG IN WARRI (NIGERIA)

When considering the increased use of LPG for cooking, the main challenges we discern relate to the provision of equitable household access to the fuel while simultaneously ensuring viability of the production and distribution sectors. These challenges raise issues such as:

1. Affordability
2. Effective pricing policy/ industry structure
3. Adequate supply and distribution infrastructure
4. Safety
5. Regulations
Based on the challenges enumerated above, the researcher intends to use the following research questions to find solutions to these challenges.

1.4 RESEARCH QUESTIONS

Based on the problem stated above, the researcher intends to use the following research questions to find solutions to the problems:

a) Is the upfront (initial) cost of becoming an LPG consumer a barrier to prospective users?

b) Is the price of LPG highly unstable?

c) Does other domestic cooking fuel cost undermine the use of LPG?

d) Does the government have a national policy to encourage the use of LPG?

e) Is the transportation system of LPG to end users effective?

f) Is the supply and distribution system of LPG in Warri (Nigeria) effective?

g) Does the pricing structure encourage high utilization of LPG?

h) Is the use of LPG as a cooking gas safe?

i) Is the organization structure in LPG industry effective?

1.5 PROBLEM STATEMENT

Warri popularly called the oil city of Nigeria, has a huge deposit of energy resources. Despite this, about 75% of its inhabitants live in homes where alternative fuel is used for cooking instead of liquefied petroleum gas (LPG). Hence this research considers the possibility of enhancing the household use of LPG, by analyzing the factors affecting current demand, salient features of the LPG supply and its distribution system. Also on the basis of the existing structure in particular, the problems regarding affordability, pricing, government policies, safety, transportation and distribution will be analyzed and identified.
1.6 RESEARCH OBJECTIVES

The objectives of this research is to:

1. Investigate and identify reasons for the liquefied petroleum gas market failure in Warri Delta State Of Nigeria

2. Suggest ways by which liquefied petroleum gas access to all, including the poor can be improved in Warri Delta State Of Nigeria

3. Develop a model for marketing liquefied petroleum gas in Warri delta state of Nigeria.

1.7 SIGNIFICANCE OF THE STUDY

The beneficiary of this research project shall include the following:

- The researcher as I stand to gain significant knowledge from the project

- The gas marketing companies. By identifying the factors that affects the marketing of LPG, a planned approach or at least basis for a planned approach will be established for LPG management.

- Marketers and the Nigerian government, as the model will eliminate the current problem in the larger Nigeria society

- liquefied petroleum gas industry,

- More so it will enlighten the public of the harmful effect of traditional fuel as against liquefied petroleum gas.

- The users of LPG / alternative fuels.
1.8 SUMMARY

Chapter one was about the random use and effects of crude method of generating heat for cooking in Warri (Nigeria), also the importance of liquefied petroleum gas and the current state of the LPG industry in Warri (Nigeria).

More so, the chapter also contained some research questions and what might be the likely causes of LPG shortage in Warri (Nigeria).

While Chapter two (literature review) will focus on marketing (definition), current LPG supply and demand and also try to forecast the demand for the next three years.

Furthermore, the chapter will also touch areas like major dealers of the LPG industry in Nigeria and their brands, filling plants, location, their capacities, and Lessons learnt from the way household LPG users were extended in other developing countries.

Chapter three (methodology) will focus on the definition of methodology, sources of data (both primary and secondary data), reasons for questionnaire and the selected method of investigation.

More so it will cover the questionnaire design and the use of chi-square method to test the hypothesis drafted from the responses of the questionnaire.

While Chapter four will focus on how the data are analyzed and interpreted.

Finally, Chapter five concludes the research work with recommendations and conclusions.
CHAPTER TWO
LITERATURE REVIEW

2.0 MARKETING

Marketing is one of man’s oldest activities and yet it is regarded as the most recent of the business disciplines. Marketing links two basic functions in the community, namely those of production and consumption. (Mitchell et al; 1965) Marketing is an activity, which is directed at satisfying the needs and wants of the customers through exchange process. An exchange process actually means the transaction between buyer and seller, in which the buyer purchases a product and pays the supplier an agreed price. The market is made up of all the actual or potential buyers of these products or services.

Mitchell et al; (1965), defines marketing as the performance of business activities that direct the flow of goods and services from producers to consumer or user, it is the creation of time, place and possession of utilities. Marketing moves goods from place to place, store them, and effect changes in ownership by buying, selling, transporting and storing goods. it includes those business activities involved in the flow of goods and services between producers and customers.

The United Kingdom (UK) Institute of Marketing defines marketing as the management process responsible for identifying, anticipating and satisfying customer’s requirements profitably. Marketing and selling are often used interchangeably; some people even think they are synonymous. However, there are vast differences between the two activities. The basic difference is that selling is internally focused. When a company markets a product and then tries to persuade customers to buy it, that’s selling. In effect the firm attempts to alter customers demand to fit the product supplied by the firm. When a firm finds out what the customers wants and develops a product that will satisfy the need and also yield a profit, that’s marketing, the company adjust its supply to the will of the customers demand.

2.1 LPG (LIQUEFIED PETROLEUM GAS)

LPG, like all fossil fuels, is a non renewable source of energy. The development of LPG begins in the crude oil field and it ends with the storage of liquid gas. The main compositions of LPG are hydrocarbons containing three or four carbon atoms. The normal components of LPG thus, are propane (C₃H₈) and butane (C₄H₁₀). Small concentration of other hydrocarbons may also be present. Depending on the source
of the LPG and how it has been produced, components other than hydrocarbons may also be present.

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When LPG is being utilized, the pressure inside the container/cylinder is reduced. In releasing the gas from the container, some of the liquid LPG then boils to produced vapour. Heat is needed to convert the liquid to vapour (known as the latent heat of vapourization). As the liquid boils, it draws the heat energy from its surroundings. This explains why container feels cold to touch and why. If there is a heavy off take, water or ice may appear on the container. When usage of LPG is stopped, the pressure will return to the equilibrium value for the surrounding temperature. The pressure of LPG in the container varies with surrounding temperatures. It is also much higher than is needed by the appliance that uses it. It needs to be controlled to ensure a steady supply at constant pressure. This is done by a regulator which limits the pressure to suit the appliance that is being fuelled. It is a colorless and odourless gas to which foul smelling hydrogen sulphide (H₂S) is added so that leaks can be easily detected. (United nation development programme (UNDP) 2002). (www.undp.org)

2.2 LPG SUPPLY AND DEMAND

In Nigeria, LPG is produced in four refineries, Warri, Port Harcourt, Eleme and Kaduna. In principle, Kaduna refinery should supply the whole country while the other refineries should produce for export. However, the refineries have been working in fits and starts and hence the LPG supply has been epileptic. : Source (NNPC, PPMC)

Imports were difficult because of the pricing policy of the Nigeria national petroleum company (NNPC) which involves huge subsidy. In October, 1998, the special adviser to the then president on petroleum matters, Mr. Aret Adams, announced the total deregulation of the LPG market. With this pronouncement, the NNPC lost its over two decade’s monopoly of the production, importation and supply of LPG to the Nigeria market. The expected upsurge in demand for LPG after deregulation, bring to the fore, the question of a reliable local source of the commodity, as import cannot be a viable option for a major oil producing country. The epileptic performance of the four national refineries means that in the short to medium term, they cannot be a
reliable source of LPG supply to the local market. However the national gas liquid (NGL) fractionation plants of the NNPC/MOBIL and NNPC chevron joint ventures are a ready and reliable source of LPG for the Nigerian market.

The LPG market has been small with stunted growth because of irregular supply. It reached a peak of 109,000MT (metric tones) in 1990, and has been on the decline since then. (ADCG, 1999). The consumption of LPG has been consistently sliding since 1992. There was a 12.1% decline in LPG demand in 1992 over 1991 level. The consumption of the product stood at 10,479 tones in 1995 which when compared with 1991 level (55,661 tones) shows a decline of 81.2% (ADCG, 1999). Depressed consumer incomes are cited as the major factor accounting for the fall in LPG consumption during the period. Supply side constraints include frequent breakdown of the refineries and distribution facilities, incessant power failure, among others.

Table 1.0  LPG DEMAND AND SUPPLY IN WARRI (Nigeria)

LPG Demand and Supply in Warri (Nigeria) (000 Tonnes)

<table>
<thead>
<tr>
<th>YEAR</th>
<th>DEMAND</th>
<th>SUPPLY</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>372</td>
<td>140</td>
</tr>
<tr>
<td>2004</td>
<td>391</td>
<td>145</td>
</tr>
<tr>
<td>2005</td>
<td>395</td>
<td>150</td>
</tr>
<tr>
<td>2006</td>
<td>401</td>
<td>155</td>
</tr>
<tr>
<td>2007</td>
<td>412</td>
<td>160</td>
</tr>
</tbody>
</table>

Source: NNPC (PPMC)

Using the moving average technique with three – period average the demand for 2008 to 2010 can be forecasted as follows:

**Year 2008**

Demand 2008 = \( \frac{\text{demand2007} + \text{demand2006} + \text{demand2005}}{3} \)

\[ = \frac{412 + 401 + 395}{3} \]

\[ = \frac{1208}{3} \]

\[ = 403,000 \text{ tonnes} \]
Year 2009

Demand 2009 = \( \text{demand2008} + \text{demand2007} + \text{demand2006} \)

\[
= \frac{403 + 412 + 401}{3} \quad (1000 \text{ tonnes})
\]

\[
= 405,000 \text{ tonnes}
\]

Year 2010

Demand 2010 = \( \text{demand2009} + \text{demand2008} + \text{demand2007} \)

\[
= \frac{405 + 403 + 412}{3} \quad (1000 \text{ tonnes})
\]

\[
= 406,000 \text{ tonnes}
\]

2.3 DISTRIBUTION

Distribution is a marketing function that directs the flow of goods and services from producers to customers. It is an indispensable function because of an ever increasing physical distance between the producers and ultimate consumers.

Kofler (1980), defines distribution as the aspect of marketing responsible for transferring economic goods from the seller to the buyers. Most producers do not sell their goods directly to the final users, hence between the producers and users stands a host of marketing intermediaries and bearing varieties of names. These intermediaries are referred to as channel of distribution. Market survey has shown that LPG is bottled and distributed in various sizes of cylinder ranging from 1.5kg to 50kg and skid tanks for bulk supplies of 0.5mt to 5mt. these cylinders are re-tested after every five years with a view to refurbishing those found to be defective. Cylinders and fittings are now standardized in conformity with the international safety standards. Market studies on LPG confirm the following demand pattern.
12.5kg cylinder 60%
50kg cylinder 15%
25kg cylinder 10%
1.5 – 3kg cylinder 10%
100kg cylinders and skid bulk tanks 5%

They are two cylinders manufacturers in Warri (Nigeria) namely:

1. Nigeria Gas Cylinder Manufacturing Company Limited, a subsidiary of total Nigeria PLC. The plant has the capacity for some 300,000 cylinders per annum in one shift. However, about 30% of the installed is utilized. The company is the most important gas cylinders manufacturer in the country.

