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Health Consequences of Using Liquefied Petroleum Gas as an Alternative Fuel in Gaza Governorates: KAP of Car Drivers

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M.PH. Thesis

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Thesis Approval

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Dedication

I dedicate this simple work …..

To my father and my mother,
To my wife and daughters,
To my brothers and sisters,

To all those who gave me every opportunity for success.

Mohammed Ahmed Abu Rahma

Declaration

I certify that this thesis submitted for the degree of Master is the result of my own research, except where otherwise acknowledged and that this thesis (or any part of the same) has not been submitted for a higher degree to any other university or institution.

Mohammed
Signed ……………….

Mohammed A. Abu Rahma

Date: December 20, 2008

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The researcher

Mohammed A. Abu Rahma

Abstract

The use of liquefied petroleum gas (LPG) as an alternative car fuel has been documented extensively in recent years. Car emissions continue to attract the attention of public health specialists and environmentalists, not only because of their adverse effects on global climate, but also because many organic compounds found in automobile emissions have adverse health effects on humans and other living organisms and ecosystems. Recently, it is generally accepted that the emissions from LPG powered vehicles are less than those from the gasoline or diesel fuelled equivalents.

The present study was aimed at the investigation of the health status of the car drivers in relation to type of fuel they used, meanwhile it also aimed at evaluation of knowledge, attitude and practices (KAP) of vehicle drivers toward the use of LPG.

Close ended questionnaire and measurements of volatile organic compounds (VOC) were the main tools of the study. Two hundred fifty five questionnaires were distributed. Appreciatively, 230 drivers filled the questionnaire with a total response rate of 90.2 %.

The results showed that non of the cars was authorized to work on LPG. However, 42.6% of car engines are powered with LPG, 48.7% with diesel, and only 8.7% with gasoline. All respondent drivers revealed a knowledge about the use of LPG as car fuel, while 67.0% of them have knowledge about the methodology for LPG switching, with car technicians were the major source of knowledge.

About 76.1% of the drivers attributed LPG switching to economical impacts of LPG. While low percentages (4.30%) of drivers believed in the health and environmental advantages of LPG.

The majority (81.3%) of the drivers showed a good knowledge with regard to the increased injuries and impairments of LPG engine as well as to negative change of LPG engine mechanical power. While, nearly half of the drivers expected a reduction of 20-60 % in fuel costs when switching to LPG.
Diesel was the favored car fuel for 72.0% of diesel and gasoline (D/G) drivers, while gasoline was the favored fuel of 73.5% of the LPG drivers. Significantly high percentage

(66.3%) of LPG drivers supported the introduction of LPG as car fuel and they greatly preferred it to be introduced under legal and official conditions, while the majority (81.1%) of D/G drivers did not support the LPG as car fuel even under legal and official conditions. The environmental and health positive impacts of LPG were not among the attitudes of drivers for recommending LPG as car fuel, where the majority (78.3%) of drivers supported the economical point of view in recommending LPG as car fuel.

More than 70.0% of LPG drivers expressed no negative changes on their health status after switching to LPG. While 59.1% of the D/G drivers reported a negative change in health status due to driving. The mean health complains score percentage (MHCSP) significantly favors LPG as better fuel on driver health. Drivers using LPG showed the lowest MHCSP followed by diesel users, while gasoline users showed the highest MHCSP.

All categories of cars showed more or less degree of VOC emissions, however the majority of the cars revealed the lowest emission level of ≤ 20 ppm. Large amount of VOC <50 ppm not recorded in any selected cars in the present study. The lowest amount of VOC was recorded in diesel-based engines, followed by LPG-based engines, while gasoline-based engines showed the highest VOC score. For all fuel types, direct and significant correlation was found between the MHCSP and the measured VOC.

In conclusion, the present study emphasizes a considerable percentage of LPG cars in the Gaza Strip. All LPG switching were performed illegally and by unauthorized technicians. The overall evaluation of KAP of drivers toward the use of LPG as alternative fuel demonstrated relatively unsatisfactory results. The public health and environmental soundness of LPG were not among the concerns of the majority of drivers who are forced to LPG switching either due to scarcity or elevated prices of traditional fuels. Last but not least, if the responsible parties and ministries are indented to authorize LPG switching, a comprehensive, informative, awareness, and advertising programs should be organized very well and aiming at the enhancement of the people to LPG switching with more concentration on public health and environmental concerns.

الملخص

لقد شهدت السنوات الأخيرة الكثير من الأبحاث و الدراسات العلمية الخاصة باستعمال الغاز البترولي المسال LPG كوقود بديل لوسائل المواصلات، و كان لمخاطر المواد المنبعثة من عوادم احتراق وقود المركبات الاهتمام الأكبر بين المعنيين بمجالات الصحة العامة و البيئية ، و ذلك ليس بسبب التأثيرات الضارة على مناخ الكرة الأرضية فحسب بل و بسبب العديد من المركبات العضوية المنبعثة من عوادم احتراق وقود المركبات والتي لها تأثير خطير على صحة الإنسان و الكائنات الحية و الأنظمة البيئية المختلفة. و حديثا تم التأكد و بالدراسات العلمية أن كمية و نوعية الانبعاثات من المركبات التي تعمل بـالغاز البترولي المسال هي اقل من تلك الانبعاثات التي تنتج عن عوادم المركبات التي تعمل بالبنزين أو الديزل.

هدفت الدراسة الحالية إلى معرفة و تقييم الحالة الصحية لسائقي السيارات حسب نوعية الوقود المستخدم في مركباتهم, و أيضا هدفت إلى تقييم معرفة وتوجهات أو ميول وممارسات سائقي المركبات نحو استعمال الغاز البترولي المسال كمصدر وقود بديل. شملت أدوات البحث على تعبئة استبيانات و كذلك عمل قياسات على المركبات العضوية المتطايرة (VOC) لتحديد كمية تسرب هذه المركبات الكيمائية في السيارات جميعا. لقد تم توزيع مائيين وخمس وخمسين ورقة استبانه علي السائقين و تم تعبئة 230 من أصل 255 استبانه من السائقين، أي بمعدل استجابة 90.2%.

أظهرت النتائج بأنه لا توجد أي سيارة مصرح لها للعمل ب الغاز البترولي المسال، بينما فعليا هناك 42.6%من محركات السيارات تعمل بـالغاز البترولي المسال و 48.7% بالديزل ,و 8.7% فقط بالبنزين. جميع السائقين الذين شملتهم الدراسة اظهروا معرفة حول استعمال الغاز البترولي المسال كوقود بديل لمحركات السيارات, بينما ثلثي السائقين لديهم معرفة حول آلية التحويل للعمل ب الغاز البترولي المسال و كان مصدر المعرفة الرئيسي للسائقين هو فنيو إصلاح السيارات.

لقد عزا ما يزيد عن ثلاثة أرباع السائقين تحولهم لاستخدام الغاز البترولي المسال إلى العوامل الاقتصادية، بينما نسبة ضئيلة (4.30%) من السائقين يعتقدون بالمميزات و المنافع الايجابية لـلغاز البترولي المسال على النواحي الصحية والبيئية. غالبية السائقين (81.3%) اظهروا معرفة جيدة حول احتمالية زيادة الأعطال على محركات المركبات التي تعمل بـالغاز البترولي المسال، إضافة إلي التغير السلبي و نقص القدرة الميكانيكية للمحركات التي تعمل بـالغاز البترولي المسال مقارنة مع محركات الديزل أو البنزين. كما و يتوقع نصف السائقين تقريبا انخفاض تكاليف الوقود بنسبة 20-60% عند استعمال الغاز البترولي المسال.
أظهرت النتائج أيضا بان البنزين هو الوقود المفضل لما يقارب 73.5% من سائقي المركبات المشغلة بـالغاز البترولي المسال، و أن الديزل هو الوقود المفضل لـ 72.0 % من سائقي المركبات التي تعمل بالديزل أو البنزين. إن ما يعادل ثلثي سائقي مركبات الغاز البترولي المسال و بدلالة إحصائية جوهرية عالية يدعمون

التوجه نحو استخدام الغاز البترولي المسال كوقود بديل للسيارات و إن الغالبية العظمى منهم تدعم أن يكون ذلك تحت ظروف قانونية و معتمدة رسميا. بينما غالبية سائقي البنزين/الديزل (81.1%) لم يؤيدوا استخدام الغاز البترولي المسال كوقود للسيارات حتى تحت الظروف قانونية والرسمية. إن المنافع الايجابية على المحوريين البيئي والصحي للغاز البترولي المسال لم تكن بين توجهات و ميول السائقين للتوصية و الترويج لاستخدام الغاز البترولي المسال كوقود بديل للسيارات، بينما ما يزيد عن ثلاثة أرباع السائقين يعتبرون التوجه النفعي الاقتصادي كنقطة انطلاق للترويج و الإعلان عن الغاز البترولي المسال.

أما فيما يتعلق بالناحية الصحية، فأكثر من 70.0% من سائقي مركبات الغاز البترولي المسال لم يعبروا عن أي تغيرات سالبيه على حالتهم الصحية بعد استعمالهم الغاز البترولي المسال ، بينما 59.1% من سائقي البنزين/الديزل اخبروا عن تغير سلبي على حالتهم الصحية نتيجة قيادتهم للمركبات. كما أن معدل الشكاوي الصحية لدي السائقين تظهر أن الغاز البترولي المسال كوقود أفضل على صحة السائقين، يليه الديزل بينما سائقي مركبات البنزين كان لديهم المعدل الأعلى من الشكاوى الصحية.

جميع السيارات المشمولة بالدراسة أظهرت درجة معينة من انبعاثات المركبات العضوية المتطايرة، و لكن غالبية السيارات قد أظهرت مستوى متدن للانبعاث $\leq$ 20 جزء في المليون ولحسن الحظ فان درجات عالية من الانبعاث $\leq$ 50 جزء في المليون لم تسجل في أي من السيارات قيد الدراسة. إن ادني معدل للمركبات العضوية المتطايرة قد تم تسجيله في المحركات التي تعتمد على الديزل, ثم يتبعها المحركات المعتمدة على الغاز البترولي المسال بينما المحركات المعتمدة على البنزين أظهرت المعدل الأعلى . كما انه تم رصد علاقة ذات دلالة إحصائية جوهرية لجميع الفئات بين معدل الشكاوي الصحية للسائقين و معدل انبعاث المركبات العضوية المتطايرة من السيارات.

استنتاجا، فان الدراسة الحالية تؤكد وجود نسبة مئوية جوهرية من السيارات التي تستخدم الغاز البترولي المسال كوقود في قطاع غزة ، و أن عمليات تحويل المحركات للعمل بالغاز البترولي المسال تمت بواسطة فنيو سيارات غير مخولين بهذا العمل. إن التقييم العام لمعرفة و توجه وممارسات السائقين نحو استخدام الغاز البترولي المسال كوقود بديل قد اظهر نتائج غير مرضية نسبيا. إن المنافع الصحي والبيئية للغاز البترولي المسال لم تكن ضمن اهتمامات ووعي غالبية السائقين الذين اضطروا لاستخدامه نتيجة ندرة أو ارتفاع أسعار الوقود التقليدي. كما أن عدم تغير أو تردي الحالة الصحية لسائقي مركبات الغاز البترولي المسال ربما تشجع السائقين الآخرين على استخدامه لمحركات السيارات.

في النهاية، فإذا توجهت السلطات المعنية نحو السماح و اعتماد استعمال الغاز البترولي المسال لتشغيل السيارات, فيجب تنظيم برامج إعلامية وإعلانية توعوية شاملة هادفة إلى تشجيع السائقين و الجمهور نحو استخدام الغاز البترولي المسال و مركزين على الميزات و التأثيرات الايجابية و النافعة على مستويي الصحة العامة و البيئية.

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Definitions

Diesel: Diesel fuel comes from the residue of the crude oil after the more volatile fuels, such as gasoline and kerosene, are removed during the petroleum refining process (Engine Mechanics, 2008).

Fuel: Is a flammable liquid hydrocarbons, which will not burn or explode in a liquid state; however, when the vapors from these liquids are mixed with air at certain temperatures, they form a highly flammable and explosive mixture (United State Marine Corps, 2008).

Gasoline: Is a mixture of compounds, called hydrocarbons, derived from petroleum crude oil plus a small amount of a few additives to improve its stability, control deposit formation in engines, and modify other characteristics (Chevron Products Company, 2008).