2. Midgal/setemec gas Cylinder Company limited, a subsidiary of tower aluminum.

2.4 MAJOR LPG DEALERS

The distribution of LPG is carried out by the gas majors, Total, Oando, National, Texaco, Agip, African petroleum, Elf and a myriad of independent marketers. Among the majors, Total has the highest market share and is closely followed by African Petroleum. However, the independent marketers combined, still rule the market.

Table 2.0 Major LPG Dealers

<table>
<thead>
<tr>
<th>COMPANY</th>
<th>BRAND</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOTAL</td>
<td>TOTAL GAS</td>
</tr>
<tr>
<td>OANDO</td>
<td>OANDO GAS</td>
</tr>
<tr>
<td>NATIONAL</td>
<td>EAGLE GAS</td>
</tr>
<tr>
<td>TEXACO</td>
<td>TEXGAS</td>
</tr>
<tr>
<td>AGIP</td>
<td>AGIPGAS</td>
</tr>
<tr>
<td>AP</td>
<td>APAGAS</td>
</tr>
<tr>
<td>ELF</td>
<td>ELFGAS</td>
</tr>
<tr>
<td>INDEPENDENT MARKETERS</td>
<td>NIDOGAS, UTILGAS, COTSGAS, SUNGAS, GREENGAS ETC.</td>
</tr>
</tbody>
</table>

Source ADCG, 1999.
Most of the gas majors and independent marketers have established gas filling centers were customers and retailers can refill their gas cylinders. These facilities are limited to only large metropolitan areas.

At the end of 2004, there were 203 filling plants in the country (Nigeria LPG sector improvement study, 2004) and is distributed as follows

**Table 2.1 LPG Filling Plants in Nigeria**

<table>
<thead>
<tr>
<th>ZONE</th>
<th>NO. OF PLANTS</th>
<th>INSTALLED CAPACITY (METRIC TONNES)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WARRI</td>
<td>21</td>
<td>1047.4</td>
</tr>
<tr>
<td>LAGOS</td>
<td>53</td>
<td>5629</td>
</tr>
<tr>
<td>PORT-HARCOURT</td>
<td>26</td>
<td>867.4</td>
</tr>
<tr>
<td>ENUGU</td>
<td>34</td>
<td>1941</td>
</tr>
<tr>
<td>CALABAR</td>
<td>9</td>
<td>360</td>
</tr>
<tr>
<td>MARKURDI</td>
<td>2</td>
<td>65</td>
</tr>
<tr>
<td>IBADAN</td>
<td>16</td>
<td>846</td>
</tr>
<tr>
<td>KADUNA</td>
<td>15</td>
<td>1068</td>
</tr>
<tr>
<td>KANO</td>
<td>9</td>
<td>410</td>
</tr>
<tr>
<td>GOMBE</td>
<td>6</td>
<td>324</td>
</tr>
<tr>
<td>GUSAU</td>
<td>2</td>
<td>77</td>
</tr>
<tr>
<td>ILORIN</td>
<td>3</td>
<td>87</td>
</tr>
<tr>
<td>PLATEAU</td>
<td>2</td>
<td>77</td>
</tr>
<tr>
<td>KOGI</td>
<td>1</td>
<td>57</td>
</tr>
<tr>
<td>NIGER</td>
<td>1</td>
<td>57</td>
</tr>
<tr>
<td>FCT</td>
<td>3</td>
<td>90</td>
</tr>
</tbody>
</table>

**SOURCE: NALPGAM 2002**

### 2.5 COOKING STOVE

LPG cooking stoves comes in various shapes and sizes. The most common being the camping gas variety. This has a simple burning ring, pan support and use a 3 or 6kg LPG bottle.

Multiple ring stoves with combined oven are also common among higher income groups.

### 2.6 SAFETY PRECAUTION IN HANDLING LPG

1. What should an operator do when handling LPG?
   1. Position the tank so that the liquid propane do not come in contact with relief valve.
   2. Make sure the lock pin engages into the cylinder.
iii. Make sure the valve is tightly closed.
iv. Store the cylinder outside in an upright position in an area where it will be secured and protected from being struck
v. Put the cylinder down gently, do not drop, dent or damage.
vi. Always protect the valve from any damage
vii. Avoid contact with liquid propane (LPG) as it can cause frostbite.
viii. Wear protective gloves while making or breaking connections.
ix. For repairs, use only components that government bodies / agencies has approved.
x. Exchange removable cylinders outdoor, or in well ventilated area and from sources of heat
xi. Close valve before breaking connections.

Source: CCOHS 1995

2.7 EXPERIENCES OF LPG PROGRAMMES

Lessons could be learnt from the way household LPG users were extended in other developing countries.

ASIA

In the Philippines, the opening of the market in 1996 encouraged several oil companies to invest there. Since 1997, more than 100 bottling plants have been built and the demand, almost entirely for the household sector has risen by about 40% (WB and WLPGA, 2002).

In the People’s Republic of China, the shift up the energy ladder from biomass based fuel to LPG was spurred by the restriction on the supply of kerosene (UNDP et al., 2002). With liberalization of the market, a number of international oil companies have established distribution and marketing operations, as joint ventures with the Chinese (WB and WLPGA, 2002). In Indonesia, LPG for domestic use has been subsidized, but kerosene subsidies are even higher, undermining the competitiveness of LPG (WB and WLPGA, 2002).

WEST AFRICA

60% of the LPG consumption in this region is concentrated in four countries, Cameroon, Cote d’ Ivoire, Ghana and Senegal, where demand has grown significantly during the 90s. Factors that have contributed to the increase in LPG use in the case of Senegal, where the highest growth has been recorded, include
subsidized LPG to small cylinders of 6kg each. (WB and WLPGA, 2001). In both Senegal and Cote d’ Ivoire, price subsidies available on small cylinder have not been extended to large bottle, emphasizing the assistance to lower – income households. (WLPGA and UNDP, 2002).

**LATIN AMERICA**

Brazil has been successful in providing LPG to about 90% of its households. The main reason for this extent adoption appears to be the controlled price of LPG through cross – subsidies from other petroleum products. This was proved in 2002, when deregulation led to increase in LPG prices and some lower income rural households switched back to fuel wood. To counteract this, an assistance programme began, providing low income families with subsidies towards LPG purchase. In addition, smaller cylinders of only 2kg each have been available, facilitating use among lower income households (WLPGA and UNDP, 2002).

Another reason for the Brazilian success in extending LPG use is a dependable system of distribution and replacement of cylinders. (UNDP et al., 2000 ch.10). Brazil is said to have 26,000 such vendors serving 35 million households (Barnes and Halpem, 2000). However, as about 81% of Brazilians families live in urban areas (IBGE, 2001). The distribution problem found in largely rural countries would not be encountered here.

In Guatemala where the LPG market is completely liberalized, installment payment plans to cover the purchase of a suitable stove and the cylinder deposit fee are common and are helping to facilitate the adoption of this fuel by low/middle – income families.

### 2.8 BUTANISATION PROGRAMME

To encourage and achieve orderly development and consumption of LPG nationwide, the NNPC embarked on the butanisation programme, with the following objectives.

1. To increase the flexibility of supply and ensure adequate supplies for sustaining expansion in LPG consumption

2. To improve LPG distribution by minimizing transportation distances.

3. To provide strategic reserves with which the buffer supplies during disruption in refineries productions
4. To generate foreign exchange by releasing LPG for export from the coastal refineries

5. To encourage substitution of LPG for kerosene thereby conserving the foreign exchange expanded on kerosene imports, and

6. To reduced the demand pressure on other liquid fuels e.g. automotive gas oil and fuel oil, and release them for export.

Besides, substitution of LPG for firewood will reduce dependence on wood fuel and assist government’s afforestation effort.

The scope of the butanization programme involved the construction of LPG depots and ancillary facilities in nine strategic locations across the country, Apapa (4,00MI), all others are 1,000MI. Ibadan, Kano, Ilorin, gusau, Gombe, makurdi, calabar, warri, and Enugu. Apapa and calabar depots are to be supplied by coastal vessels while the other will be supplied by road.

2.9 SUMMARY

Chapter two (literature review) focused on marketing (definition), current LPG supply and demand and also forecasted the demand for the next three years.

Furthermore, the chapter also touched areas like major dealers of the LPG industry and their brands, filling plants, location, their capacity, and Lessons learnt from the way household LPG users were extended in other developing countries.

While Chapter three (methodology) will focus on the definition of methodology, sources of data (both primary and secondary data), reasons for questionnaire and the selected method of investigation.

More so it will cover the questionnaire design and the use of chi-square method to test the hypothesis drafted from the responses of the questionnaire.
CHAPTER THREE
METHODOLOGY

3.0 INTRODUCTION

In any research work, usually the procedure to be used should be relevant to the scope and objectives of the study. Therefore, the need to understand the research methodology used is essential.

Leedy, (1974) define methodology “as an operational frame work within which facts are placed so that their meaning may be seen more clearly”. He further stated that methodology supplies the researcher with logical rules that guides our findings and subsequent analysis.

Chisnal, (1978) stated that “a central part of research study is to develop an effective research strategy or design”, he said that a research design forms the framework of the entire research process.

According to Nachmias and Nachmias, (1981), "a research design is the programme that guides the investigator in the process of collecting, analyzing, and interpreting observations.

Kerlinger, (1973), sees a research design as the plan, structure and strategy of investigation conceived so as to obtain answers to research questions and to control variance. He explained plan as the overall scheme or programme of the research which includes an outline of what the investigator will do from writing the hypothesis and their operational implications to the final analysis of data.

3.1 DATA COLLECTION METHOD

There are two kinds of data used mostly in research. These are primary data and secondary data. (Kitler & Armstrong 1986).
1. **Primary Data**

In primary data collection, data are collected by the researcher using methods such as interviews and questionnaires. The key point here is, data collected is unique to you and your research and, until you publish, no one else has access to it. (Kitler & Armstrong 1986).

Primary data collection is necessary when a researcher cannot find the data needed in secondary sources. (Kitler & Armstrong 1986).

There are many methods of collecting primary data and the main methods include:

- Questionnaires
- Interviews
- Focus Group Interviews
- Observation
- Case-studies
- Diaries
- Critical Incidents
- Survey

(Kitler and Armstrong, 1986)

The choice of method is influenced by time, money, personnel, and facilities and is largely dependent on the nature of the problem. For this research work, the survey method was used for gathering primary data.