Knowledge, Attitude and Practice (KAP): KAP Studies are usually performed to tell what people know about certain things, how they feel and also how they behave. The three topics that a KAP study measures are Knowledge, Attitude and Practice. The Knowledge possessed by a community refers to their understanding of any given topic. Attitude refers to the subjects feelings and believes towards this subject, as well as any preconceived ideas that they may have towards it and Practice refers to the ways in which the subjects/target demonstrate their knowledge and attitude through their actions regarding certain topic **(**Kaliyaperumal, 2004).

LPG: Is a by-product generated in petroleum refineries, which is widely used as fuels in residential, industrial and vehicle applications (Quan *et al*., 2004).

Natural Gas: Is a combustible mixture of hydrocarbon gases, and it is formed primarily of methane, it can also include ethane, propane, butane and pentane (Natural Gas Organization, 2007).

Volatile Organic Compounds (VOCs): are emitted as gases from certain solids or liquids. VOCs include a variety of chemicals, some of which may have short- and long-term adverse health effects (EPA, 2008).

List of Abbreviations

1-NP	1-nitropyrene
BTEX	Benzene, toluene, ethyl benzene, and xylenes
C	Carbon
CNG	Compressed natural gas
CO_2	Carbon dioxide
D/G	Diesel and gasoline
DEP	Diesel exhaust particles.
DWSF	Diesel water soluble fraction
ECG	Electro cardio gram
EVs	Electric vehicles
H	Hydrogen
H_2O	Water
H_2S	Hydrogen Sulfide
HCs	Hydrocarbons
ICEs	Internal combustion engines
KAP	Knowledge, Attitude and Practice
LEL	Lower Explosive Limit
LNG	Liquefied natural gas
LPG	Liquefied petroleum gas
MAMC	Metropolitan Area of Mexico City
MHCSP	Mean health complains score percentage
MOT	Ministry of Transportation
MTBE	Methyl tert-butyl ether
NG	Natural gas
NGV	Natural gas vehicle
NO_3	Nitrate
NO_x	Nitrogen oxides
NREL	National renewable energy laboratory
OEM	Original equipment manufacturer.
OH	Hydroxide
PAHs	polycyclic aromatic hydrocarbons
Pb	Lead
PCBS	Palestinian Central Bureau of Statistics
PM	Particulate matter
PNMC	Para 4-nitro-m-cresol
ppm	Part per million
Sox	Sulfur oxides
SPSS	Statistical Package for the Social Sciences
THC	Total hydrocarbon
TK	Thamdine Kinas.
ULP	Unleaded petrol
VMT	Vehicle miles traveled.
VOC	Volatile organic compound
WHO	World health organization

Chapter One

Introduction

1.1 Background

Vehicles are considered as a major source of pollution and a major consumer of the world energy sources. In this regard, about 50% of the world energy sources are utilized by the different modes of transportation, while it reaches more than 60 % of the total local fuel in Palestine. The increasing number of vehicles leads to increase demand on fuel and consequently to increases environmental pollution. Moreover, the expansion in vehicle numbers in Palestine together with the constrains on fuel importation resulted in the scarcity and less availability of fuel availability in the local market (Sehili & Abaza, 2006).

The increasing awareness about the consequences of fuel combustion on the local and global environmental in addition to the continued and sharp increments in petroleum oil prices, enhance and promote the use of alternative fuel types that includes the natural gases (NG). NG is a powerful candidate because of its comparable and feasible prices in addition it considered as environmentally-sounded fuel (Di Pascoli *et al.*, 2001).

Nowadays, the ministries of transportation in different countries try to introduce valuable and applicable measures and procedures in order to decrease atmospheric pollution and environmental threats that resulted from vehicles. Among these measures and procedures is the introduction and use of environment friendly fuels such as NG instead of Gasoline and Diesel. Currently, there are more than 130,000 NG-based vehicles (NGV) on the road in the United States, and more than 2.5 million NGV worldwide (Natural Gas Organization, 2004).

1.1.1 The area of the study :

The Gaza Strip (Geographic coordinates 31^{o} 25' N, 34^{o} 20 E') of Palestine, is a narrow piece (365 Km^2) of land along the Mediterranean coast, just 40km long and 10km wide. The Gaza Strip is divided into five governorates: the North, Gaza, Mid Zone, KhanYounis, and Rafah governorate. It is considered as one of the most populated areas in the world (4054/km^2) with an estimated population of about 1.48 million according to July 2007 estimates (Palestine Central Bureau of Statistic, 2007).

1.1.2 Living and political Contexts:

Palestine in general and the Gaza Strip in particular are under fluctuated or unstable conditions that include social, living, economical and political conditions. The cities, villages and camps of Palestine are udder a full control of the Israeli occupied authorities which monitoring and permitting (if applicable) the types and quantity of goods and products that may be allowed to enter the Palestinian areas. In the Gaza Strip the situation is relatively worse and more complicated. Since the last Palestinian legislative elections in January 2006, the economical situation at the Gaza Strip reaches it worst point due to the siege, constrains and severe closure of the Gaza Strip trade and cross points. The last two years are considered as the most difficult era for the Palestinian peoples of the Gaza strip with all aspects: economical, political, social, availability of living requirements and needs.

No one could expect what next days are carry for the people of the Gaza Strip. Each day has its features and circumstances.

1.2 Justification of the study

An increasing number of drivers at the Gaza governorates are switching their car from gasoline- or diesel-based into LPG-based engine. The switching to LPG is proceeds without any official or legal procedure and the LPG cars are now leading the streets in the Gaza Strip without any approval or monitoring from the authorizing parties that include: the Ministry of Transportation, the Ministry of Trades and Industries, the Ministry of Health, and /or the Petroleum and Environmental Authorities. The above mentioned situation, therefore, justifies the necessity for the present pilot study that evaluate the experience of the car drivers at the Gaza governorates toward the use of LPG as an alternative fuel. The present study includes health, socioeconomic, and environmental justifications.

1.3 Research Problem

As an occupation authority, Israel is controlling, by all means, all the living issues of the people in the Gaza Strip, accordingly, all people in the Gaza governorates are suffering from deteriorated economical situation. Among the Israeli controls of goods entered to the Gaza Strip are the petroleum products and derivatives (e.g. gasoline, diesel, and LPG) which are used as car and energy production sources. In addition to their shortage and scarcity, the car fuel (gasoline and diesel) imported from Israeli companies is very expensive and incomparable to the prices of these fuels in neighboring countries like Egypt and Jordan.

Based on the records (Annex 2) of the Palestinian Ministry of Transportation (MOT), the number of vehicles in the Gaza Strip is about 58,700, the most of which are gasoline- or diesel-based cars (Palestinian Ministry of Transportation, 2007).

The proposal for approving and authorizing the LPG as an alternative and as environmentally sounded car fuel in Palestine has reached advanced level in the official processes (Palestinian Ministry of Transportation, 2006). The Palestinian cabinet resolution which approved the use of LPG as car fuel in Palestine is attached to Annex (1) . However, the official implementation and processing of LPG switching is still waited. Moreover, the vehicle drivers and without any official monitoring or accreditation started to switch their car engine to LPG upon their own responsibility and personal vision and prospect.

According to the above mentioned constrains applied by the Israeli occupation, considerable numbers of car drivers in the Gaza governorates switched their vehicle engine to LPG instead of gasoline or diesel.

1.4 Aims of the Study

We designed the present study in order to identify the health status of the drivers with regard to the type of fuel used in cars, and also to evaluate the KAP of car drivers toward the use of LPG as a alternative fuel in the Gaza governorates. Our study also aimed at the recommendation of preventive measures that could improve the new experience in using the LPG as alternative car fuel.

1.5 Objectives of the study

- To evaluate and compare the health status and complains of the divers according to the type of fuel they used in cars.
- To identify any correlation or association between the health status and complains of the drivers and the amount of emitted VOC.
- To identify and assess the KAP of LPG car drivers in the Gaza governorates.
- To evaluate and compare the emitted amounts of volatile organic compound (VOC) from the different fuel types.
- To identify the relationship between socioeconomic status and the switching to LPG as alternative fuel.
- To suggest a proper recommendations that could improve the experience of using LPG as car fuel.

1.6 Research Questions

- What is the major health complains that addressed by the drivers?
- Which type of drives scored the lowest health complains score?
- How the car engine types are differ with respect the amount of emitted VOC?
- Is there any correlation or association between the health complains of the drivers and the amount of emitted VOC?
- What is the relationship between socioeconomic factors and the switching to LPG among the Gaza Strip car drivers?
- Does the switching to LPG reflect an environmental awareness?
- Does the use of LPG lead to health hazard?
- Dose the knowledge and background of car drivers enough to use of LPG as alternative fuel?
- What is the attitude of car drivers toward the use of LPG as alternative fuel?

- Does the practices of LPG car drivers concomitant with the safety and public health standards?
- What are the procedures and rules for gasoline/diesel – LPG switching in the Gaza governorates?
- What are the recommendations that could improve the LPG experience in the Gaza governorates?

1.7 Limitations of the study

1- The health status of the drivers was assessed using close ended questionnaire.
2- No laboratory or clinical investigations were done.
3- The political and the economical situation of the Gaza Strip is subjected to continuous fluctuations that may affect the result and conclusions of the study.
4- Limited scientific researches that addressed the KAP of the car drivers toward the use of alternative fuels.
5- Fluctuations in the prices and availability of petroleum products and derivatives in the Gaza Strip.
6- All LPG cars are not officially registered at the ministry of transportation.

1.8 The Structure of the Thesis

The thesis is composed of six chapters: introduction, literature review, conceptual framework, materials and methods, results and discussion and finally the conclusions and recommendations.

The first chapter was assigned as an introduction to the overall work, where the researcher provided a brief background about the subject. Also he mentioned the problem statement and the justifications of the study. A list of the research main questions and the study hypotheses are specified in the first chapter as well.

In the second chapter which deals with scientific revision of the available literature about the topic, variables, and interfering factors, the researcher tried to provide an up-to-date information about the types of fuels, traditional and alternative, that are used for powering vehicle engines and the advantages and disadvantages of the most common types. Also the researcher provided environmental and health consequences for using traditional and alterative fuels.

The conceptual framework of the study was mentioned in the third chapter of this thesis. In chapter three the researcher provided a schematic representation of the conceptual framework of the study, and he also provided theoretical information and description about the items included in the scheme and how these items are utilized and interfered in the practical part of the thesis.

The fourth Chapter "material and methods" contains more details information and procedures about the methodologies underlining the present work. In this chapter the researcher provided full description and information about the study design, target group, ethical considerations, research tools, study population, sampling, and data treatment and statistical analysis.

The bulk of data and the core of the work is presented in results and discussion section which aligned to chapter 5. In this chapter the researcher presented and discussed his results and outcomes with respect to the available published previous studies. He mentioned these results as self explanatory tables which guide the readers to understand and comment on the results easily.

The major conclusions and recommendations that harvested from the present work are mentioned in the last chapter, chapter 6. All conclusions and recommendations are formulated upon the results of the present study with evidences from the current situation of the LPG switching experience at the Gaza Strip.

Chapter two

Literature review

2.1 Vehicles fuel

Fuel is any material that is burn or altered in order to obtain energy**,** vehicle fuel releases its energy through a chemical reaction called combustion that occurs inside the combustion chamber of the vehicle engine (Christine & Scott, 2008).

2.2 Type of vehicle fuels

The vehicle fuels are conventionally categorized into traditional (conventional) and alternative or non-conventional fuels. Conventional vehicle fuels include: gasoline and diesel while alternative fuels are any material or substance that can be used as vehicle fuel, other than conventional fuels. Some well known alternative fuels include biodiesel, bioalcohol (ethanol, butanol), chemically stored electricity (batteries and fuel cells), hydrogen, non-fossil methane, vegetable oil, and natural gases (William, 2001).

Vehicles in Gaza are powered by one or more of three types of fuel, which are gasoline, diesel, and recently by LPG. Gasoline and diesel are used legally, but LPG is used illegally. Each of the three types of fuel (gasoline, diesel, and LPG) has its own effects on health, environment, and economy (Armstrong, 1980; Chih-Chung *et al.,* 2001; Di Pascoli *et al.,* 2001; Karamangil, 2007).

2.2.1 Gasoline (petrol) as traditional car fuel:

Gasoline is a complex mixture of hydrocarbons that may have between 5 to 12 carbons. Smaller amounts of alkane cyclic and aromatic compounds are may also present (Kangende, 2004).