2. **Secondary data.**

Secondary Data is data or information that is already available. This data is collected by a person or organization other than the user of the data. (Kitler and Armstrong, 1986)
Advantages of secondary data are that it is cheap and inexpensive. It is easily accessible. It is already available. It saves time and efforts. It is unobtrusive. It avoids data collection problems and it provides a basis for comparison. Disadvantages are related to the credibility of the source who has published this information and the small nuances that may not fit into your research objectives. Another disadvantage is that, the data might be outdated. Similarly you have no control over the quality of data and you do not know how authentic the measures used for data collection have been. (Rajeshshri 1982)

Source of Secondary Data used in this research include, but are not limited to: Books, Magazines, websites, Already published reports, TV, Radio, Newspapers, Films, Journals and publications, Research papers etc.

3.2 Questionnaire Design

Questionnaires are an inexpensive way to gather data from a potentially large number of respondents. (Dr Thomas. F. Burgess). Often they are the only feasible way to reach a number of reviewers large enough to allow statistically analysis of the results. A well-designed questionnaire that is used effectively can gather information on both the overall performance of the test system as well as information on specific components of the system. If the questionnaire includes demographic questions on the participants, they can be used to correlate performance and satisfaction with the test system among different groups of users.

It is important to remember that a questionnaire should be viewed as a multi-stage process beginning with definition of the aspects to be examined and ending with interpretation of the results. (Dr Thomas. F. Burgess) Every step needs to be designed carefully because the final results are only as good as the weakest link in the questionnaire process. Although questionnaires may be cheap to administer compared to other data collection methods, they are every bit as expensive in terms of design time and interpretation. (Dr Thomas. F. Burgess)
The steps required to design and administer a questionnaire include:

1. Defining the Objectives of the survey
2. Determining the Sampling Group
3. Designing the Questionnaire
4. Administering the Questionnaire
5. Interpretation of the Results. (Kitler & Armstrong 1986).

This aspect will concentrate on how to formulate objectives and write the questionnaire. Before these steps are examined in detail, it is good to consider what questionnaires are good at measuring and when it is appropriate to use questionnaires.

### 3.2.1 What can questionnaires measure?

Questionnaires are quite flexible in what they can measure, however they are not equally suited to measuring all types of data. (Leung WC 2001). We can classify data in two ways, Subjective vs. Objective and Quantitative vs. Qualitative.

Questions may be designed to gather either qualitative or quantitative data. (Leung WC 2001) By their very nature, quantitative questions are more exact then qualitative. For example, the word "easy" and "difficult" can mean radically different things to different people. Any question must be carefully crafted, but in particular questions that assess a qualitative measure must be phrased to avoid ambiguity. Qualitative questions may also require more thought on the part of the participant and may cause them to become bored with the questionnaire sooner. In general, we can say that questionnaires can measure both qualitative and quantitative data well, but that qualitative questions require more care in design, administration, and interpretation.

### 3.2.2 When to use a questionnaire?

There is no all encompassing rule for when to use a questionnaire. (Dorman P.J 1997). The choice will be made based on a variety of factors including the type of information to be gathered and the available resources for the experiment. A questionnaire should be considered in the following circumstances.
1. When resources and money are limited. A Questionnaire can be quite inexpensive to administer. Although preparation may be costly, any data collection scheme will have similar preparation expenses. The administration cost per person of a questionnaire can be as low as postage and a few photocopies. Time is also an important resource that questionnaires can maximize. If a questionnaire is self-administering, such as an e-mail questionnaire, potentially several thousand people could respond in a few days. It would be impossible to get a similar number of usability tests completed in the same short time. (Bissett AF1994)

2. When it is necessary to protect the privacy of the participants. Questionnaires are easy to administer confidentially. Often confidentiality is necessary to ensure that participants will respond honestly if at all. Examples of such cases would include studies that need to ask embarrassing questions about private or personal behaviour. (Bissett AF 1994)

3. When corroborating other findings. In studies that have resources to pursue other data collection strategies, questionnaires can be a useful confirmation tools. More costly schemes may turn up interesting trends, but occasionally there will not be resources to run these other tests on large enough participant groups to make the results statistically significant. A follow-up large scale questionnaire may be necessary to corroborate these earlier results. (Bissett AF 1994)

3.2.3. Defining the Objectives of the Survey

The importance of well-defined objectives cannot be over emphasized. A questionnaire that is written without a clear goal and purpose is inevitably going to overlook important issues and waste participants' time by asking useless questions. The questionnaire may lack a logical flow and thereby cause the participant to lose interest. Consequentl, what useful data you may have collected could be further compromised. The problems of a poorly defined questionnaire do not end here, but continue on to the analysis stage. It is difficult to imagine identifying a problem and its cause, let alone its solution, from responses to broad and generalizing questions. In other words, how would it be possible to reach insightful conclusions if one didn't actually know what they had been looking for or planning to observe.
An example such as, "to identify points of user dissatisfaction with the interface and how these negatively affect the software's performance" may sound clear and to the point, but it is not. The questionnaire designer must clarify what is meant by user dissatisfaction. Is this dissatisfaction with the learning of the software, the power of the software, or the ease of learning the software? Is it important for the users to learn the software quickly if they learn it well? What is meant by the software's performance? How accurate must the measurements be? All of these issues must be narrowed and focused before a single question is formulated. A good rule of thumb is that if you are finding it difficult to write the questions, then you haven’t spent enough time defining the objectives of the questionnaire. Go back and do this step again. The questions should follow quite naturally from the objectives.

3.2.4. Writing the Questionnaire

At this point, we assume that we have already decided what kind of data we are to measure, formulated the objectives of the investigation, and decided on a participant group. Now we must compose our questions.

If the preceding steps have been faithfully executed, most of the questions will be on obvious topics. Most questionnaires, however, also gather demographic data on the participants. This is used to correlate response sets between different groups of people. It is important to see whether responses are consistent across groups. For example, if one group of participants is noticeably less satisfied with the test interface, it is likely that the interface was designed without fair consideration of this group’s specific needs. This may signify the need for fundamental redesign of the interface. In addition, certain questions simply may only be applicable to certain kinds of users. For example, if one is asking the participants whether they find the new tutorial helpful, we do not want to include in our final tally the responses of experienced users who learned the system with an older tutorial. There is no accurate way to filter out these responses without simply asking the users when they learned the interface.

Typically, demographic data is collected at the beginning of the questionnaire, but such questions could be located anywhere or even scattered throughout the questionnaire. One obvious argument in favor of the beginning of the questionnaire
is that normally background questions are easier to answer and can ease the respondent into the questionnaire. One does not want to put off the participant by jumping in to the most difficult questions. We are all familiar with such kinds of questions.

It is important to ask only those background questions that are necessary. Do not ask income of the respondent unless there is at least some rational for suspecting a variance across income levels. There is often only a fine line between background and personal information. You do not want to cross over in to the personal realm unless absolutely necessary. If you need to solicit personal information, phrase your questions as unobtrusively as possible to avoid ruffling your participants and causing them to answer less than truthfully.

3.2.5 What kind of questions do we ask?

In general, there are two types of questions one will ask, open format or closed format. (Bissett AF 1994).

Open format questions are those that ask for unprompted opinions. In other words, there are no predetermined set of responses, and the participant is free to answer however he chooses. Open format questions are good for soliciting subjective data or when the range of responses is not tightly defined. An obvious advantage is that the variety of responses should be wider and more truly reflect the opinions of the respondents. This increases the likelihood of you receiving unexpected and insightful suggestions, for it is impossible to predict the full range of opinion. It is common for a questionnaire to end with and open format question asking the respondent for her unabashed ideas for changes or improvements.

Open format questions have several disadvantages. First, their very nature requires them to be read individually. There is no way to automatically tabulate or perform statistical analysis on them. (Bissett AF 1994). This is obviously more costly in both time and money, and may not be practical for lower budget or time sensitive evaluations. They are also open to the influence of the reader, for no two people will interpret an answer in precisely the same way. This conflict can be eliminated by using a single reader, but a large number of responses can make this impossible. Finally, open format questions require more thought and time on the part of the
respondent. When too much questions are asked, the chance of tiring or boring the respondent increases.

Closed format questions usually take the form of a multiple-choice question. They are easy for the respondent.

There is no clear consensus on the number of options that should be given in a closed format question. (Bissett AF 1994). Obviously, there needs to be sufficient choices to fully cover the range of answers but not so many that the distinction between them becomes blurred. Usually this translates into five to ten possible answers per questions. For questions that measure a single variable or opinion, such as ease of use or liability, over a complete range (easy to difficult, like to dislike), conventional wisdom says that there should be an odd number of alternatives. This allows a neutral or no opinion response. Other schools of thought contend that an even number of choices is best because it forces the respondent to get off the fence. However, it is equally arguable that the neutral answer is over utilized, especially by bored questionnaire takers. For larger questionnaires that test opinions on a very large number of items, such as a music test, it may be best to use an even number of choices to prevent large numbers of no-thought neutral answers.

Closed format questions offer many advantages in time and money. By restricting the answer set, it is easy to calculate percentages and other hard statistical data over the whole group or over any subgroup of participants. Modern scanners and computers make it possible to administer, tabulate, and perform preliminary analysis in a matter of days. Closed format questions also make it easier to track opinion over time by administering the same questionnaire to different but similar participant groups at regular intervals. Finally closed format questions allow the researcher to filter out useless or extreme answers that might occur in an open format question. (Bissett AF 1994).

Whether your questions are open or closed format, there are several points that must be considered when writing and interpreting questionnaires:

1. **Clarity:** This is probably the area that causes the greatest source of mistakes in questionnaires. Questions must be clear, succinct, and unambiguous. The goal is to eliminate the chance that the question will mean different things to different people. If
the designer fails to do this, then essentially participants will be answering different questions.

2. **Leading Questions:** A leading question is one that forces or implies a certain type of answer. It is easy to make this mistake not in the question, but in the choice of answers. A closed format question must supply answers that not only cover the whole range of responses, but that are also equally distributed throughout the range. All answers should be equally likely. An obvious, nearly comical, example would be a question that supplied these answers choices:

1. Superb
2. Excellent
3. Great
4. Good
5. Fair
6. Not so Great

3. **Phrasing:** Most adjectives, verbs, and nouns in English have either a positive or negative connotation. Two words may have equivalent meaning, yet one may be a compliment and the other an insult. Consider the two words "child-like" and "childish", which have virtually identical meaning. Child-like is an affectionate term that can be applied to both men and women, and young and old, yet no one wishes to be thought of as childish.

A more subtle, but no less troublesome, example can be made with verbs that have neither strong negative or positive overtones. Consider the following two questions:

(A) Do you agree with the Governor's plan to oppose increased development of wetlands?

(B) Do you agree with the Governor's plan to support curtailed development of wetlands?

They both ask the same thing, but will likely produce different data. One asked in a positive way and the other in a negative way. It is impossible to predict how the
outcomes will vary, so one method to counter this is to be aware of different ways to word questions and provide a mix in your questionnaire. If the participant pool is very large, several versions may be prepared and distributed to cancel out these effects.