Gasoline is the fuel designed for spark-ignition internal combustion engines. Conventional gasoline is derived from petroleum crude plus a small amount of a few additives to improve its stability, control deposit formation in engines, and modify other characteristics (Chevron Product Company, 2008). It is a complex manufactured mixture that does not exist naturally in the environment. Chemicals that are in gasoline are generally present in several physical states (gaseous, liquid, or others) in human settlements. Gasoline used as a fuel for engines in automobiles and other vehicles. Gasoline contains more than 150 chemicals including small amounts of benzene, toluene, xylene, and sometimes lead. The actual composition varies with the source of the crude petroleum, the manufacturer, and the time of year, gasoline is a colorless, pale brown or pink liquid, gasoline is very flammable, it catches on fire quite easily, evaporates quickly, and forms explosive mixtures with air (Sidney, 1998).

2.2.1.1 Health effects of Gasoline:

Many studies were performed to examine the effects of gasoline on health and to explain rout of exposure to gasoline, which is considered important points to increase awareness of public about risks of gasoline (Caprino & Togna, 1998).

Breathing is considered as the main route of exposure to gasoline at service station when filling car's fuel tanks. Air levels as high as 99 ppm was measured at one fuel station during filling of a car's tank with gasoline. The most harmful effects seen after exposure to gasoline are due to the individual chemicals in the gasoline mixture, such as benzene and lead in very small amounts. Inhaling or swallowing large amounts of gasoline can cause death. The lethal dose of gasoline that may kill people is about 10,000–20,000 ppm when breathed in and about 12 ounces when swallowed. High concentrations of gasoline are irritating to the lungs when breathed in and irritating to the lining of the stomach when swallowed. Gasoline is also a skin irritant. Breathing in high levels of gasoline for short periods of time or swallowing large amounts of gasoline may also cause harmful effects on the nervous system. These effects become more serious as the amount of gasoline breathed in or swallowed increases. Less serious nervous system effects include dizziness and headaches, while more serious effects include coma and the inability to breathe. According to USA estimates, as many as 75,000–100,000 underground storage tanks leak millions of gallons of gasoline into groundwater each year (Sidney, 1998).

Mudipalli, in 2007, stated that, health risks are increasingly associated with environmental exposures to leaded gasoline in developing countries. Large amount (~33%) of the absorbed lead in soft tissue stored in liver. Many signs and symptoms observed in persons after exposure to very high concentrations of leaded gasoline like, neuronal encephalopathy, gastrointestinal colic (abdominal pain, constipation, intestinal paralysis) is a consistent early symptom of leaded gasoline poisoning in humans. Severe gastrointestinal effects are consistently observed in patients with a blood lead range of 30 to 80 µg/dl. Ingestion of leaded gasoline is one of the primary causes of its hepatotoxic effects. Also Mudipalli, 2007 mentioned the hepatocarcinogenic effects of leaded gasoline that investigated in animal toxicology studies (Mudipalli, 2007).

The epidemiological evidence suggests that acute myelogenous leukemia associated with chronic occupational benzene exposure can be best described by dose-response relationships. The toxicological and epidemiological literature on chronic exposure to unleaded gasoline indicates that the benzene exposures required to induce a measurable carcinogenic response are substantially greater than exposures likely to be encountered from exposure to gasoline at contaminated properties (Jamall & Willhite, 2007).

The results of an assessment study of health effects on 37 workers exposed to gasoline at gasoline stations between 1985 and 1996 indicated that workers have suffered from liver disorders: lipoid degeneration of liver (14 of 37), chronic functional damages of liver (3 of 37), cirrhosis (1 of 37). Ultrasound examination indicated chronic kidney damages in 8 of 37 of the workers (Pranjic *et al.,* 2002) .

Another study showed significant reduction in the serum levels of all reproduction hormones in both male and female experimental animals. The results suggested that inhalation gasoline exposure significantly lowers the levels of reproductive hormones in albino rats and may thus interfere with reproduction (Ugwoke *et al.*, 2005).

The results of study done by Liang *et al.,* in 2005 entitled "a Genotoxicity comparison between gasoline- and methanol-fueled exhaust by Thamdine Kinas (TK) gene mutation assay" showed that the genotoxicity of gasoline-fueled exhaust is stronger than that of methanol-fueled exhaust, while the cytotoxicity of methanol-fueled exhaust is stronger than that of gasoline-fueled exhaust at dose range (Liang *et al.*, 2005).

2.2.1.2 Environment effects of Gasoline:

Small amounts of the gasoline evaporate into the air during fill the car fuel tank or when gasoline is accidentally spilled onto surfaces and soils or into surface waters. Other chemicals in gasoline dissolve in water after spills to surface waters or underground storage tank leaks into the groundwater. The movement of individual chemicals in gasoline is influenced by physical and chemical properties, such as how easily they dissolve in water, how quickly they evaporate, and whether they stick to soil. In surface releases, most chemicals in gasoline will probably evaporate; others may dissolve in and be carried away by water; a few will probably stick to soil. The chemicals that evaporate are broken down by sunlight and other chemicals in the air; the completion of this process may take from hours to weeks. The chemicals that dissolve in water also break down quickly by natural processes. Bioaccumulations of most chemicals in gasoline do not reach high levels in plants or animals. The most dangerous environmental effect of gasoline is the gaseous emissions that resulted from the combustion of gasoline in vehicle engine. In selected studies performed in different countries, higher levels of Volatile organic compound (VOC) emissions were related to gasoline combustion (Wikimedia Foundation, 2008a).

Lui and coworkers in 2005, studied and measured a total of 108 VOCs at six sites in Beijing city. The results indicated that gasoline vehicle exhaust contributed on average 57.7% of the total VOC measurements of the six location at Beijing city. Concomitantly, Song *et al.*, 2007, investigated eight sources for VOC emissions in Beijing and their results showed that Gasoline-related emissions contributed to more than 52 % of the total ambient VOCs. Song and coworkers concluded that the gasoline-related emissions were the major contributors to ozone formation potentials in Beijing (Lui *et al.,* 2005 & Song *et al.,* 2007).

A study conducted by Mashi *et al.,* in 2005, and aimed to assess the impact of various vehicular traffic densities on lead accumulations in some environmental components in Katsina, a semi-arid urban area of Nigeria. Samples were taken from the surface soils, fruits, kernels, leaves, and barks of Balanites aegyptica from locations of different vehicular traffic densities in the area. The results indicate a strong influence of vehicular traffic density on Pb emission into surrounding atmosphere and its subsequent precipitation on soil, tree bark should be the best index of assessing Pb pollution in the area, as it maintains the closest contact with the surrounding atmosphere (Mashi *et al.,* 2005).

While Roux and Marra in 2007, studied the presence and impact of environmental lead in passerine birds along an urban to rural land use gradient. Soil lead concentration was significantly higher in urban sites compared to rural sites. Accordingly, adult and nestling birds captured in urban sites had significantly higher blood lead concentrations than their rural counterparts. Lead contamination is one more features of urbanization that birds and other wildlife must face in an increasingly developed world (Roux & Marra, 2007).

Silva *et al.*, in 2002, studied urban groundwater contamination with gasoline hydrocarbon compounds, such as benzene, toluene, ethyl benzene, and xylenes (BTEX) which is highly toxic and can have severe public health consequences, besides posing the risk of intake from the water table by way of contamination. The results of this study indicate that, two out of ten water samples from the study area presented BTEX concentrations above the national water quality standard (Silva *et al.*, 2002).

Dakhel *et al.,* in 2003, who studied the impact of gasoline containing methyl tert-butyl ether (MTBE) and ethanol on groundwater quality. Results revealed that all soluble compounds including ethanol were transported to the groundwater. Ethanol disappeared concomitantly with benzene and all other petroleum hydrocarbons ,except isooctane, from the aerobic groundwater due to biodegradation. MTBE persisted for longer than 6 months at concentrations larger than 125000 microg L(-1). No evidence for MTBE biodegradation was found, whereas > 99.6% of ethanol removal was due to biodegradation (Dakhel *et al.,* 2003).

A study done to examine the role of airborne lead in increased body burden of lead in Hartford children. The ingestion of airborne lead fallout is the mechanism responsible for increased lead body burdens found in 10 urban Connecticut children. The result indicated that the concentration of lead in dirt and household dust was high enough to theoretically result in excessive lead accumulation in young children who are putting their dusty, dirty hands in their mouths during play (Lepow *et al.,* 1974).

Olsgard and colleagues in 2008, conducted study to assess the effects of inhalation exposure to a binary mixture of benzene and toluene on vitamin a status and humoral and cell-mediated immunity in wild and captive American kestrels. The research groups stated that, Benzene and toluene are representative (VOC) released during production, storage, and transportation associated with the oil and gas industry and are chemicals of concern, as they are released in greater and possibly more biologically significant concentrations than other compounds. The results also revealed altered immune responses in mammalian exposures were evident in kestrels. A decreased cell-mediated immunity, measured by delayed-type hypersensitivity testing, was evident in all exposed birds. Plasma retinol levels as measured by high-performance liquid chromatography (HPLC) analysis were decreased in wild and captive kestrels exposed to the rodent Loael for combined benzene and toluene (Olsgard *et al.,* 2008).

2.2.2 Diesel as traditional fuel:

The term “diesel fuel” is generic; it refers to any fuel for a compression ignition engine. In common use, however, it refers to the fuels made commercially for diesel-powered vehicles. Diesel fuel that readily burns, or has good ignition quality, improves cold start performance. Diesel, recognizing that the liquid petroleum byproducts might be better engine fuels than coal dust, began to experiment with one of them. This fuel change, coupled with some mechanical design changes, resulted in a successful prototype engine in 1895. Today, diesel engines are used worldwide for transportation, manufacturing, power generation, construction, and farming. The types of diesel engines are as varied as their use from small, high-speed indirect-injection engines to low-speed direct-injection behemoths with cylinders one meter (three feet) in diameter. Their success comes from their efficiency, economy, and reliability (Chevron Products Company, 2007).

2.2.2.1 Effects of Diesel on Health:

Diesel exhaust from sources such as buses, trucks, and farm equipment is a major component of air pollution around the world and has been linked with lung cancer and other illnesses. Both the Environmental Protection Agency and the National Toxicology Program, the interagency program charged with assessing the impact of different chemicals on human health, have classified diesel exhaust as a probable human carcinogen. Now, researchers have found a way to measure people's exposures to this pollutant by tracking a specific chemical in their urine. Found almost exclusively in diesel exhaust is a chemical called 1-nitropyrene, or 1-NP. The body breaks down inhaled 1-NP into several smaller molecules, called metabolites, that show up in urine (Goho, 2007).

Peretz and coworkers in 2008, stated that particulate matter air pollution is associated with alterations in cardiac conductance and sudden cardiac death in epidemiological studies. Traffic-related air pollutants, including diesel exhaust could at least partly responsible for these effects (Peretz *et al.*, 2008). A study was done by Ulfvarson *et al.,* 1987, to examine the effects of exposure to vehicle exhaust on health. The results showed that pulmonary function was affected during a workday of occupational exposure to engine emissions, but it normalized after a few days with no exposure (Ulfvarson *et al.*, 1987).

Mamessier *et al.,* in 2006 assessed the effect of diesel exhaust particles on T-cell activation in severe uncontrolled asthmatics. The results revealed a higher effect of diesel exhaust particles in exacerbated asthmatics and also suggested that uncontrolled asthma is a risk factor for aggravation under exposure to traffic pollutants (Mamessier *et al.*, 2006).

The results of the study which was done by Peterson and Saxon in 1996, and aimed to recognize and evaluate potential relationship between allergic respiratory disease and polyaromatic hydrocarbons as air pollutants from industrial and automotive fuel sources, indicates that allergic rhinitis and allergic asthma have significantly increased in prevalence over the past two centuries with epidemiologic data suggest that certain pollutants such as those produced from the burning of fossil fuels may have played an important role in the prevalence changes. Also important are studies showing that diesel exhaust, a prototypical fossil fuel, is able to enhance in vitro and in vivo IgE production.

Increased levels of the compounds resulting from fossil fuel combustion may be partly responsible for the increased prevalence of allergic respiratory disease (Peterson & Saxon 1996).