4 Embarrassing Questions: Embarrassing questions dealing with personal or private matters should be avoided. Your data is only as good as the trust and care that your respondents give you. If you make them feel uncomfortable, you will lose their trust. Do not ask embarrassing questions.

5 Hypothetical Questions Hypothetical is based, at best, on conjecture and, at worst, on fantasy. I simple question such as:

If you were governor what would you do to stop crime?

This force the respondent to give thought to something he may have never considered. This does not produce clear and consistent data representing real opinion. Do not ask hypothetical questions.

6 Prestige Bias: Prestige bias is the tendency for respondents to answer in a way that make them feel better. People may not lie directly, but may try to put a better light on themselves. For example, it is not uncommon for people to respond to a political opinion poll by saying they support Samaritan social programs, such as food stamps, but then go on to vote for candidates who oppose those very programs. Data from other questions, such as those that ask how long it takes to learn an interface, must be viewed with a little skepticism. People tend to say they are faster learners than they are.

There is little that can be done to prevent prestige bias. Sometimes there is just no way to phrase a question so that all the answers are noble. The best means to deal with prestige bias is to make the questionnaire as private as possible. Telephone interviews are better than person-to-person interviews, and written questionnaires mailed to participants are even better still. The farther away the critical eye of the researcher is, the more honest the answers.
3.2.6 Now What?

Now that the questionnaires have been completed, it is still not ready to be sent out. Just like any manufactured product, your questionnaire needs to go through quality testing. The major hurdle in questionnaire design is making it clear and understandable to all. Though great care has been taking to be clear and concise, it is still unreasonable to think that any one person can anticipate all the potential problems. Just as a usability test observes a test user with the actual interface, the researcher observed a few test questionnaire takers. The researcher then reviewed the questionnaire with the test takers and discussed all points that were in any way confusing and we worked together to solve the problems. I then produced a new questionnaire. It is possible that this step may need to be repeated more than once depending on resources and the need for accuracy.

Conclusions

Questionnaire design is a long process that demands careful attention. A questionnaire is a powerful evaluation tool and should not be taken lightly. Design begins with an understanding of the capabilities of a questionnaire and how they can help your research. If it is determined that a questionnaire is to be used, the greatest care goes into the planning of the objectives. Questionnaires are like any scientific experiment. One does not collect data and then see if they found something interesting. One form a hypothesis and an experiment that will help prove or disprove the hypothesis.

Questionnaires are versatile, allowing the collection of both subjective and objective data through the use of open or closed format questions. Modern computers have only made the task of collecting and extracting valuable material more efficient. However, a questionnaire is only as good as the questions it contains. There are many guidelines that must be met before your questionnaire can be considered a sound research tool. The majority deal with making the questionnaire understandable and free of bias. Mindful review and testing is necessary to weed out minor mistakes that can cause great changes in meaning and interpretation. When these guidelines are followed, the questionnaire becomes a powerful and economic evaluation tool.
3.3 METHOD OF INVESTIGATION SELECTED AND APPLICATION

Effort was made to gather unbiased information for the analysis of the problems addressed in the research project. The major instrument used in collection of data relevant to the factors affecting the market and marketing of LPG in Warri Nigeria includes the administration of personal interview and questionnaires. In this method of investigation, the researcher intends to use both the personal interview and questionnaire to arrive at detailed and reliable data.

The sampling technique used was selective because the personal interview/questionnaire were devoted to the management and staff of the various gas companies, agents and marketers visited while the questionnaires were distributed to selected customers of LPG.

3.4 ANALYSIS TECHNIQUE

3.4.1 THE NULL HYPOTHESIS

In statistic a null hypothesis ($H_0$) is a hypothesis set up to be nullified or refuted in order to support an alternative hypothesis. When used, the null hypothesis is presumed true until statistical evidence, in the form of a hypothesis test, indicates otherwise — that is, when the researcher has a certain degree of confidence, usually 95% to 99%, that the data does not support the null hypothesis. It is possible for an experiment to fail to reject the null hypothesis. It is also possible that both the null hypothesis and the alternate hypothesis are rejected if there are more than those two possibilities. (Fisher, R.A. 1966).

The purpose of hypothesis testing is to test the viability of the null hypothesis in the light of experimental data. Depending on the data, the null hypothesis either will or will not be rejected as a viable possibility. The null hypothesis is often the reverse of what the experimenter actually believes; it is put forward to allow the data to contradict it.

In scientific and medical applications, the null hypothesis plays a major role in testing the significance of differences in treatment and control groups. The assumption at the outset of the experiment is that no difference exists between the two groups (for the variable being compared); this is the null hypothesis in this instance.
It should be stressed that researchers very frequently put forward a null hypothesis in the hope that they can discredit it. For example, consider an educational researcher who designed a new way to teach a particular concept in science, and wanted to test experimentally whether this new method worked better than the existing method. The researcher would design an experiment comparing the two methods. Since the null hypothesis would be that there is no difference between the two methods, the researcher would be hoping to reject the null hypothesis and conclude that the method he or she developed is the better of the two. The symbol $H_0$ is used to indicate the null hypothesis. For example consider a researcher interested in whether the time to respond to a tone is affected by the consumption of alcohol. The null hypothesis is that $\mu_1 - \mu_2 = 0$ where $\mu_1$ is the mean time to respond after consuming alcohol and $\mu_2$ is the mean time to respond otherwise. Thus, the null hypothesis concerns the parameter $\mu_1 - \mu_2$ and the null hypothesis is that the parameter equals zero.

$$H_0: \mu_1=\mu_2=0$$

or

$$H_0: \mu_1 = \mu_2.$$ 

The null hypothesis is typically a hypothesis of no difference. That is why the word "null" in "null hypothesis" is used -- it is the hypothesis of no difference. (Fisher, R.A. 1966).

Despite the "null" in "null hypothesis," there are occasions when the parameter is not hypothesized to be 0. For instance, it is possible for the null hypothesis to be that the difference between population means is a particular value. Or, the null hypothesis could be that the mean SAT score in some population is 600. The null hypothesis would then be stated as: $H_0: \mu = 600$. Although null hypotheses involve the testing of hypotheses about one or more population means, null hypotheses can involve any parameter (Fisher, R.A 1966.).

### 3.4.2 SIGNIFICANCE LEVEL

One may want to compare the test scores of two random samples of men and women, and ask whether or not one population has a mean score different from the other. A null hypothesis would be that the mean score of the male population was the same as the mean score of the female population:
\[ H_0: \mu_1 = \mu_2 \]

Where:

\[ H_0 = \text{the null hypothesis} \]
\[ \mu_1 = \text{the mean of population 1, and} \]
\[ \mu_2 = \text{the mean of population 2.} \]

Alternatively, the null hypothesis can postulate that the two samples are drawn from the same population, so that the variance and shape of the distributions are equal, as well as the means.

Formulation of the null hypothesis is a vital step in testing statistical significance. Having formulated such a hypothesis, one can establish the probability of observing the obtained data or data more different from the prediction of the null hypothesis, if the null hypothesis is true. That probability is what is commonly called the “significance level” of the results. (Fisher, R.A. 1966).

### 3.4.3 Type I Error

In a hypothesis test, a type I error occurs when the null hypothesis is rejected when it is in fact true; that is, \( H_0 \) is wrongly rejected.

For example, in a clinical trial of a new drug, the null hypothesis might be that the new drug is no better, on average, than the current drug; i.e.

\[ H_0: \text{there is no difference between the two drugs on average.} \]

A type I error would occur if we concluded that the two drugs produced different effects when in fact there was no difference between them.

The table below gives a summary of possible results of any hypothesis test:

<table>
<thead>
<tr>
<th>DECISION</th>
<th>REJECT Ho</th>
<th>DON'T REJECT Ho</th>
</tr>
</thead>
<tbody>
<tr>
<td>Truth Ho</td>
<td>Type 1 Error</td>
<td>Right Decision</td>
</tr>
<tr>
<td>Truth Hi</td>
<td>Right Decision</td>
<td>Type II Error</td>
</tr>
</tbody>
</table>

31
A type I error is often considered to be more serious, and therefore more important to avoid, than a type II error. The hypothesis test procedure is therefore adjusted so that there is a guaranteed 'low' probability of rejecting the null hypothesis wrongly; this probability is never 0. This probability of a type I error can be precisely computed as

\[ P(\text{type I error}) = \text{significance level} = \alpha \]

The exact probability of a type II error is generally unknown.

If we do not reject the null hypothesis, it may still be false (a type II error) as the sample may not be big enough to identify the falseness of the null hypothesis (especially if the truth is very close to hypothesis).

For any given set of data, type I and type II errors are inversely related; the smaller the risk of one, the higher the risk of the other.

A type I error can also be referred to as an error of the first kind. (Fisher, R.A. 1966).

3.4.4 Type II Error

In a hypothesis test, a type II error occurs when the null hypothesis H0, is not rejected when it is in fact false. For example, in a clinical trial of a new drug, the null hypothesis might be that the new drug is no better, on average, than the current drug; i.e.

H0: There is no difference between the two drugs on average.

A type II error would occur if it was concluded that the two drugs produced the same effect, i.e. there is no difference between the two drugs on average, when in fact they produced different ones.

A type II error is frequently due to sample sizes being too small.

The probability of a type II error is generally unknown, but is symbolized by \( \beta \) and written

\[ P(\text{type II error}) = \beta \]

A type II error can also be referred to as an error of the second kind. (Fisher, R.A. 1966).
3.4.5 STATEMENT OF THE NULL HYPOTHESIS

For the purpose of this research the researcher will be using the null hypothesis in accepting or rejecting the following research questions:

1. **HO:** High upfront of cost of liquefied petroleum gas (LPG) does not affect the marketing of LPG in Warri Nigeria.

2. **HO:** Instability in the price of LPG does not affect the marketing of LPG in Warri Nigeria.

3. **HO:** Lower costs of other cooking fuels (biomass based fuel/kerosene) do not affect the marketing of LPG in Warri Nigeria.

4. **HO:** Ineffective transportation system does not affect the marketing of LPG in Warri Nigeria.

5. **HO:** Ineffective supply and distribution system does not affect the marketing of LPG in Warri Nigeria.

6. **HO:** Inappropriate pricing structure of LPG does not affect the marketing of LPG in Warri Nigeria.

7. **HO:** Inadequate awareness / enlightenment campaign on LPG does not affect the marketing of LPG in Warri Nigeria.

8. **HO:** Poor state of cylinders in circulation does not affect the marketing of LPG in Warri Nigeria.

9. **HO:** Lack of proper implementation of government policies / gas strategies does not affect the marketing of LPG in Warri Nigeria.

10. **HO:** Ineffective organizational structure of LPG industries does not affect the marketing of LPG in Warri Nigeria.

11. **HO:** Ineffectiveness of regulatory body of LPG industry does not affect the marketing of LPG in Warri Nigeria.
3.5 CHI-SQUARE

What is the chi-square statistic?

The chi-square (chi, the Greek letter pronounced "kye") statistic is a nonparametric statistical technique used to determine if a distribution of observed frequencies differs from the theoretical expected frequencies. (Dorak, 2006). Chi-square statistics use nominal (categorical) or ordinal level data, thus instead of using means and variances, this test uses frequencies. (Dorak, 2006).

The value of the chi-square statistic is given by

\[ X^2 = \Sigma \frac{(O - E)^2}{E} \]  

(1)

Where \( X^2 \) is the chi-square statistic, \( O \) is the observed frequency and \( E \) is the expected frequency.

Generally the chi-square statistic summarizes the discrepancies between the expected number of times each outcome occurs (assuming that the model is true) and the observed number of times each outcome occurs, by summing the squares of the discrepancies, normalized by the expected numbers, over all the categories (Dorak, 2006).

Data used in a chi-square analysis has to satisfy the following conditions

1. Randomly drawn from the population,
2. reported in raw counts of frequency,
3. measured variables must be independent,
4. observed frequencies cannot be too small, and
5. Values of independent and dependent variables must be mutually exclusive. (Dorak, 2006)

There are two types of chi-square test.

- The Chi-square test for goodness of fit which compares the expected and observed values to determine how well an experimenter's predictions fit the data.
• The Chi-square test for independence which compares two sets of categories to determine whether the two groups are distributed differently among the categories. (McGibbon, 2006).

3.5.1 Chi-square test for Goodness of Fit

Goodness of fit means how well a statistical model fits a set of observations. A measure of goodness of fit typically summarizes the discrepancy between observed values and the values expected under the model in question. Such measures can be used in statistical hypothesis testing, e.g., to test for normality of residuals, to test whether two samples are drawn from identical distributions.

Suppose a coin is tossed 100 times, the outcomes would be expected to be 50 heads and 50 tails. If 47 heads and 53 tails are observed instead, does this deviation occur because the coin is biased, or is it by chance?

3.5.2 Establish Hypothesis

The Null hypothesis for the above experiment is that the observed values are close to the predicted values. The alternative hypothesis is that they are not close to the predicted values. These hypothesis hold for all Chi-square goodness of fit tests. Thus in this case the null and alternative hypotheses correspond to: Null hypothesis:
The coin is fair
Alternative hypothesis: The coin is biased.

Table 3.0 Tabulated results of Observed and Expected frequencies

<table>
<thead>
<tr>
<th></th>
<th>Heads</th>
<th>Tails</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observed</td>
<td>47</td>
<td>53</td>
</tr>
<tr>
<td>Expected</td>
<td>50</td>
<td>50</td>
</tr>
</tbody>
</table>
3.5.3 Calculate the chi-square statistic

We calculate chi-square by substituting values for \( O \) and \( E \)
For Heads: \( X_2 = (47-50)2/50 = 0.12 \)
For Tails \( X_2 = (53-50)2/50 = 0.12 \)
The sum of these categories is \( 0.12 + 0.12 = 0.24 \)

3.5.4 Assessing significance levels

Significance of the chi-square test for goodness of fit value is established by calculating the degree of freedom \( \nu \) (the Greek letter nu) and by using the chi-square distribution table (Bissonnette, 2006). The \( \nu \) in a chi-square goodness of fit test is equal to the number of categories, \( c \), minus one (\( \nu = c-1 \)). This is done in order to check if the null hypothesis is valid or not, by looking at the critical chi-square value from the table that corresponds to the calculated \( \nu \). If the calculated Chi-square is greater than the value in the table, then the null hypothesis is rejected and it is concluded that the predictions made were incorrect. (Bissonnette, 2006). In the above experiment,

\[ \nu = (2-1) = 1. \]

A chi-square for this example at \( a = 0.05 \) and \( \nu = 1 \) is 3.84 which is greater than \( X_2 = 0.24 \). Therefore the null hypothesis is not rejected; hence the coin toss was fair.

3.5.5 Chi-square test for Independence

The chi-square test for independence is used to determine the relationship between two variables of a sample. [QMSS, 2006]. In this context independence means that the two factors are not related. [QMSS, 2006] Typically in social science research, we're interested in finding factors which are related, e.g. education and income, occupation and prestige, age and voting behaviour.
Example: We want to know whether boys or girls get into trouble more often in school. Below is the table documenting the frequency of boys and girls who got into trouble in school.

Table 3.1: Tabulated results of the Observed and Expected frequency [QMSS, 2006]

<table>
<thead>
<tr>
<th></th>
<th>Got into trouble (Observed)</th>
<th>Not in trouble (Observed)</th>
<th>Total</th>
<th>Got into trouble (Expected)</th>
<th>Not in trouble (Expected)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys</td>
<td>46</td>
<td>71</td>
<td>117</td>
<td>(40.97)</td>
<td>(76.02)</td>
</tr>
<tr>
<td>Girls</td>
<td>37</td>
<td>83</td>
<td>120</td>
<td>(42.03)</td>
<td>(77.97)</td>
</tr>
<tr>
<td>Total</td>
<td>83</td>
<td>154</td>
<td>237</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

To examine statistically whether boys got in trouble more often in school, we need to establish Hypothesis for the question.

3.5.6 Establish Hypothesis

The null hypothesis is that the two variables are independent or in this particular case is that the likelihood of getting in trouble is the same for boys and girls. The alternative hypothesis to be tested is that the likelihood of getting in trouble is not the same for boys and girls.

Cautionary Note

It is important to keep in mind that the chi-square test for independence only tests whether two variables are independent or not, it cannot address questions of which is greater or less (Dorak, 2006). Using the chi-square test for independence, it cannot be evaluated directly from the hypotheses who get more in trouble between boys and girls.

3.5.7 Calculate the expected value for each cell of the table

As with the goodness of fit example described earlier, the key idea of the chi-square test for independence is a comparison of observed and expected values.
Expected values are calculated based on the row and column totals from the table. The expected value for each cell of the table can be calculated using the following equation:

\[
\text{Expected value} = \frac{\text{Row total} \times \text{Column total}}{\text{Total for table (2)}}
\]

3.5.8 Calculate Chi-square statistic

With the values in Table 2, the chi-square statistic can be calculated using Equation 1 as follows:

\[
X^2 = \frac{(46-40.97)^2}{40.97} + \frac{(37-42.03)^2}{42.03} + \frac{(71-76.03)^2}{76.03} + \frac{(83-77.97)^2}{77.97} = 1.87
\]

3.5.9 Assessing significance levels

In the chi-square test for independence, the degree of freedom is equal to the number of columns in the table minus one multiplied by the number of rows in the table minus one.

I.e. \(\text{dof} = (r-1)(c-1) = 1\). Where \text{dof}, means degree of freedom.

Thus the value calculated from the formula above is compared with values in the chi-square distribution table (Bissonnette, 2006). The value returned from the table is \(p < 20\%\). Therefore the null hypothesis is not rejected; hence boys are not significantly more likely to get in trouble in school than girls.

Refer to appendix 3 for chi-square distribution table.

3.6 MAKING DECISION: A TEST OF AN HYPOTHESIS

The reasoning employed in testing a hypothesis bears a striking resemblance to the procedure used in a court trial. In trying a man for theft, the court assumes the accused innocent until proven guilty. The prosecution collects and present all available evidence in an attempt to contradict the “not guilty” hypothesis and hence to obtain a conviction. Consider a vaccine being tested to determine its effectiveness in preventing the common cold. The statistical problem portrays the vaccine as the accused. The hypothesis to be tested, called the null hypothesis, is that the vaccine
is ineffective. The evidence in the case is obtained in the sample drawn from the population of potential vaccine customers. The experimenter playing the role of the procedural believes that an alternative hypothesis is true, namely, that the vaccine is really effective. Hence the experimenter attempts to use the evidence contained in a sample to reject the null hypothesis, the contention that the vaccine is in fact, a very successful cold vaccine.

In making decisions, the experimenter is faced with two possible errors in rejecting or accepting the null hypothesis (Mendenhall/Reinmuth, 1982).

**TYPE 1 Error:** Rejecting the null hypothesis when it is true for a statistical test

**TYPE 2 Error:** Accepting the null hypothesis when it is false for a statistical test.

### 3.7 SIGNIFICANCE LEVEL

The probability of making a type 1 error is often called the significance of the statistical test, a term that originated in the following ways; the probability of the observed value of the test statistic, or some value even more contradictory to the null hypothesis, measures, in a sense, the weight of evidence favouring rejection.

The significance level represents a probability of observing a sample outcome more contradictory to Ho than the observed sample result if, in fact, Ho is true. The smaller the value of this probability, the heavier is the weight of the sample evidence for rejecting Ho.

### 3.8 SUMMARY

**Chapter three** (methodology) focused on the definition of methodology, sources of data (both primary and secondary data), reasons for questionnaire and the selected method of investigation.

More so it also covered the questionnaire design and the use of chi-square method to test the hypothesis drafted from the responses of the questionnaire.

While **chapter four** will focus on how the data are analysed and interpreted.
CHAPTER FOUR
PRESENTATION AND ANALYSIS OF DATA

Chapter three of the dissertation shows how the data was collected. This chapter will show how the data is analyzed and interpreted.

4.0 DATA ANALYSIS

Data are useful only after analysis. Data analysis involves converting a series of recorded observations into descriptive statements and/or inferences about relationship. (Frances, C, 1997)

During this research the collected data was analyzed by testing for association with the hypotheses using chi-square statistical tool.

Forty questionnaires were distributed to the management and staff of various gas companies, agents, marketers and consumers of LPG in Warri and other parts of Nigeria.

4.1 RESULTS

The Responses to the questionnaire are depicted in the table 4.0 below.

Table 4.0 Responses to Questionnaire (Appendix 1)

<table>
<thead>
<tr>
<th>QUESTIONS</th>
<th>NUMBER OF RESPONDENT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>YES</td>
</tr>
<tr>
<td>1a</td>
<td>23</td>
</tr>
<tr>
<td>B</td>
<td>21</td>
</tr>
<tr>
<td>2a</td>
<td>21</td>
</tr>
<tr>
<td>B</td>
<td>20</td>
</tr>
<tr>
<td>3a</td>
<td>22</td>
</tr>
<tr>
<td>B</td>
<td>21</td>
</tr>
<tr>
<td>4a</td>
<td>20</td>
</tr>
<tr>
<td>B</td>
<td>21</td>
</tr>
</tbody>
</table>
4.2 HYPOTHESIS

1. **HO:** High upfront cost of liquefied petroleum gas (LPG) does not affect the marketing of LPG in Warri Nigeria.

2. **HO:** Instability in the price of LPG does not affect the marketing of LPG in Warri Nigeria.

3. **HO:** Lower costs of other cooking fuels (biomass based fuel/kerosene) do not affect the marketing of LPG in Warri Nigeria.