2.2.2.2 Effects of diesel on environment:

The diesel engine is the most efficient prime transporter commonly available today. Diesel engines move a large portion of the world's goods, power much of the world's equipment, and generate electricity more economically than any other device in their size range. But the diesel is one of the largest contributors to environmental pollution problems worldwide, and will remain so, with large increases expected in vehicle population and vehicle miles traveled (VMT) causing ever-increasing global emissions. Diesel emissions contribute to the development of cancer; cardiovascular and respiratory health effects; pollution of air, water, and soil; soiling; reductions in visibility; and global climate change. Diesel engine and vehicle manufacturing, as well as the production, storage, and distribution of diesel fuel, have adverse environmental consequences. Hydrocarbons (HCs) are released from wells, refineries storage tanks, and pipelines into the atmosphere, ground, and groundwater. Runoff from leaks and spills enters surface water, while atmospheric deposition adds to ground and surface water contamination. Vehicle and engine production (including steel production and product transport) emit HCs and particulate matter (PM) that also pollute air, water, and land (Cackette & Lloyd, 2001).

Zielinska, in 2005, stated that the major physical and chemical transformations are due to the primary diesel emissions during dispersion and transport in the atmosphere. The most important chemical reactions of diesel exhaust constituents are with OH radicals, followed by ozone, NO_3 radicals and light (Zielinska, 2005). While, Ausma *et al.*, in 2002, stated that emissions of volatile HCs from bioremediation facilities containing soils contaminated with petroleum HCs may negatively impact regional air quality or human health (Ausma *et al.*, 2002). The results of the study which aimed to examine the effect of compost in phytoremediation of diesel-contaminated soils indicated that the presence of diesel reduces grass growth, and that compost helps reduced the impact of diesel on grass growth. The addition of compost helps increase diesel loss from the soils both with and without grass, though the addition of grass leads to lower diesel levels compared with controls (Vouillamoz & Milke, 2001).

Diesel exhaust particles have the highest proportion of black carbon, or “soot”, of any combustion emissions. This soot, a complex mixture of carbon, sulfur, nitrogen, hydrogen, and oxygen, adsorbs organic and sulfur gases containing irritants that cause short-term respiratory distress and long-term lung cancers. This soot absorbs visible light, contributing to urban and regional hazes and to changes in the Earth’s radiation balance. Owing to its low volatility, diesel fuel persists longer than gasoline when spilled or leaked into waterways or land surfaces. Cleanup after these accidents has been technically challenging, time-consuming, and costly (Orange County Convention Center, 2001).

Recent epidemiological studies strengthen the hypothesis of an increased lung cancer risk related to residential exposure to air pollution and to occupational exposure to diesel exhausts. Few papers suggest that traffic-related air pollution may be associated with an increased risk of childhood leukemia. The observed relative risks are small but the exposure is widespread. Therefore, the overall impact of exposure to current levels of urban air pollution may be substantial (Lagorio *et al.*, 2000).

2.3 Alternative vehicle fuel

Alternative fuels are defined as any other fuels that are traditionally used in producing thermal, electrical or mechanical energy. They are usually derived from resources other than petroleum. Some are produced domestically, reducing our dependence on imported oil, and some are derived from renewable sources. Often, they produce less pollution than traditional fuels like charcoal, gasoline or diesel. Among the most common alternative fuels that widely utilized in the world are the different forms and compositions of natural gases (Fuel Economy, 2007a).

2.3.1 Natural gas:

Natural gas is a vital component of the world's supply of energy. It is one of the cleanest, safest, and most useful of all energy sources. Natural gas is colorless, shapeless, and odorless in its pure form. Natural gas is combustible, and when burned it gives off a great deal of energy. Unlike other fossil fuels, however, natural gas is clean burning and emits lower levels of potentially harmful byproducts into the air. Natural gas is a combustible mixture of hydrocarbon gases, and it is formed primarily of methane, it can also include ethane, propane, butane and pentane. Natural gas is considered 'dry' when it is almost pure methane, having had most of the other commonly associated hydrocarbons removed, when other hydrocarbons are present, the natural gas is 'wet' (Kayne, 2008).

2.3.2 Natural gas as an alternative vehicle fuel:

The crucial and fundamental advantage of natural gas vehicles (NGVs) is that they reduce environmentally harmful emissions. NGVs can achieve up to a 93% reduction in carbon monoxide emissions, 33% reduction in emissions of various oxides of nitrogen and a 50 % reduction in reactive hydrocarbons when compared to gasoline vehicles. NGVs are also safer than gasoline or diesel vehicles (Corvalán *et al.*, 2003a). The fuel storage tanks on an NGV are thicker and stronger than gasoline or diesel tanks. Economically, NG costs at fuel stations are almost 33 % lower than gasoline, meanwhile, NG prices have exhibited significant stability compared to oil prices. Furthermore, NGVs have lower maintenance costs because NG burns so cleanly and results in less wear and tear on the engine and extends the time between tune-ups and oil changes (Colling Wood School, 2003a).

The desired to achieve even lower emission lead to renewed interest in alternative fuel which include methane and NG. The buses operating on NG in Sacramento-California have had reduce emission, operating cost and have been judged. NG has higher energy density and higher octane rating than any other fuel available today, which allows vehicles to run more efficiently (Di Pascoli *et al.*, 2001; Colling Wood School, 2003b). NG, where available, can be cost effective and environmental beneficial option for many developing countries (Fernandez *et al.*, 2004). One of the biggest complaints about NGVs is that they aren't as roomy as gasoline cars, because NGVs have to give up precious cargo and trunk space to accommodate the fuel storage cylinders. Not only that, these cylinders can be expensive to design and build. Sustainability of NG is not secured. NG, like gasoline, is a fossil fuel and cannot be considered a renewable resource (Harris, 2008).

According to the international association for natural gas vehicles, the most recent (and mostly outdated) statistics showed that more than 6.3 million NGV and over 10,000 NGV refueling main stations are found in the world (James, 2007).

Stefano *et al.*, in 2001, described NG as a relatively 'clean' and cheap fuel looking for users. In comparison to other forms of energy for vehicles, NG engenders low pressures on the environment. At the same time, because of its technical characteristics, NG is very suitable for motor use. Moreover, NG is relatively cheap. Thus, NGVs would be expected to attract the interest of a great number of people, including politicians, and achieve rapid and widespread diffusion. A well-known fact about NG is that it exhibits the highest H/C ratio of all the fossil fuels, which implies both lower CO_2 emissions and a lower material intensity (lower mass per unit of energy). From an energy point of view, in fossil fuels only carbon (C) and hydrogen (H) contribute significantly to the energy content, while other elements (oxygen, sulfur, nitrogen) play a minor role. If combustion is performed under the best of conditions (correct quantity of oxygen), hydrogen leads to water vapor (H_2O), while carbon gives CO_2. Since water emissions have a lower environmental impact than CO_2, a high H/C ratio is preferred. NG exhibits another important advantage over fuel oil (for both environmental and technical purposes): its content of contaminants is very low, if any. This leads to a marked reduction in the highly dangerous 'secondary' emissions (benzene, lead, nitrogen oxides, particulate, carbon oxide) which are typical of petroleum derivatives (Stefano *et al.*, 2001).

2.3.3 Types of natural gas:

There are four major types or forms of NG that available for utilization worldwide. The first type is the low-pressure NG (LNG) which is used mainly in households for cooking or heating and it comes from the underground pipe system and networks from the gas commercial companies. The second type is the compressed natural gas (CNG), which is compressed into high-pressure fuel cylinders in order to power large vehicles and trucks, it comes from special CNG fuel stations. The third type refers to the liquefied natural gas (LNG), which is made by refrigerating natural gas to condense it into a liquid form. The LNG form is much denser than natural gas or CNG. The fourth type is the liquefied petroleum gas (LPG). Actually, LPG is made of a mixture of propane and other similar types of hydrocarbon gases. Most people call LPG as propane because propane is the major or the dominant hydrocarbon in LPG. Different batches of LPG have slightly different amounts of the different kinds of hydrocarbon molecules. These hydrocarbons are gases at room temperature, but turn to liquid when they are compressed. LPG is stored in special tanks that keep it under pressure, so it stays a liquid. The pressure of these tanks is usually about 200 pounds per square inch (California Energy Commission, 2006a). In the Gaza Strip, the LPG is the type of fuel gas that available at the market (Khouzondar, 2008).

2.3.4 Uses of natural gas:

The uses of natural gas ranges from the household purposes, car flues, to small scales and large scales industrial purposes. cooking; central heating; natural gas fires; powering mechanical factories and industries, generating electricity, and cars fuel are among the most popular fuels for using NG (James, 2007; Firmusens Energy, 2007).

2.3.5 Route of exposure to natural gas and toxicity:

The primary route of exposure to NG is through inhalation. NG may be present during fueling and /or repair work. NG is widely used in residences and industry and the potential for serious inhalation problems is low. NG is practically inert, below the flammability limits and has no known acute or chronic physiological effects (Getbus, 2008).

2.3.6 Effect of natural gas on health:

The major components of NG are butane, propane, methane, and ethane, these are highly toxic chemical hydrocarbon gases when inhaled (Natural Gas organization, 2007). In concentrations exceeding 7 percent fuel/air mixtures, NG will displace oxygen necessary to sustain life and asphyxiation may occur. The exposure guideline commonly referred to for simple asphyxiates is 1000 ppm. The primary route of exposure to NG is through inhalation. NG may be present during fueling and /or repair works (Getbus, 2008).

Saadat and Bahaoddini, 2004 assessed the hematological changes due to chronic exposure to natural gas leakage in polluted areas of Masjid-i-Sulaiman, the result showed that, the absolute mean number of red blood cells, percentages of hematocrit, level of hemoglobin, and absolute number of platelets were significantly higher among the exposed subjects compared with the control group. The absolute mean numbers of white blood cells, lymphocytes, and neutrophils were significantly decreased in the exposed group compared with the control (Saadat & Bahaoddini, 2004). A study done by Saadat and coworkers in 2004, to examine alterations in blood pressure due to chronic exposure to natural gas leakage, showed that the systolic blood pressure significantly decreased while the diastolic blood pressure and heart rate significantly increased in individuals living in the contaminated areas with natural gas compared with those of normal mean values. The systolic and diastolic blood pressure decreased and increased, respectively, in individuals chronically exposed to natural sour gas containing sulfur compounds (Saadat *et al.,* 2004).

Spitzer *et al.,* in 1989, showed that residents of the exposed area to natural gas reported an excess number of symptoms and health problems there were no significant differences in the mortality rate, incidence of cancer, reproductive problems, major ailments, hair levels of arsenic and certain metals or respiratory function between the groups (Spitzer *et al.,* 1989). While, Saadat *et al.,* in 2005, in his study entitled "Environmental exposure to natural gas containing sulfur compounds lead to elevated depression and hopelessness scores" indicated high endogenous H_2S levels have been found in the brain and it is involved in the brain functions. Depression and hopelessness were also determined in the exposed subjects. The results also revealed significantly differences between the exposed subjects and the control group (Saadat *et al.,* 2005).

Bahaoddini *et al.,* in 2007, who investigated electrocardiogram (ECG) alteration in accordance to prolong exposure to natural gas leakage containing sulfur compounds in polluted areas of Masjid-I-Sulaiman, mentioned an altered ECG in exposed subjects as compared to standard values. They also concluded that chronic exposure to sour gas containing hydrogen sulfide contaminated air may provoke alterations of electrical activity of the heart (Bahaoddini *et al.,* 2007). While Saha and coworkers in 2005, showed that, LPG is a safer fuel with no or limited deterioration of pulmonary functions (Saha *et al.,* 2005).

A study was conducted by Corvalán *et al.,* in 2003, to evaluate the effectiveness in the use of natural gas for the reduction of atmospheric emissions. The results for their study revealed that stationary combustion sources that replaced their fuel reduced PM emissions by 61%, sulfur oxides (SOx) by 91%, nitrogen oxides (NOx) by 40%, and VOC by 10%. Carbon monoxide (CO) emissions were reduced by 1% (Corvalán *et al.,* 2003b).

2.3.7 Safety measures when use the natural gas as fuel:

A natural gas leak can be dangerous because it increases the risk of fire or explosion. Because methane--and therefore, natural gas does not have any odor, the gas company adds a warning "rotten-egg" smell (mercaptan or a similar sulfur-based compound) that can be easily detected by most people. Many detectors will respond to other dangerous chemicals in addition to natural gas, such as propane (LP). The Lower Explosive Limit (LEL) is the lowest amount of gas that will cause an explosion. Gas detectors vary in the level of gas that will set off an alarm (for example, 15% of the LEL, 20% of the LEL, etc.). Detectors that sense lower levels of gas will warn you more quickly of the presence of natural gas than detectors that sense higher levels **(**National Institute on Deafness and Other Communication Disorders, 2002).