4. **HO:** Ineffective transportation system does not affect the marketing of LPG in Warri Nigeria.

5. **HO:** Ineffective supply and distribution system does not affect the marketing of LPG in Warri Nigeria.

6. **HO:** Inappropriate pricing structure of LPG does not affect the marketing of LPG in Warri Nigeria.

7. **HO:** Inadequate awareness / enlightenment campaign on LPG does not
affect the marketing of LPG in Warri Nigeria.

8. **HO:** Poor state of cylinders in circulation does not affect the marketing of LPG in Warri Nigeria.

9. **HO:** Lack of proper implementation of government policies / gas strategies does not affect the marketing of LPG in Warri Nigeria.

10. **HO:** Ineffective organizational structure of LPG industries does not affect the marketing of LPG in Warri Nigeria.

11. **HO:** Ineffectiveness of regulatory body of LPG industry does not affect the marketing of LPG in Warri Nigeria.

### 4.3 TESTING FOR ASSOCIATION

The Chi-Squared Test of Association allows the comparison of two attributes in a sample of data to determine if there is any relationship between them. (Frances, C, 1997).

The idea behind this test is to compare the observed frequencies with the frequencies that would be expected if the null hypothesis of no association / statistical independence were true. By assuming the variables are independent, we can also predict an expected frequency for each cell in the contingency table.

If the value of the test statistic for the chi-squared test of association is too large, it indicates a poor agreement between the observed and expected frequencies and the null hypothesis of independence / no association is rejected.

In general, the null hypothesis is to be tested by a 2 by 2 contingency table. Association takes two forms depending on the experimental design used to collect the data. The two forms are test of independence and test of homogeneity. (Frances, C, 1997)

For this research test of independence is appropriate for testing for association.
4.4 TEST OF INDEPENDENCE

In a test of independence, the only number directly under control of the researcher is the overall sample size. (Frances, C, 1997). A sample size of 40 is drawn randomly and each object is classified according to the level of each of the two variables under study. Intuitively speaking, when these variables are independent, knowledge of classification level relative to one variable yields no information concerning its level relative to the other variable. Let's consider the first hypothesis. To state the null and research hypothesis, let us denote the two variables under study by A and B. The null hypothesis of no association is,

Ho: A and B are independent (no association). The research theory is

HA: A and B are not independent (an association exist)

The null hypothesis is that, high upfront cost of LPG does not affect the Marketing of LPG. The research theory is that upfront cost of LPG affects the marketing of LPG.

Table 4.1 shows the observed (from the questionnaire) and expected frequencies with estimated expectations in parenthesis. The question to be answered statistically is: Are these differences extreme enough to allow us to reject Ho: and conclude that high upfront cost of LPG affect the marketing of LPG.

<table>
<thead>
<tr>
<th>AFFECTS MARKETING OF LPG</th>
<th>YES (A)</th>
<th>NO (B)</th>
<th>TOTAL (C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>YES (1)</td>
<td>16(12.08)</td>
<td>3(8.93)</td>
<td>21</td>
</tr>
<tr>
<td>NO (2)</td>
<td>5(10.9)</td>
<td>14(8.08)</td>
<td>19</td>
</tr>
<tr>
<td>TOTAL (3)</td>
<td>23</td>
<td>17</td>
<td>40</td>
</tr>
</tbody>
</table>

TABLE 4.1 (a 2 by 2 contingency table)
We need a test statistic whose probability distribution is known under the assumption that \( H_0: \) is true.

### 4.5 THE MODEL

The model required is given as

\[
X = \sum \frac{(E_{ij} - N_{ij})^2}{E_{ij}}
\]  

(1)

Where \( X \) is the sum of all cells, \( E_{ij} \) be the observed frequency and \( N_{ij} \) the expected frequency.

It can be shown that the test statistic follows a chi-square distribution with one degree of freedom. Since the test is based on assessing how well the observed frequencies match or fit the ones expected if \( H_0: \) is true.

From the responses to the questionnaire on table 4.1, the expected frequency in (parenthesis) on the table can be calculated using this expression:

Expected (F) \( E = \frac{\text{Sum total of row 1 (C1) \times Sum total of column A (A3)}}{\text{Sum total of both totals of row 3 and column C (C3)}} \)

Where C3 is constant. Hence substituting values for the observed frequency, from the 2 by 2 contingency table 4.1

\[
E_{11} = \frac{21 \times 23}{40} = 12.08
\]

\[
E_{12} = \frac{21 \times 17}{40} = 8.93
\]

\[
E_{21} = \frac{23 \times 19}{40} = 10.93
\]

\[
E_{22} = \frac{17 \times 19}{40} = 8.08
\]
$E_{11} - E_{22}$ represent the expected frequencies for each cell.

To get the sum of all cells, we use equation 1

$$X = \Sigma [(E_{ij} - N_{ij})^2 / E_{ij}]$$

$$= (12.08 - 18)^2 + (8.93 - 3)^2 + (10.93 - 5)^2 + (8.08 - 14)^2$$

$$= 2.90 + 3.34 + 3.22 + 4.34 = 14.40$$

From the chi-square distribution table at one degree of freedom,

$X_2 = 10.83$ at level of significance of 0.001.

**DECISION**

The obtained value of 14.40 exceeds the tabulated value of 10.83 which is significant at the 0.001 level of significance. The null hypothesis can be rejected, and so conclude that the high upfront cost of LPG affects the marketing of LPG in Nigeria.

**HYPOTHESIS 2**

<table>
<thead>
<tr>
<th>AFFECTS MARKETING OF LPG</th>
<th>UNSTABLE PRICE OF LPG</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>YES</td>
<td>16(10.5)</td>
<td>20</td>
</tr>
<tr>
<td>NO</td>
<td>5(10.5)</td>
<td>20</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>21</strong></td>
<td><strong>19</strong></td>
</tr>
</tbody>
</table>

TABLE 4.2 (a 2 by 2 contingency table).

$$E_{11} = \frac{20 \times 21}{40} = 10.5$$
\[ E_{12} = \frac{20 \times 19}{40} = 9.5 \]

\[ E_{21} = \frac{20 \times 19}{40} = 10.5 \]

\[ E_{22} = \frac{20 \times 19}{40} = 9.5 \]

\[ X = \sum \left( \frac{(E_{ij} - N_{ij})^2}{E_{ij}} \right) \]

\[ = \frac{(10.5 - 16)^2}{10.5} + \frac{(9.5 - 4)^2}{9.5} + \frac{(10.5 - 5)^2}{10.5} + \frac{(9.5 - 15)^2}{9.5} = 12.13 \]

From the chi-square distribution table at one degree of freedom, \( X_2 = 10.83 \) at level of significance of 0.001.

**DECISION**

The obtained value of 12.13 exceeds the tabulated value of 10.83 which is significant at the 0.001 level of significance. The null hypothesis can be rejected and so conclude that instability in the price of LPG affects the marketing of LPG in Warri Nigeria.
HYPOTHESIS 3

<table>
<thead>
<tr>
<th>AFFECTS MARKETING OF LPG</th>
<th>LOWER COST OF OTHER COOKING FUEL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>YES</td>
</tr>
<tr>
<td>YES</td>
<td>17(11.55)</td>
</tr>
<tr>
<td>NO</td>
<td>5(10.45)</td>
</tr>
<tr>
<td>TOTAL</td>
<td>22</td>
</tr>
</tbody>
</table>

TABLE 4.3 (a 2 by 2 contingency table).

\[
E_{11} = \frac{21 \times 22}{40} = 11.55
\]

\[
E_{12} = \frac{21 \times 18}{40} = 9.45
\]

\[
E_{21} = \frac{22 \times 19}{40} = 10.45
\]

\[
E_{22} = \frac{18 \times 19}{40} = 8.55
\]

\[
X = \sum \frac{(E_{ij} - N_{ij})^2}{E_{ij}}
\]

\[
= (11.55 - 17)^2 + (9.45 - 4)^2 + (10.45 - 5)^2 + (14 - 8.55)^2 = 12.02
\]

47
From the chi-square distribution table at one degree of freedom, \( X_2 = 10.83 \) at level of significance of 0.001.

**DECISION**

The obtained value of 12.02 exceeds the tabulated value of 10.83 which is significant at the 0.001 level of significance. The null hypothesis can be rejected, and so conclude that lower cost of other cooking fuel like kerosene, wood etc does affect the marketing of LPG in Warri Nigeria.

**HYPOTHESIS 4**

<table>
<thead>
<tr>
<th>AFFECTS MARKETING OF LPG</th>
<th>YES (10.5)</th>
<th>NO (10.5)</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>YES</td>
<td>16</td>
<td>5</td>
<td>21</td>
</tr>
<tr>
<td>NO</td>
<td>4</td>
<td>15</td>
<td>19</td>
</tr>
<tr>
<td>TOTAL</td>
<td>20</td>
<td>20</td>
<td>40</td>
</tr>
</tbody>
</table>

TABLE 4.4 (a 2 by 2 contingency table).

\[
E_{11} = \frac{20 \times 21}{40} = 10.5
\]

\[
E_{12} = \frac{20 \times 21}{40} = 10.5
\]

\[
E_{21} = \frac{20 \times 19}{40} = 9.5
\]
\[ E_{22} = \frac{20 \times 19}{40} = 9.5 \]

\[ X = \sum [(E_{ij} - N_{ij})^2 / E_{ij}] \]

\[ = (10.5 - 16)^2 + (10.5 - 5)^2 + (9.5 - 4)^2 + (9.5 - 15)^2 = 12.13 \]

From the chi-square distribution table at one degree of freedom \( X_2 = 10.83 \) at level of significance of 0.001

**DECISION**

The obtained value of 12.13 exceeds the tabulated value of 10.83 which is significant at the 0.001 level of significance. The null hypothesis can be rejected, and so conclude that ineffective transport system affects the marketing of LPG in Warri Nigeria

**HYPOTHESIS 5**

<table>
<thead>
<tr>
<th></th>
<th>Ineffective Supply and Distribution System</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Affects Marketing of LPG</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>Yes</td>
<td>20(14.40)</td>
</tr>
<tr>
<td>No</td>
<td>4(10.20)</td>
</tr>
<tr>
<td>Total</td>
<td>24</td>
</tr>
</tbody>
</table>

*TABLE 4.5 (a 2 by 2 contingency table).*
\[ E_{11} = \frac{23 \times 24}{40} = 14.40 \]

\[ E_{12} = \frac{23 \times 16}{40} = 9.20 \]

\[ E_{21} = \frac{24 \times 17}{40} = 10.20 \]

\[ E_{22} = \frac{17 \times 16}{40} = 6.8 \]

\[ X = \Sigma \frac{[(E_{ij} - N_{ij})^2]}{E_{ij}} \]

\[ = \frac{(14.40 - 20)^2 + (9.20 - 3)^2 + (10.20 - 4)^2 + (6.8 - 13)^2}{14.40} = 15.77 \]