2.4 LPG as alternative fuel

In the Gaza Strip, the LPG (mainly propane) is the type of gas that available at the market (Khouzondar, 2008). LPG is heavier than air, if a leak in fuel system occurs the gas will have a tendency to sink into any enclosed area and this poses a risk of expulsion and fire. Propane is nontoxic; however, when abused as an inhalant it poses a mild asphyxiation risk through oxygen deprivation. It must also be noted that commercial product contains hydrocarbons beyond propane, which may increase risk. Propane and its mixtures, under normal pressures experienced while being stored in a tank, may cause mild frostbite during rapid expansion. Propane in its liquid form remains a cool -42 degrees Celsius with an ambient exterior temperature of 20 degrees Celsius. Propane combustion is much cleaner than gasoline, though not as clean as natural gas. The presence of C-C bonds, plus the multiple bonds of propylene and butylene, creates organic exhausts besides carbon dioxide and water vapor during typical combustion, these bonds also cause propane to burn with a visible flame (Wikimedia foundation, 2008b). Propane, also known as LPG (liquefied petroleum gas), is the leading alternative fuel in the United States. It is also the third most common vehicular fuel today, after gasoline and diesel. There are over 270,000 on-road vehicles in the United States and more than 10 million worldwide that operate on propane. A large number of these are used in fleets that include light-to heavy-duty trucks, buses, taxicabs, police cars, and rental and delivery vehicles (Propane Education and Research Council, 2008a).

LPG is a by-product generated in petroleum refineries, which is widely used as fuels in residential, industrial and vehicle applications. Usually, LPG contains certain amount of residues, i.e. hydrocarbons with higher vaporization points falling in the range of lubricant oils (Quan *et al.,* 2004). In natural gas processing, the heavier hydrocarbons that naturally accompany natural gas, such as LPG, butane, ethane, and pentane, are removed prior to the natural gas entering the pipeline distribution system. In crude oil refining, LPG is the first product that results at the start of the refining process and is therefore always produced when crude oil is refined (Consumer Energy Center, 2007).

Although LPG is conventionally known as propane however, LPG is made of a mixture of propane and other similar types of hydrocarbon gases. Different batches of LPG have slightly different amounts of the different kinds of hydrocarbon molecules. These hydrocarbons are gases at room temperature, but turn to liquid when they are compressed. Today, more than 10 million vehicles around the world run on LPG, a fuel that delivers high-octane power but fewer greenhouse gas emissions than gasoline, and considerably less nitrogen oxide and particulate pollution than diesel (Propane Education & Research Council, 2008b).

The percentage of LPG vehicles is increasing because LPG is more economical and it is considered less polluting than gasoline and diesel. Currently, in effort to reduce pollutant emission in Korea, the government is trying to make a law that encourages people to buy LPG vehicles, such as reducing the excise taxes on LPG fuel and LPG fueled vehicles (Propane council, 2008).

2.4.1 Switching to LPG:

LPG injection kits include all the components needed to convert an engine, such as an LPG computer, injectors, fuel rails, vaporizer (pressure regulator), lock-off and filter assembly, wiring harness and sensors. LPG injection systems incorporate to use of the original equipment manufacturer (OEM) computer to control the LPG system. OEM computer performs its normal duties of monitoring the engine operation and changing fuel delivery and timing to maximize the engine operation no matter which fuel is being used. When the engine is running on propane, the OEM instructions are sent through the LPG computer to change LPG fuel levels as instructed. The LPG computer changes the amount of fuel delivered to satisfy the OEM computer. Using this method the OEM computer has complete control of the LPG system and no false check engine lights occur. The LPG injection uses individual injectors for each cylinder, the same as the OEM gasoline system. This ensures proper fuel distribution and eliminates the possibility of intake manifold backfires, which were a common problem for 1996 and newer vehicles using core equipment. Backfires contributed to significant maintenance costs and made owners reluctant to convert (Burkett & Randy, 2007). The invention relates to a system for shutting off the LPG fuel supply route in a vehicle except in case of necessity. Namely, when an engine is stopped and a starting switch is in switched off, a solenoid valve is operated to shut off the LPG fuel supply route to prevent the LPG fuel from leaking out to the carburetor and to keep the vehicle from suddenly lurching out (Free Patents Online, 2008).

2.4.2 Environmental pollution and LPG:

The study of Schifter *et al.,* in 2000, entitled "Contribution of LPG-derived emissions to air pollution in the metropolitan area of Guadalajara City" showed that the three most important contributors to LPG emissions were refilling of LPG-fueled vehicles and commercial and domestic consumption (Schifter *et al.,* 2000a). Also Schifter and coworkers in 2000b, conducted study to evaluate the regulated exhaust emission and other parameters on 134 representative vehicles of that fleet. The result showed that, more than

95% of the in-use vehicles using LPG presented regulated emissions which exceeded in one or more the environmental regulations values required for certification. The poor maintenance of the vehicles and the type of conversion kit installed could be the culprits of the results obtained (Schifter *et al.,* 2000b).

Gamas *et al.,* in 2000, estimated the hydrocarbon emissions caused by the consumption of LPG in the Metropolitan Area of Mexico City (MAMC). The result showed that the most important contribution is found during the domestic consumption of LPG (70%) and they suggested the development of a control program of LPG losses, and expected a 77% reduction in emission is expected in a 5-yr period. The calculated amounts of LPG emissions when correlated with the consumption of LPG, combined with information from air samples from the MAMC, do not point to LPG emissions as the most important factor contributing to troposphere ozone in the air in Mexico City (Gamas *et al.,* 2000).

2.5 Other alternative fuels

2.5.1 Biodiesel:

Biodiesel is a form of diesel fuel manufactured from vegetable oils, animal fats, or recycled restaurant greases. It is safe, biodegradable, and produces less air pollutants than petroleum-based diesel (Fuel Economy, 2007b). Biodiesel is an alternative fuel produced from domestic, renewable resources. It is safe to use in any diesel engine and is more sustainable and far less polluting than conventional petroleum diesel. Biodiesel significantly reduces asthma-causing soot, greenhouse gases, carbon dioxide, and sulfur dioxide in air emissions. Along with creating less pollution, biodiesel is simple to use, biodegradable and non-toxic. Produced from renewable resources such as waste cooking oil or soybean oil, biodiesel reduces dependence on limited energy resources and foreign oil. The “fat to fuel” process recovers energy and recycles waste oils that are either dumped in landfills or flushed down drains, clogging pipes and causing costly sewer spills (Jeff, 2007).

2.5.2 Ethanol:

Ethanol is an alcohol-based fuel made by fermenting and distilling starch crops, such as corn. It can also be made from "cellulosic biomass" such as trees and grasses. The use of ethanol can reduce our dependence upon foreign oil and reduce greenhouse gas emissions (Fuel Economy, 2007c). Ethanol is prepared by the fermentation of sugars, which is a well-established and known technology, generally used for human consumption in the form of beers, wines and spirits. The use as fuel is not widespread (Astbury, 2008).

2.5.3 Electric fuel:

Electricity for Electric vehicles EVs is produced by power plants, which send it to substations through transmission lines and then to homes and businesses through distribution systems. An EV’s electric motor converts electricity—usually from a battery pack—into mechanical power that runs the vehicle. After a certain vehicle driving range, however, EV batteries must be recharged. More than 4,000 EVs are traveling U.S. roads and highways. Although some EVs are found nationwide, California has the greatest concentration of the alternative fuel vehicles. EVs do not produce tailpipe emissions, but generators producing the electricity used to charge EV batteries do emit pollutants (Environmental Protection Agency, 2002).

2.5.4 Hydrogen fuel:

Hydrogen (H_2) is being aggressively explored as a fuel for passenger vehicles. It can be used in fuel cells to power electric motors or burned in internal combustion engines (ICEs). It is an environmentally friendly fuel that has the potential to dramatically reduce our dependence on foreign oil, but several significant challenges must be overcome before it can be widely used (USA Department of Energy, 2007).

2.6 LPG versus other vehicle fuels

Comparative study of regulated and unregulated air pollutant emissions before and after conversion of automobiles from gasoline power to LPG was conducted by Yang *et al.,* in 2007, In this study, emissions of regulated (CO, THC, NO(x) and unregulated air pollutants, including CO_2, PM, polycyclic aromatic hydrocarbons (PAHs), and BTEX (acronym for benzene, toluene, ethylbenzene, xylene), were measured before and after conversion of nine gasoline-powered automobiles to LPG/ gasoline dual-fuel retrofits. Their results showed that, average emission factors of 0.14 g/km, 0.33 mg/km, 0.09 g/km, 0.44 g/km, and 197 g/km for CO, THC, NO(x), PM, and CO2, respectively, for LPG/ gasoline dual-fuel retrofits. Results also indicated that the emissions of CO, THC, and CO_2 were significantly reduced with the retrofit in comparison with gasoline-powered automobiles. The reduction percentages were 71%, 89%, and 14% for CO, THC, and CO_2, respectively. The average total PAH emission factor for LPG was significantly lower than gasoline (Yang *et al.,* 2007). Moreover, the comparative study which was conducted by Ristovski *et al.,* in 2005, to measure Particle and carbon dioxide emissions from passenger vehicles operating on unleaded petrol (ULP) and LPG fuel, showed that, LPG was found to be a 'cleaner' fuel, although in most cases. The particle number emission factors was over 70% less with LPG compared to ULP. Carbon dioxide emission factors were 10% to 18% greater with ULP than with LPG (Ristovski *et al.,* 2005).

The term volatile organic compounds includes a wide variety of chemical substances with the common feature of being carbon compounds that are volatile at ambient temperature. They can be classified into different families defined by their chemical formulae, each of which possesses common properties, although there may be major differences in terms of toxicity. For that reason the effects of VOC on health have to be considered both in an individual way and also from a global viewpoint on account of their common toxic properties and the role they play in the formation of environmental photo-oxidative pollutants, both outdoors and indoors (Cicolella, 2007).

2.7 Vehicles emissions

Motor vehicles emitted many different types of pollutant gases, which have many effects on human and environment, differ according to type of pollutant. The most gases emitted from vehicle are; carbon oxides (Cox), sulfur oxide (Sox), nitrogen oxide (Nox), hydrocarbons (Hc), lead (Pb) (Sehili & Abaza, 2006).

A study were conducted by Economopoulou and Economopoulos in 2002, to assess Air pollution in Athens basin and health risk. The results indicate that for CO, NOx and VOC the major source is road traffic, while for PM2.5 and SO2 both space heating and traffic share responsibility. The results of the above analysis show that the levels of all 'classical' pollutants, with the exception of SO2 and Pb, exceed significantly the WHO guidelines and are thus expected to exert a significant health impact. In addition, The results show that the existing levels of fine particle concentrations in Athens increase significantly the mortality and morbidity, and reduce the average longevity of the entire population from 1.3 to 1.7 years (Economopoulou & Economopoulos, 2002).

A study conducted by Srivastava *et al.*, in 2005, to evaluate emissions of VOCs at urban petrol retail distribution centres in India. The authors of the study mentioned that, Air pollution has assumed gigantic proportion killing almost half a million Asians every year. Urban pollution mainly comprises of emissions from buses, trucks, motorcycle other forms of motorized transport and its supporting activities. The result indicated that, concentration of benzene in ambient air in clearly shows the effect of intervention in use of petroleum and diesel fuel and shift to NG. Diesel combustion engines, refueling emissions are also major sources of evaporative emissions are found to contribute maximum to total VOC concentration in ambient air (Srivastava *et al.*, 2005).

Chapter 3

Conceptual Framework

3.1 Introduction

The use of LPG as an alternative fuel for road vehicles has been documented and investigated extensively in recent years. Car emissions continue to attract the attention of public health specialists, environmentalists and toxicologists not only because of their adverse effects on global climate, but also because many organic compounds found in automobile emissions have high ozone forming potential and health effects on humans and other living organisms and ecosystems. Many studies of the emissions from LPG powered vehicles have been reported in recent literature and now it is generally accepted that the emissions from a LPG powered vehicle are less than those from the gasoline or diesel fuelled equivalents (Di Pascoli *et al.*, 2001).

In the present study the researcher attempted to identify comparatively the health consequences of using LPG as alternative fuel in Gaza governorates. On the other hand the study investigated the levels of knowledge, attitudes and practices of car drivers towards the use of LPG as alternative fuel. To achieve the aims the researcher used a closed ended questionnaire together with the C-21 VOC Gas Sensor to measure the amount or level of emitted VOC from the different kinds of cars. A schematic representation of the conceptual framework of the present study is mentioned in Fig. 3.1.

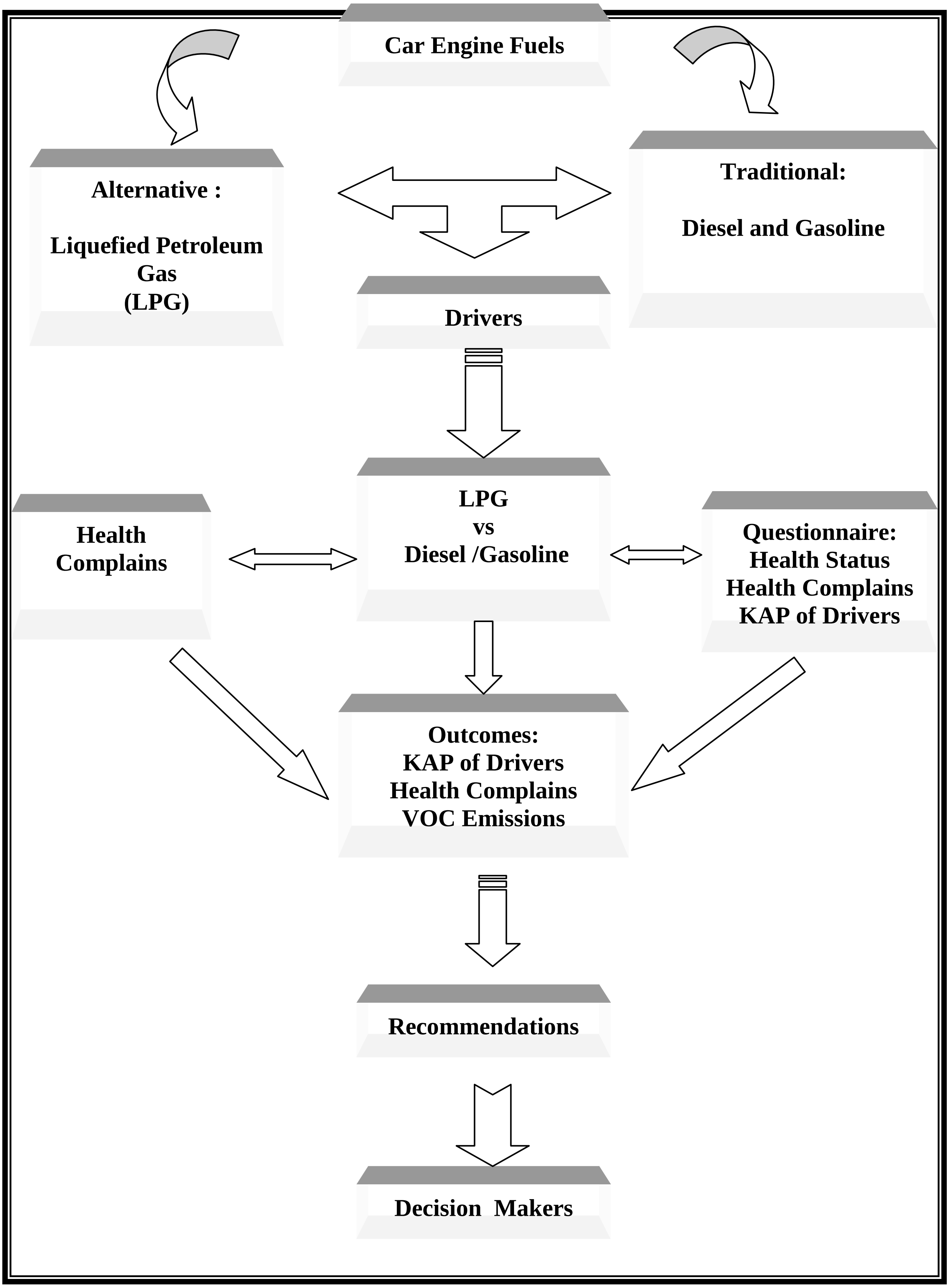

Fig. 3.1. Schematic representation of the conceptual framework of the study

3.2 Liquefied petroleum gas (LPG)

LPG is produced during the normal petrol chemical distilling process of crude oil and the letters LPG stand for Liquefied Petroleum Gas, which is 100% octane. LPG is stored in a liquid form because being 250x more dense than as a gas it requires less space within the car. Many car manufacturers offer LPG cars direct from the dealership as part of the range. Other manufacturers such as Ford, Range Rover and Chrysler may not have an LPG vehicle as part of the range but will allow conversions to be carried out after manufacture as long as they are LPG approved. Interestingly two of the largest countries for LPG use in vehicles are Italy and Japan, who are not oil producers (Van Thuijl *et al.*, 2003) .

In Gaza Strip LPG is used for household purposes that include cooking, and heating. Recently, LPG become, unofficially, a major fuel for cars in the Gaza Strip used as car fuel by informal way.

LPG is the generic name for commercial propane and/or butane. These are hydrocarbon products produced by the oil and gas industries. Commercial Propane and butane predominantly consists of hydrocarbons containing three and four carbon atoms, respectively. They have the special property of becoming liquid at atmospheric temperature if moderately compressed, and reverting to gases when the pressure is sufficiently reduced. Advantage is taken of this property to transport and store these products in the liquid state, in which they are roughly 250 times as dense as they are when gases. Butane is usually supplied to customers in cylinders. Propane can be supplied in cylinders or in bulk for storage in tanks at the customers premises (LP Gas Association, 2004).

3.3 Diesel

Diesel fuel comes from the residue of crude oil after the more volatile fuels, such as gasoline and kerosene, are removed during the petroleum refining process (Engine Mechanics, 2008). Some chemical characteristics and natural impurities in diesel fuel can affect exhaust emissions from diesel engines, which may damage or impede the operation of emission control devices, and can increase secondary pollutant formation in the atmosphere (Environmental Protection Agency, 1997). In the Gaza Strip diesel is fully authorized as fuel for all types of cars.

3.4 Gasoline

Gasoline, a by-product of petroleum, contains carbon and hydrogen. This factor allows the fuel to burn freely and to create extensive heat energy. Two types of gasoline are used: leaded and unleaded. Leaded gasoline has a higher octane rating than unleaded gasoline and is more effective as a valve and valve seat lubricant; however, leaded gasoline has almost been discontinued, because engines that use it emit a great amount of harmful hydrocarbons that pollute the atmosphere. Engines that use unleaded gasoline emit fewer hydrocarbons, have fewer combustion chamber deposits, and provide a longer life for spark plugs, exhaust systems, and carburetors; however, unleaded gasoline emits about the same amount of carbons gasoline emits about the same amount of carbon monoxide and nitrogen oxide as leaded gasoline (Engine Mechanics, 2008b). In Gaza governorate leaded and unleaded gasoline are fully authorized to be used as traditional fuel for all kinds of cars.

3.5 Health and Environmental Impacts of fuels

Many studies were published and comparatively discussed the health and environmental impacts of the chemical materials and gases emitted from the combustion of the different types of vehicle fuels, both traditional and alternative fuels. Most of these scientific studies favors the alternative fuels as health and environmentally sounded fuels that positively ameliorates the negative impacts of the traditional fuels on the living organisms and their ecosystems. A detailed presentation of these studies is mentioned in the previous chapter of the literature review.

In our study, the data related to health complains of the drivers were summarized as single parameter that reflects the number of complains of the drivers and then calculated as percentage.

3.6 Knowledge, Attitude and Practice (KAP)

KAP Studies are usually performed to tell what people know about certain things, how they feel and also how they behave. The three topics that a KAP study measures are Knowledge, Attitude and Practice.

The Knowledge possessed by a community refers to their understanding of any given topic. In our case the use of LPG as a car fuel is the topic of our KAP study. Attitude refers to the driver's feelings and believes towards this subject, as well as any preconceived ideas that they may have towards it. Practice refers to the ways in which the drivers demonstrate their knowledge and attitude through their actions regarding the use or switching to LPG as car fuel.

Understanding the levels of Knowledge, Attitude and Practice of the drivers at the Gaza Strip will enable a more efficient process of awareness creation as it will allow the proposed programs for LPG switching to be tailored more appropriately to the needs of community and the benefits on the public and environmental health (Kaliyaperumal, 2004).

3.7 Volatile organic compounds (VOCs)

The researcher used a device (C-21 VOC Gas Sensor) to measure VOCs inside the car, this device valid to measure leakage of LPG, diesel and gasoline car fuels and gases emitted from combustion of these fuels.

VOCs are emitted as gases from certain solids or liquids. VOCs include a variety of chemicals, some of which may have short- and long-term adverse health effects. Concentrations of many VOCs are consistently higher indoors (up to ten times higher) than outdoors. VOCs are emitted by a wide array of products numbering in the thousands. Examples include: paints and lacquers, paint strippers, cleaning supplies, pesticides, building materials and furnishings, office equipment such as copiers and printers, correction fluids and carbonless copy paper, graphics and craft materials including glues and adhesives, permanent markers, and photographic solutions. Organic chemicals are widely used as ingredients in household products. Paints, varnishes, and wax all contain organic solvents, as do many cleaning, disinfecting, cosmetic, degreasing, and hobby products. Fuels are made up of organic chemicals. All of these products can release organic compounds while we are using them, and, to some degree, when they are stored (Environmental Protection Agency, 2008).

In the present work, VOC levels were measured inside cars while engines are working, and correlations and comparisons were investigated between different cars.

Chapter 4

Materials and methods

4.1 Study Design

The present work was designed as cross sectional study, which is useful for the descriptive purposes. It is less costly and saves time and efforts. Cross-sectional study can give some indications about the association among different exposures or variables under investigation and their outcomes (Mann, 2003).

4.2 Setting

This study was carried out in the five governorates of the Gaza Strip: North, Gaza, Mid Zone, Khanyounis, and Rafah, with sample size relatively compatible, as much as possible, with the population size of each governorate. Field works were conducted at the five governorates of the Gaza Strip between May 2008 to August 2008.

4.3 Target Population

The target population of the present work was the LPG, Gasoline, and Diesel car drivers in the different governorates of the Gaza Strip.

4.4 Ethical Consideration

The approvals of the present study were obtained from the Helsinki committee (Annex 3) and occupational health department at the Palestinian MOH, as well the Palestinian MOT. The researcher explained the purpose and objectives of the study as well as the name of the researcher, and he declared and committed to the participant about the confidentiality of the study. After the free acceptance, the subjects were asked to fill the proper questionnaire (Annex 4). At the end of the questionnaire the participant driver signed the consent statement of the study. The inclusion in the study was optional and confidential. Neither name nor personal data were published. All ethical considerations were maintained, including respect of people, truth and confidentiality.

4.5 Research Tools

In order to achieve the objectives of the present work, the researcher relied on close ended questionnaire together with the measurements of VOC as the main tools of the research.

4.5.1 Questionnaire:

The data was collected by using close-ended questionnaire which was constructed and conducted in Arabic language. The questionnaire (Annex 4) was designed to include six major components with 53 items:

1- Socio-demographic and general characteristics of the drivers (8 items).

2- Technical and descriptive information about the cars of the drivers (6 items).

3- Knowledge of drivers towards using of LPG as alternative fuel (13 items).

4- Attitude of drivers towards using of LPG as alternative fuel (6 items).

5- General practice of all Drivers (7 items).

6- Specific practice of LPG drivers towards using of LPG as alternative fuel (7 items).

7- Health status and health complains addressed by all drivers (6 items).

The items and components of the questionnaire were arbitrated and validated at three levels. The first was criterion related validity that depended on the construction of questionnaire items after reviewing the related literature. The Second was content validity; the questionnaire was checked by university scientists and experts (Annex 5). The objectives of the study were attached with the questionnaire form. Some of the items were added, some modified and some were excluded. The third level is through piloting procedure, where the fifteen copies where distributed to volunteers and the questionnaire content was also modified for confusion, redundancy and time factors.

The questionnaire was distributed to the drivers at the traffic stations and location where the drivers grouped (like gas supply station) of the five governorates. The researcher explained the purpose and objectives of the study and he declared and committed to the participant about the confidentiality of the study. After the free acceptance, the subjects were asked to fill the proper questionnaire. The average time for filling the questionnaire was about ten minutes.

The data related to health complains of the drivers were summarized as single parameter that reflects the number of complains of the drivers and then calculated as percentage. The driver who mentioned 6 complains was scored as 100 % complain, while who mentioned no complains was scored as 0 % complain. The others categories were: 20 %, 40 %, 60 %, 80 % complains which correspond to 1, 2, 3, 4 complains respectively.