From the chi-square distribution table at one degree of freedom \( X^2 = 10.83 \) at level of significance of 0.001

**DECISION**

The obtained value of 15.77 exceeds the tabulated value of 10.83 which is significant at the 0.001 level of significance. The null hypothesis can be rejected, and so conclude that ineffective supply and distribution system affects the marketing of LPG in Warri Nigeria.
**HYPOTHESIS 6**

<table>
<thead>
<tr>
<th>AFFECTS MARKETING OF LPG</th>
<th>YES</th>
<th>NO</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>YES</td>
<td>20(15)</td>
<td>4(9)</td>
<td>24</td>
</tr>
<tr>
<td>NO</td>
<td>5(10)</td>
<td>11(6)</td>
<td>16</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>25</strong></td>
<td><strong>15</strong></td>
<td><strong>40</strong></td>
</tr>
</tbody>
</table>

TABLE 4.6 (a 2 by 2 contingency table).

\[
E_{11} = \frac{24 \times 25}{40} = 15
\]

\[
E_{12} = \frac{24 \times 15}{40} = 9
\]

\[
E_{21} = \frac{25 \times 16}{40} = 10
\]

\[
E_{22} = \frac{16 \times 15}{40} = 6
\]

\[
X = \sum \left[\frac{(E_{ij} - N_{ij})^2}{E_{ij}}\right]
\]

\[
= \frac{(15 - 20)^2}{15} + \frac{(9 - 4)^2}{9} + \frac{(10 - 5)^2}{10} + \frac{(6 - 11)^2}{6} = 11.12
\]

From the chi-square distribution table at one degree of freedom $X^2 = 10.83$ at level of significance of 0.001
DECISION

The obtained value of 11.12 exceeds the critical value of 10.83 which is significant at the 0.001 level of significance. The null hypothesis can be rejected, and so conclude that inappropriate pricing structure affects the marketing of LPG in Warri Nigeria.

HYPOTHESIS 7

<table>
<thead>
<tr>
<th></th>
<th>INADEQUATE AWARENESS/ENLIGHTENMENT CAMPAIGN</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AFFECTS MARKETING OF LPG</td>
</tr>
<tr>
<td></td>
<td>YES</td>
</tr>
<tr>
<td></td>
<td>NO</td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
</tr>
</tbody>
</table>

TABLE 4.7 (a 2 by 2 contingency table).

\[
E_{11} = \frac{24 \times 23}{40} = 13.8
\]

\[
E_{12} = \frac{24 \times 17}{40} = 10.2
\]

\[
E_{21} = \frac{23 \times 16}{40} = 9.2
\]

\[
E_{22} = \frac{16 \times 17}{40} = 6.8
\]

\[
X = \sum \frac{(E_{ij} - N_{ij})^2}{E_{ij}}
\]
\[ (13.8 - 20)^2 + (10.2 - 4)^2 + (9.2 - 3)^2 + (6.8 - 13)^2 = 16.38 \]

From the chi-square distribution table at one degree of freedom, \( X^2 = 10.83 \) at level of significance of 0.001

**DECISION**

The obtained value of 16.38 exceeds the tabulated value of 10.83 which is significant at the 0.001 level of significance. The null hypothesis can be rejected, and so conclude that inadequate awareness/enlightenment campaign on LPG affects the marketing of LPG in Warri Nigeria.

**HYPOTHESIS 8**

<table>
<thead>
<tr>
<th>AFFECTS MARKETING OF LPG</th>
<th>YES</th>
<th>NO</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>YES</td>
<td>19(13.8)</td>
<td>4(9.2)</td>
<td>23</td>
</tr>
<tr>
<td>NO</td>
<td>5(10.2)</td>
<td>12(6.8)</td>
<td>17</td>
</tr>
<tr>
<td>TOTAL</td>
<td>24</td>
<td>16</td>
<td>40</td>
</tr>
</tbody>
</table>

TABLE 4.8 (a 2 by 2 contingency table).

\[
E_{11} = \frac{24 \times 23}{40} = 13.8
\]

\[
E_{12} = \frac{23 \times 16}{40} = 9.2
\]
\[ E_{21} = \frac{17 \times 24}{40} = 10.2 \]

\[ E_{22} = \frac{16 \times 17}{40} = 6.8 \]

\[ X = \sum \frac{[(E_{ij} - N_{ij})^2]}{E_{ij}} \]

\[ = (13.8 - 19)^2 + (9.2 - 4)^2 + (10.2 - 5)^2 + (6 - 8.12)^2 = 11.58 \]

From the chi-square distribution table at one degree of freedom, \( X_2 = 10.83 \) at level of significance of 0.001

**DECISION**

The obtained value of 11.53 exceeds the tabulated value of 10.83 which is significant at the 0.001 level of significance. The null hypothesis can be rejected, and so conclude that the poor state of cylinders in circulation affects the marketing of LPG in Warri Nigeria.

**HYPOTHESIS 9**

<table>
<thead>
<tr>
<th></th>
<th>LACK OF PROPER IMPLEMENTATION OF GOVERNMENT POLICIES/STRATEGIES ON GAS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AFFECTS MARKETING OF LPG</td>
</tr>
<tr>
<td>YES</td>
<td>16(10.5)</td>
</tr>
<tr>
<td>NO</td>
<td>54(9.5)</td>
</tr>
<tr>
<td>TOTAL</td>
<td>20</td>
</tr>
</tbody>
</table>

TABLE 4.9 (a 2 by 2 contingency table).
\[ E_{11} = \frac{21 \times 20}{40} = 10.5 \]
\[ E_{12} = \frac{21 \times 20}{40} = 10.5 \]
\[ E_{21} = \frac{20 \times 19}{40} = 9.5 \]
\[ E_{22} = \frac{20 \times 19}{40} = 9.5 \]

\[ X = \sum [ (E_{ij} - N_{ij})^2 / E_{ij} ] \]

\[ = \frac{(10.5 - 16)^2}{10.5} + \frac{(10.5 - 5)^2}{10.5} + \frac{(9.5 - 4)^2}{9.5} + \frac{(9.5 - 15)^2}{9.5} = 12.13 \]

From the chi-square distribution table at one degree of freedom, \(X_2 = 10.83\) at level of significance of 0.001

**DECISION**

The obtained value of 12.13 exceeds the tabulated value of 10.83 which is significant at the 0.001 level of significance. The null hypothesis can be rejected, and so conclude that the lack of proper implementation of government policies and gas strategies affects the marketing of LPG in Warri Nigeria.
HYPOTHESIS 10

<table>
<thead>
<tr>
<th>AFFECTS MARKETING OF LPG</th>
<th>YES</th>
<th>NO</th>
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<tbody>
<tr>
<td>YES</td>
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<td>3(9.35)</td>
<td>22</td>
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<tr>
<td>NO</td>
<td>4(10.35)</td>
<td>14(7.65)</td>
<td>18</td>
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<tr>
<td>TOTAL</td>
<td>23</td>
<td>17</td>
<td>40</td>
</tr>
</tbody>
</table>

**TABLE 4.10** (a 2 by 2 contingency table).

\[
E_{11} = \frac{22 \times 23}{40} = 12.65
\]

\[
E_{12} = \frac{22 \times 17}{40} = 9.35
\]

\[
E_{21} = \frac{23 \times 18}{40} = 10.35
\]

\[
E_{22} = \frac{17 \times 18}{40} = 7.65
\]

\[
X = \sum \left( \frac{(E_{ij} - N_{ij})^2}{E_{ij}} \right)
\]

\[
= \frac{(12.65 - 19)^2 + (9.35 - 3)^2 + (10.35 - 4)^2 + (7.65 - 14)^2}{12.65 \quad 9.35 \quad 10.35 \quad 9.5} = 16.67
\]
From the chi-square distribution table at one degree of freedom, $X^2 = 10.83$ at level of significance of 0.001

**DECISION**

The obtained value of 16.67 exceeds the tabulated value of 10.83 which is significant at the 0.001 level of significance. The null hypothesis can be rejected, and so conclude that ineffective organizational structure of LPG affects the marketing of LPG in Warri Nigeria.

**HYPOTHESIS 11**

<table>
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<th>AFFECTS MARKETING OF LPG</th>
<th>YES</th>
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<td><strong>40</strong></td>
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</tbody>
</table>

**TABLE 4.11** (a 2 by 2 contingency table).

$$E_{11} = \frac{23 \times 24}{40} = 14.40$$

$$E_{12} = \frac{23 \times 16}{40} = 9.20$$

$$E_{21} = \frac{17 \times 24}{40} = 10.20$$
\[ E_{22} = \frac{16 \times 17}{40} = 6.8 \]

\[ X = \sum \left( \frac{(E_{ij} - N_{ij})^2}{E_{ij}} \right) \]

\[ = (14.40 - 20)^2 + (9.20 - 3)^2 + (10.20 - 4)^2 + (6.8 - 13)^2 = 15.77 \]

From the chi-square distribution table at one degree of freedom, \( X_2 = 10.83 \) at level of significance of 0.001

**DECISION**

The obtained value of 15.77 exceeds the tabulated value of 10.83 which is significant at the 0.001 level of significance. The null hypothesis can be rejected, and so conclude that the ineffectiveness of the regulatory body of LPG industry affects the marketing of LPG in Warri Nigeria.

Therefore, from the above it can be concluded that:

1. High up-front cost of LPG constitutes a hurdle to the poor.

2. The actual and potential LPG consumers face a market place of volatile pricing

3. The lesser cost of other fuels like kerosene, wood, etc undermines the use of LPG.

4. Coastal transportation is an effective means of supplying LPG but has been hampered by low polarization resulting in high shipping cost, including demurrage.

5. The domestic LPG market depends effectively on refineries’ and they have proved to be an unreliable supplier.

6. The awareness/enlightenment campaign on the potential of LPG is inadequate.
7. Most of the existing cylinders are in poor condition, because of age and lack of proper maintenance.

8. Government policies have not been supportive of the LPG industries and its actual and potential customers.

4.6 DISCUSSION OF FINDINGS

ACCESS TO THE POOR

The initial cost of becoming an LPG consumer is a real barrier for the poor, not least because consumer credit is a rarity in Nigeria. Uncertainty regarding availability and pricing, together with safety concerns, are deterrents.

PRICING OF LPG / INDUSTRY STRUCTURE

The industry comprises of a variety of players – large and small but lacks a single authoritative and representative organization to be its voice and to provide focus.

Marketers need to recover control and margins from distributors and resellers. A more orderly market, adequately supplied and properly controlled, will be reflected in more stable competitive pricing.

LPG SUPPLY / REFINERIES / TRANSPORTATION / DISTRIBUTION.