4.5.2 Measurements of VOC:

Additionally, the levels of VOC were measured using the C-21 VOC Gas Sensor (ECO Sensors, Inc., USA) which is suitable to relatively quantify the amount of the leakage of VOC of LPG, diesel, and gasoline inside the car space. The bargraph (LCD screen) of the VOC apparatus displays the following results: < 20 ppm, 40 ppm, 50 ppm, 100 ppm, and 140 ppm which respectively correspond to normal/accepted, caution/moderate, danger/high, very high, and the highest.

The C-21 VOC Gas Sensor device was examine and calibrated as mentioned in the manufacture instructions to measure volatile home gas, car fumes and volatile fuel like gasoline and kerosene.

4.6 Pilot Study

About fifteen drivers were assigned for the piloting stage of the present work. The questionnaires of the 15 volunteer's drivers were not included in the data analysis and treatments. The volunteer drivers were asked freely to answer the questionnaire and the VOC measurements were performed on their cars. The questionnaire content was modified for confusion, redundancy and time factors, while The C-21 VOC Gas Sensor device set up and calibration were maintained in the piloting stage.

4.7 Study Population and Sampling

The study population of the present work was all LPG, gasoline, and diesel car drivers who are working at the different governorates of the Gaza Strip.

4.7.1 Eligibility criteria:

4.7.1.1 Inclusion criteria:

All drivers more than or equal18 years old, powering their car engine with LPG, diesel or gasoline and residence in the Gaza Strip were eligible for the study.

4.7.1.2 Exclusion criteria:

Any driver who is less than 18 years old, using food oil as engine fuel, not living in the Gaza Strip, were excluded from the present study.

4.7.2 Sample size:

The sample size of the present study was calculated according to the published tables by the University of Florida, USA, which provides the sample size for a given set of criteria. In determining the sample size, we calculate it under 10% Precision Level. In our study, almost 58,700 vehicles are working on the Gaza Strip, which approximately represent the number of the practicing drivers. Accordingly, our samples size should be at least 100 drivers/cars. For no-responsive expectations, and to avoid low number of cases and hence low frequencies per cell our provisional sample size has been increased and 255 questionnaires were distributed to the drivers (Glenn, 2003).

4.7.3. Sampling procedure:

The sample size from each governorate was, as much as possible, comparable to the population size of each governorate. From each governorate the driver's samples were selected mainly from cars stations according to the convenience sampling procedure.

4.8 Data treatment and Statistical analysis

The data from the questionnaire were tabulated, encoded and statistically analyzed using the Statistical Package for the Social Sciences (SPSS) version 13. The following measurements and tests were performed aiming at the description, identification of significant relationship, correlations and differences among the health status, knowledge, attitude, and practice of the respondent drivers of the present study.

4.8.1 Frequency tables:

The cross tabs procedure was followed to present the frequencies of the different items of the questionnaire. Moreover all significances were mentioned on each table.

4.8.2 Chi square test:

The chi square test was used to determine whether the difference in frequency (percentage) among the same groups is significant or not, which means significance between row percentages in a single column of a table.

4.8.3 Z-test:

For significance determination of the difference between two population proportion (differences between column percentages in a single row of a table), the Z-test was used and calculated according to the following equation:

$$Z \cong \frac{(\hat{p}_1 - \hat{p}_2) - (p_1 - p_2)}{\sqrt{\hat{p} \cdot (1 - \hat{p}) \cdot \left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} \qquad \text{where } \hat{p} = \frac{X_1 + X_2}{n_1 + n_2}$$

X_1 and X_2 are the numbers in the first (n_1) and second (n_2) population samples respectively. P value = 1- Z (Daniel, 1991**)**.

4.8.5 The spearman rank correlation coefficient :

The correlation between two variables was determined using the spearman rank correlation coefficient**:** (also known as Spearman's rho) which yields a statement of the degree of interdependence of the scores of the two rank-ordered scales.

4.8.6 The Kruskal –Wallis test:

The Kruskal –Wallis test is one-way analysis of variance by ranks and was used for testing equality of population medians among groups.

Chapter 5

Results and Discussion

5.1 Introduction

The present study was conducted at the five governorates of the Gaza Strip and aimed at the investigation of the health status of the car drivers in relation to type of fuel they used, meanwhile it further aimed at the evaluation of the knowledge, attitude and practices of vehicle drivers toward the use of LPG as a alternative fuel in Gaza Strip. Also it aimed at the recommendation of preventive measures that could improve the new experience in using the LPG as car fuel in the Gaza Strip. Up to our best knowledge and available published resources, our study could be considered as the first ever study that address the topic of LPG switching.

5.2 Data Collection and Statistical Analysis

Close ended questionnaire was the main tool of the present study, meanwhile the researcher measured the VOC using the C-21 VOC Gas Sensor. The SPSS version 13 program was used for treatment of data and statistical analysis. Differences and correlation were considered significant at $p<0.05$. different statistical measurements and tests were performed aiming at the description, identification of significant relationship, correlations and differences among the health status, knowledge, attitude, and practice of the respondent drivers of the present study. Details about the statistical tests performed were mentioned in the previous chapter (chapter 4 the materials and methods).

5.3 Presentation of the Results

5.3.1 Respondent Rate:

Two hundreds fifty five questionnaire were distributed by the researcher to the drivers who were sampled by convenient sampling. Appreciatively, 230 of the 255 drivers filled the questionnaire which indicated a total response rate of 90.2 %. The distribution of the respondent drivers in the different governorates is mentioned in Table (5.1).

Table (5.1): Distribution of participated drivers (n=230) of the different governorates

Governorate	Number	Percentage
North	**44**	**19.1**
Gaza	**57**	**24.8**
Mid Zone	**49**	**21.3**
Khanyounis	**47**	**20.4**
Rafah	**33**	**14.3**
Total	**230**	**100**

The relatively high response rate (90.2 %) of the drivers reflects considerable level of awareness and responsiveness to the topic, aims and objectives behind performing the present work. Also, it could provide us with an early indicators and signs when official steps are being adopted to authorize the LPG cars in the Gaza Strip.

5.3.2 General characteristic of the respondent drivers:

The 230 respondent drivers were classified according to the type of fuel used during the conduction of the present work. The number of car drivers who using LPG was 98 (42.6%), while those who using diesel or gasoline (D/G) was 132 (57.4%). The general characteristics of the overall drivers as well as the general characteristics of the D/G and LPG drivers were mentioned in Table (5.2). The mean age of the drivers was 33.46 ± 10.17, the majority (76.1 %) of the drivers were in the age group 18-40 years. Fortunately, none of the drivers was illiterate which relatively minimized heterogeneity of the questionnaire results, while the category of drivers with at least 10 years of education comprised 67.8 % of the sample.

Driving was the main profession of 45.2 % of the respondents, meanwhile 40.0 % of the respondents were below 6 years of experience in driving.

The mean age of the respondent drivers (33.46 years), with more than three-fourths of them between 18-40 years old, and that the primary profession of about half of them is driving could be a reflection of the bad economical situation of the people of the Gaza Strip due to the blockade administrated by occupation authorities.

The included drivers varied in the type of driving license, the majority 52.2 % having commercial driving license, while 32.6 % having private driving license and 13.9 % having general driving license. Three drivers 1.3 % were not holding driving license.

Table (5.2) General characteristics of the drivers

General characteristics	**Overall drivers** (N= 230)		**D/ G drivers** (N= 132)		**LPG drivers** (N= 98)	
	N	%	N	%	N	%
Age (years)						
18-30	**106**	**46.1**	**66**	**50.0**	**40**	**40.8**
31-40	**69**	**30.0**	**30**	**22.7**	**39**	**39.8**
41-50	**37**	**16.1**	**25**	**18.9**	**12**	**12.2**
≥ 51	**18**	**7.8**	**11**	**8.4**	**7**	**7.2**
Education						
University degree (≥ 16 years)	**49**	**21.3**	**27**	**20.5**	**22**	**22.4**
Diploma (13-15 years)	**17**	**7.4**	**6**	**4.5**	**11**	**11.2**
Secondary school (10-12)	**90**	**39.1**	**56**	**42.4**	**34**	**34.7**
Preparatory school (7-9)	**44**	**19.1**	**26**	**19.7**	**18**	**18.4**
Primary school (1-6)	**30**	**13.1**	**17**	**12.9**	**13**	**13.3**
Illiterate	**0**	**0**	**0**	**0**	**0**	**0**
Driving license type						
Private	**75**	**32.6**	**37**	**28.0**	**38**	**38.8**
Commercial /marketing	**120**	**52.2**	**64**	**48.5**	**54**	**57.1**
General	**32**	**13.9**	**28**	**21.2**	**4**	**4.1**
Not holding driving license	**3**	**1.3**	**3**	**2.3**	**0**	**0**
Profession						
Driver	**104**	**45.2**	**74**	**56.1**	**30**	**30.6**
Technician	**45**	**19.6**	**26**	**19.7**	**19**	**19.4**
Worker	**31**	**13.5**	**14**	**10.6**	**17**	**17.3**
Governmental staff	**31**	**13.5**	**10**	**7.5**	**21**	**21.4**
Nongovernmental staff	**19**	**8.2**	**8**	**6.1**	**11**	**11.3**
Experience in driving						
1-5 years	**92**	**40.0**	**54**	**40.9**	**38**	**38.8**
6-10	**61**	**26.5**	**31**	**23.5**	**30**	**30.6**
11-20	**51**	**22.2**	**28**	**21.2**	**23**	**23.4**
21-30	**15**	**6.5**	**12**	**9.1**	**3**	**3.1**
≥ 31	**11**	**4.8**	**7**	**5.3**	**4**	**4.1**

5.3.4 General characteristic of the included cars:

The general characteristics of the cars included in the present work were mentioned in Table (5.3). The cars age varied from the 1970 to 2004, while the median car age was 22.0 years. The majority (63.9 %) of cars were produced between 1980-1989. Cars that license as private vehicles constituted 74.3 % of the over all cars, and 62.9 % of the D/G cars and 89.8 % of the LPG cars. Valid license and insurance was reported in 78.7 % and 50.43 % respectively of the overall cars, while 50.0 % of the overall cars were licensed and insured.

According to official license of the cars, non of the car engine was authorized to work on LPG, while 63.0 % were authorized as gasoline engine and 37.0 % as diesel engine. However, 42.6 % of the car engines are currently working on LPG, 48.7 % on diesel, and only 8.7 % on gasoline.

The economical crisis and the constrains applied by the occupation authorities are reflected clearly in the mean age (20.41 years) of the cars working on the roads of the Gaza Strip, with two-thirds of them were produced between 1980-1989. The poor quality of life of the people is also obvious from the percentage of cars (50.0 %) that are licensed to work and insured.

Opportunely, the proposal for adopting and authorizing LPG as a vehicles fuel in Palestine was discussed and approved by the Minister Council in 2006, however, neither the official decision was yet declared nor the methodology for switching cars to LPG was approved. Although, 42.6 % are currently working on LPG with no official or specialized follow up and consideration.

Table (5.3): General characteristics of the included cars

General characteristics	Overall cars (N= 230)		D /G cars (N= 132)		LPG cars (N= 98)	
Production year	N	%	N	%	N	%
2000-2004	**16**	**7.0**	**11**	**8.3**	**5**	**5.1**
1990-1999	**61**	**26.5**	**40**	**30.3**	**21**	**21.4**
1980-1989	**147**	**63.9**	**78**	**59.1**	**69**	**70.4**
1970-1979	**6**	**2.6**	**3**	**2.3**	**3**	**3.1**
Car licensed as						
Private	**171**	**74.3**	**83**	**62.9**	**88**	**89.8**
Commercial/marketing	**30**	**13.1**	**21**	**15.9**	**9**	**1.0**
General	**29**	**12.6**	**28**	**21.2**	**1**	**9.2**
License validity						
Valid	**181**	**78.7**	**104**	**78.8**	**77**	**78.6**
Not valid	**49**	**21.3**	**28**	**21.2**	**21**	**21.4**
Insurance validity						
Valid	**116**	**50.43**	**67**	**50.8**	**49**	**50.0**
Not valid	**114**	**49.57**	**65**	**49.2**	**49**	**50.0**
Both license and insurance validity						
Valid	**113**	**49.13**	**66**	**50.0**	**47**	**48.0**
Not valid	**115**	**50.87**	**66**	**50.0**	**51**	**52.0**
Car authorized fuel						
Gasoline	**145**	**63.0**	**47**	**35.6**	**98**	**100.0**
Diesel	**85**	**37.0**	**85**	**64.4**	**0**	**0**
Current fuel used						
LPG	**98**	**42.6**	**0**	**0**	**98**	**100**
Gasoline	**20**	**8.7**	**20**	**15.2**	**0**	**0**
Diesel	**112**	**48.7**	**112**	**84.8**	**0**	**0**

5.3.5 Knowledge of the drivers toward the use of LPG as car fuel:

Table (5.4) summarizes the knowledge of the drivers (D/G, and LPG) toward the use of LPG as car fuel. Interestingly, all the respondent drivers revealed a knowledge about the use of LPG as car fuel, while the majority of them (61.4 % of the D/G drivers and 74.5 % of the LPG drivers) have knowledge about the methodology for LPG switching. The percentage of LPG drivers who have a knowledge about the methodology of how LPG is used as car fuel was significantly higher than that of D/G drivers, p=0.019. Expectantly, the major knowledge source for D/G and LPG drivers (43.9 % and 79.0 % respectively) about LPG is the car technicians, which could be considered significantly when the responsible authorities design their programs and advertisements aiming at the encouragement of the drivers for LPG switching.