The industries effectively depend upon the refineries and imports for supply and, at times supplies have been inefficient, overpriced and unreliable. Inadequate facilities and low priority have consistently impeded lifting when LPG was available at the refineries. Large quantities of LPG are being exported while the domestic market is undersupplied. Also inland transportation infrastructure for LPG is underdeveloped.

The butanization depots and some LPG plants have been left idle and are in various states of disrepair. Coastal shipping and road transport incur high costs and suffer low operational efficiency; also many road tankers are dilapidated.

SAFETY / IMAGE / CYLINDERS

While many consumers express satisfaction with LPG, there is a perception that is unsafe. No statistical record of accidents was found but the incidence may be
significant, giving the condition of cylinders and prevailing circumstances. Despite positive consumer attitudes towards the product, the LPG industry has a poor public image. Media coverage tends to highlight the industry problem.

Many cylinders are in poor condition from age, and lack of proper maintenance. Leaking cylinder valves are common. Unauthorized cylinder filling has helped to undermine the former disciplines of periodic inspection and maintenance. There is no clear accountability and traceability in the event of an accident or of under filling.

AWARENESS / ENLIGHTENMENT CAMPAIGN

The general public is under informed about the many benefits of LPG over lesser form of fuel for domestic cooking (kerosene, biomass based fuel).

GOVERNMENT POLICIES / NATIONAL GAS STRATEGY

The commendable government initiative with butanization has not been sustained and, while Nigeria has become a major LPG exporter, nothing has been done to secure domestic supply from indigenous sources other than the all too uncertain refinery production. Gas strategy planning is receiving serious attention but appears to be focused on natural gas to the exclusion of LPG. Yet access to LPG can advance the federal government mission to eradicate poverty through modern energy provision.
CHAPTER FIVE

5.0 SUMMARY / CONCLUSION AND RECOMMENDATION

SUMMARY OF FINDING / CONCLUSION

The best prospect for extending LPG access to everybody is from a well rounded industry. No realistic prospect of achieving this second objective in a sustainable manner is feasible, until the first objective has been implemented, that is, until sector recovery has been achieved.

The LPG industries in Nigeria have experienced a dramatic contraction of its market in recent years. Development strategies have given way to survival strategies, but with little consolidation, plants have been closed to await better times.

Actual and potential LPG consumers face a market place of uncertainty supply and extremely volatile pricing. End users prices are effectively set by final resellers many of whom exploit a real contrived scarcity to raise prices arbitrarily. When LPG becomes available, prospective customers are deterred by the uncertainty regarding future prices and availability. A less turbulent market is essential for sector recovery, which is to maintain users and encourage prospective LPG users to make the necessary initial cash outlay.

The successful attainment of the study objectives depends critically on consistent government policy, clearly stated and demonstratably supportive. Key policy issues should bring the LPG sector into the government gas policy, zero flaring objectives for 2010, and the overall gas master plan and strategy.

5.1 ACCESS TO THE POOR.

Abundant supply of LPG will help revitalize the industry and extend availability geographically and across socioeconomic groups. It will deal with the issue of product availability and price stability. Affordability, however would require the gamut of facilitating targeted measures such as lowering the costs for cylinders and equipment by tax and duty exemption, reading access of soft financing (especially in per urban and rural areas) and other complementary measures without which the high up front and investments and initial cost of becoming an LPG consumer will remain a barrier to access to many especially for the poor.
5.2 INDUSTRY STRUCTURE

The domestic LPG market is highly fragmented and the industry acknowledges the need for a single and more representative LPG association, to realize its full potential and for effective communication with the government.

5.3 SUPPLY/REFINERIES

The domestic LPG market depended effectively on the past on the refineries. The refineries have proved to be unreliable suppliers to the extent that currently the domestic market depends on import and will continue to do so in the immediate short term. Consumers have switched from LPG to kerosene, wood, which have been cheaper and readily available.

5.4 DISTRIBUTION AND TRANSPORTATION

Currently, road transport is the only practical option for inland distribution, other modes of transport such as rail, road and pipelines as well as additional capacity of existing stock, will be required.

5.5 SAFETY/CYLINDERS/ENLIGHTENMENT CAMPAIGN

There is a strong perception that LPG is unsafe. Most of the cylinders in circulation are in poor condition from the lack of proper maintenance and renewal.

5.6 LEGISLATION/REGULATION

The legal framework for the sector is very weak and needs serious upgrading and consolidation to enable the sector to develop as a standalone industry.

5.7 HOSEHOLD COOKING AND LIGHTING DEMAND

The research reveals a significant suppressed demand for LPG. Many household are forced to use kerosene when the preferred cooking fuel is LPG.

5.8 RECOMMENDATIONS

The following recommendations are hereby put forward as a way towards effective and efficient marketing of LPG in Warri Nigeria.

5.8.1 POLICY/REGULATION

1. Adopting a policy of LPG promotion as a preferred cooking fuel where natural gas is not yet available.

2. Harmonizing energy and fiscal policies to ensure that neither tax nor tax differentials impede LPG sector recovery and access to the poor.
3. The federal government of Nigeria should establish a regulatory structure and process which will facilitate the policy of LPG promotion while protecting public and consumer interest.

5.8.2 AVAILABILITY/DISTRIBUTION

1. Introduce new sources of LPG supply for domestic market by:
   - Diverting LPG destined for export into domestic market
   - Development of associated gas separation/fractionation Projects specifically to supply the domestic market.

2. Improve lifting of LPG when it is available at the refineries.

3. Reactivate the butanization depots so that they can become the primary LPG supply/distribution depot as originally envisaged.

4. Rationalize the bottle necks associated with both inland and coastal LPG transportation.

5.8.3 INSTITUTIONAL DEVELOPMENT

1. Establish a new more fully representative LPG industry association which will;
   a) Be empowered and resourced to deal effectively with industrial issues
   b) Provide focus for dialogue with stakeholders
   c) Promote the benefits and safe use of LPG
   d) Secure recognition from policymakers and the regulatory authorities
   e) Gain access to global LPG expertise and institutions through membership of the world LPG association.

2. Prepare an institution development plan for LPG sector by:
   a) Sourcing for funds and practical assistance from agencies which are active in institutional development
   b) Enlisting appropriate specialist support to develop the plan.
5.8.4 SAFETY / STANDARDS

1. Revive safety awareness and practice within the industry by;
   a) Adopting the world LPG association guidelines on safety and good industry practice

2. Rationalize cylinders sizes and facilitate safe, easy exchange by standardizing cylinder valves and regulators.

3. Remove unsafe cylinders progressively from the market and replace with safe cylinders

4. Improve consumer safety by:
   b) Initiating safety awareness programmes
   c) Addressing the particular needs of new users

5.8.5 ACCESS TO THE POOR

1. Adopt LPG access to the poor as an objective of government policy

2. Evaluate alternative, less expensive modes of servicing the poor without compromising safety by facilitating access to micro financing and soft credit for the acquisition of first equipment.

3. Source affordable LPG appliances which meet the needs of poor households, rural and urban.

4. Promote and monitor consumer credit schemes which facilitate access to LPG

5.8.6 INVESTMENT NEEDS AND OPPORTUNITIES

1. Establish the market and regulatory conditions for sustainable sector recovery and future expansion

2. Promote awareness of the potential of the market through investment seminar and media briefing

3. Target financial institutions – domestic and institutional – which have declared interest in the Nigerian and oil gas sector.

4. Establish a point of contact for prospective investors to obtain details of specific projects identified in the study, that is:
a) Primary (coastal, rail, pipeline, road) transportation
b) Primary storage / supply depots LPG supply
c) Cylinders and equipment manufacture
d) Cylinders filling / retail / maintenance infrastructure.

5.8.7 STEERING COMMITTEE

i. Ensure that the steering committee is adequately resourced to enable it to fulfill its functions.

ii. Provide the steering committee with appropriate guidelines, terms of reference, and a clear initial, time bound, and work plan.
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APPENDIX 2

QUESTIONNAIRE

ACADEMIC RESEARCH PURPOSES ONLY

(PRIVATE & CONFIDENTIAL)

1. Is the upfront cost of liquefied petroleum gas (LPG) and stove together an hurdle
   YES ☐ NO ☐
   Does this affect the marketing of LPG in Warri (Nigeria)? YES ☐ NO ☐

2. Is the price of LPG highly unstable?
   YES ☐ NO ☐
   Does this affect the marketing of LPG in Warri (Nigeria)? YES ☐ NO ☐

3. Does other fuel cost (wood / biomass based / kerosene) undermine the use of LPG?
   YES ☐ NO ☐
   Does this affect the marketing of LPG in Warri Nigeria? YES ☐ NO ☐

4. Is the transportation system of LPG to end users effective?
   YES ☐ NO ☐
   Does this affect the marketing of LPG in Warri Nigeria? YES ☐ NO ☐
5. Is the supply and distribution system of LPG in Warri Nigeria effective?  
   YES ☐  NO ☐  
   Does this affect the marketing of LPG in Warri Nigeria?  YES ☐  NO ☐  

6. Is there an attractive pricing structure to encourage high levels of gas utilization?  
   YES ☐  NO ☐  
   Does this affect the marketing of LPG in Warri Nigeria?  YES ☐  NO ☐  

7. Is there adequate awareness / enlightenment campaign on LPG?  
   YES ☐  NO ☐  
   Does this affect the marketing of LPG in Warri Nigeria?  YES ☐  NO ☐  

8. Is the use of LPG as a cooking fuel safe?  
   YES ☐  NO ☐  
   Does this affect the marketing of LPG in Warri Nigeria?  YES ☐  NO ☐  

9. Does the government have any fiscal incentive for LPG utilization in Warri Nigeria?  
   YES ☐  NO ☐  
   Does this affect the marketing of LPG in Warri Nigeria?  YES ☐  NO ☐  

10. Is the response to the gas policy incentives appreciable?  
    YES ☐  NO ☐  
    Does this affect the marketing of LPG in Warri Nigeria?  YES ☐  NO ☐  

11. Can the market for LPG be expanded?  YES ☐  NO ☐  
    Does this affect the marketing of LPG in Warri Nigeria?  YES ☐  NO ☐  

12. Are most of the cylinders in circulation in poor condition?  
    YES ☐  NO ☐  
    Does this affect the marketing of LPG in Warri Nigeria?  YES ☐  NO ☐  

13. Is there government policy / gas strategy to support the use of LPG?  
    YES ☐  NO ☐
14  Is the organizational structure in LPG industry effective?

YES  NO

Does this affect the marketing of LPG in Warri Nigeria?

YES  NO

15  Is the regulatory body of the LPG industry effective?

YES  NO

Does this affect the marketing of LPG in Warri Nigeria?

YES  NO
APPENDIX 3

The Chi-Squared Distribution Table

Table of Chi-square statistics

t-statistics
F-statistics with other P-values: $P=0.05$ | $P=0.01$ | $P=0.001$

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### APPENDIX 4

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