The majority of the drivers (80.3 % of the D/G and 72.4 % of LPG) knew that LPG is not an authorized car fuel yet in the Gaza Strip. However, and despite of their reduced percentage, some drivers believed incorrectly that LPG is already authorized for car use. When the drivers were questioned about their knowledge regarding the LPG switching whether it performed within authorized atelier or not, they (87.9 % of D/G and 85.7 % of LPG) showed good knowledge that all LPG switching occurred with unauthorized ateliers. The main cause of increasing maintenance and reduced efficiency of LPG cars was the conversion by unapproved specialist and/or ateliers. Therefore, it should be taken into consideration that only specialized and experienced ateliers are authorized and followed up for LPG switching **(**Karamangil, 2007).

Although of its health, and environmental soundness, however, the vast majority of the drivers (79.5 % of D/G and 71.4 % of LPG) attributed the LPG switching to the economical impact of the LPG compared to diesel or gasoline. The constrains powered by the occupation authorities in terms of gasoline and diesel scarcity and continued increasing prices could be a direct explanation for the LPG switching in the Gaza Strip. Unfortunately, lower percentages of the drivers (8.3 % of the D/G and 35.7 % of LPG) showed correct knowledge about the healthy and environmentally advantages of LPG. However, the percentage of LPG drivers was significantly higher that of D/G drivers, $p < 0.001$. Therefore, the responsible authorities should focus on the environmental and health issues together with the economical impacts when advertising the LPG switching.

Regarding the security and public safety of LPG switching under the current way and conditions, the vast majority of the drivers (93.9 % of D/G and 75.5 % of LPG) expressed their anxious and worries about public safety. In this it is worthwhile to mention that a considerable number of explosive accidents from LPG leakage were attributed to the haphazard and unauthorized switch to LPG (Sugie *et al.*, 2004). Therefore, and to secure public safety from a relatively preventable explosions and fires, specific standards and constrains must be adopted when the LPG switching is approved in the Gaza governorates.

The drivers of the present study (83.3 % for D/G and 78.6 %for LPG) showed a good knowledge with regard to the increased injuries and impairments of the LPG engine as well as (84.8 % of D/G and 76.5 % of LPG) to the negative change of the LPG engine mechanical power compared to diesel or gasoline engines. The reports and studies in this regard explain the increased injuries and impairments of the LPG engine to the non-lubricating nature of the LPG fuel as compared to gasoline or diesel which continuously provide the car engine with lubrications needed for the power valves to work properly. Absence or reduced valve lubrication results in valve damage and therefore increase injuries and reduce the life of the engine. This issue is not applicable for the cars that originally built-in to work on LPG. However, for switched cars, which is also known as hybrid fuel or dual fuel cars, powering the engine regularly with gasoline or diesel could solve the lubrication problem properly (Katsuaki *et al.*, 1999; Kimihiko *et al.*, 2000).

Reports also mentioned a power loss of about 4 -20 % among engines that have been converted to burn LPG. However, solutions for the reduced power of the LPG engines could be overcame by using superchargers or turbochargers to increase the volume of air that's burned with LPG in the engine's combustion chambers (Naoya *et al.*, 1999; Leea & Ryub, 2005; Olvera, 2008).

On the other hand, the regular maintenance of the engine can be reduced when using LPG. Using LPG reduces the wear and tear on spark-ignited engines. Engine oil does not need to be changed as frequently, plus spark plugs and engines have been found to last longer than cars powered by gasoline. Typically, LPG-fueled cars start easier in cold temperatures, too, but the opposite can be true in hot days (Olivera, 2008).

Table (5.4) knowledge of drivers toward the use of LPG as car fuel

Item / Question	D/G N=132				LPG N=98				Z test	
	N	**%**	**Chi sq**	**p value**	**N**	**%**	**Chi sq**	**P value**	**Z value**	**P value**
Knowing that LPG used as car fuel										
Know	132	100			98	100				
Knowledge about how LPG is used as cars fuel										
Yes	81	61.4	6.82	**0.009**	73	74.5	23.51	**0.000**	2.09	**0.019**
Source of knowledge										
Car technicians	58	43.9	95.25	**0.000**	48	49.0	69.74	**0.000**	0.77	**>0.05**
media	12	9.1			16	16.3			1.65	**0.049**
Others	5	3.8			6	6.1			0.80	**>0.05**
Formal organizations	6	4.5			3	3.1			0.54	**>0.05**
LPG is authorized as car fuel										
yes	26	19.7	46.8	**0.000**	27	27.6	19.76	**0.000**	1.41	**>0.05**
Up To your knowledge, the Reason behind using LPG as car fuel										
Economical	105	79.5	338.70	**0.000**	70	71.4	72.82	**0.000**	1.42	**>0.05**
Obligatory	19	14.4			26	26.5			2.29	**0.011**
Environmental	3	2.3			2	2.0			0.15	**>0.05**
Health	5	3.8			0	0.0			1.95	**0.026**
Switching to LPG is performed by authorized atelier										
Yes	16	12.1	68.26	**0.000**	14	14.3	46.34	**0.000**	0.49	**>0.05**
LPG is healthy and environmentally sounded fuel										
Yes	11	8.3	91.67	**0.000**	35	35.7	8.00	**0.005**	5.14	**0.000**
In the current way, LPG is secure for public safety										
Yes	8	6.1	101.94	**0.000**	24	24.5	25.51	**0.000**	3.99	**0.000**

Continue, Table (5.4) knowledge of drivers toward the use of LPG as car fuel

	D/G N=132				LPG N=98				Z test	
Item / Question	**N**	**%**	**Chi sq**	**P value**	**N**	**%**	**Chi sq**	**P value**	**Z value**	**P value**
Using LPG will affect motor injury (impairments)									.	
Increased	110	83.3	58.67	**0.000**	77	78.6	32.00	**0.000**	0.90	**>0.05**
Decreased	22	16.7			21	21.4			0.90	**>0.05**
Reduction in fuel cost when using LPG									.	
< 20 %	21	15.9	53.30	**0.000**	12	12.2	35.39	**0.00**	0.79	**>0.05**
20-40 %	66	50.0			26	26.5			3.60	**0.000**
40-60 %	31	23.5			48	49.0			4.03	**0.000**
> 60 %	14	10.6			12	12.2			0.38	**>0.05**
Expected change in motor power with LPG									.	
Positive	9	6.8	87.68	**0.000**	18	18.4	34.94	**0.000**	2.70	**0.003**
Negative	112	84.8			75	76.5			1.60	**>0.05**
No change	11	8.4			5	5.1			0.97	**>0.05**
For same amount of money, Car moves more kilometers with									.	
LPG	31	23.5	10.77	**0.005**	54	55.1	27.02	**0.000**	4.91	**0.000**
Diesel	61	46.2			12	12.2			5.48	**0.000**
Gasoline	40	30.3			32	32.7			0.39	**>0.05**
Up To your knowledge, the Best fuel for cars is										
Diesel	95	72.0	69.82	**0.000**	6	6.1	74.04	**0.000**	9.96	**0.000**
Gasoline	32	24.2			72	73.5			7.43	**0.000**
LPG	5	3.8			20	20.4			4.00	**0.000**

With respect to economical benefits, 50 % of D/G drivers expected a reduction of 20-40 % in fuel costs when switching to LPG, while 49.0 % of LPG drivers expected a reduction of about 40-60 % of fuel costs. However, the D/G drivers voted for diesel and LPG drivers voted for LPG for cars to move more kilometers with same amount of money. The knowledge of the drivers toward the reduction in fuel cost and the functional kilometers when conversion to LPG was satisfactory and comparable with the results of the studies published in this regard. The LPG drivers expected a reduction of 40-60 % in fuel costs, which is concomitant to the published figures which showed that running an LPG car can help driver to save up to 50% on his fuel costs (Armstrong, 1980, Di Pascoli *et al.,* 2001).

At last, the majority (72.0 %, $p < 0.001$) of D/G drivers and the majority (73.5 %, $p < 0.001$) of LPG drivers are considering diesel and gasoline respectively as best fuel for their cars. This could be explained and related to different interfering factors. One of these factors is the disorganized switching to LPG by unapproved and less experienced motor technicians, which put the drivers under hesitated and uncertain situation. Secondly, the absence of the LPG fuel stations that facilitates and allows the direct filling of the LPG tank or cylinder conveniently. Thirdly, is the absence of informative brochures and pamphlets that could guide the drivers towards all advantages of LPG and hence enhance his believe and trust in the LPG as alternative fuel with all personal and environmental benefits. Last but not least, is the lack of support and advertisement for the LPG from the responsible authorities in Palestine represented by the related ministries like transportation, environmental affairs, finance, and petroleum and energy authorities? We could expect an increased number of drivers switching their car engine to LPG if the conversion occurs under the full supervision and responsibility of the ministry of transportation.

5.3.6 Attitude of drivers toward the use of LPG as car fuel:

The responses to the questions about the attitude of the drivers toward the use of LPG are mentioned in Table (5.5) and constituting five items. Significantly higher percentage (66.3 %, p =0.001) of LPG drivers supported the introduction of LPG as car fuel, while the majority (81.1 %) of D/G drivers did not support the LPG as car fuel. Although the drivers in their general knowledge favored diesel and gasoline over LPG, however, in their attitude the LPG drivers significantly (66.3 %, p <0.001) supported the introduction of LPG as car fuel, and they greatly preferred (75.5 %, p <0.001) it to be introduced under legal and official conditions. Unfortunately the D/G drivers don't favor (81.1 %, p ,0.001) LPG introduction even under legal and official conditions (65.9 %, p< 0.001), and this could be explained due to lack of experience of those drivers in manipulating and utilizing LPG as car fuel. The attitude of those D/G drivers could be changed if they take the opportunity to use LPG cars.

When the drivers were asked about the preferable fuel under equal or comparable economical benefits, the majority (82.7 %) of LPG drivers preferred the LPG. However, 53.8 % of D/G drivers significantly preferred diesel, 42.4 % preferred gasoline, and only 3.8 % preferred LPG.

Regarding the attitude of the drivers toward the recommendation of LPG as car fuel, the majority of D/G drivers (83.3 %) and LPG driver (71.4 %) supported the economical point of view in recommending LPG as car fuel, while only 5.7 % of the drivers could recommend it due to environmental and health considerations. The environmental and health positive impacts of LPG were not among the attitude of the drivers for advertising and recommending LPG. The majority of the D/G and LPG drivers thought that LPG could be recommended for economical point of view. The unconsciousness of the environmental and health benefits of LPG as car fuel and its role in reducing the emissions that threaten the environment and public health could be solved through organizing workshops, media programs and meetings, brochures, and providing the people with facts and information in this regard.

Table (5.5) Attitude of drivers toward the use of LPG as car fuel

	D/G drivers N= 132				LPG N= 98				Z test	
Item / Question	**N**	**%**	**Chi sq**	**P value**	**N**	**%**	**Chi sq**	**P value**	**Z value**	**P value**
Support using LPG as car fuel										
Yes	25	18.9	50.94	**0.000**	65	66.3	10.45	**0.001**	7.28	**0.000**
LPG is the best fuel for the car engine										
Yes	18	13.6	78.07	**0.000**	68	69.4	14.74	**0.000**	8.65	**0.000**
Agree to use LPG in the present conditions										
Yes	37	28.0	25.49	**0.000**	55	56.1	1.47	**0.225**	4.30	**0.000**
Agree to use LPG under legal and official conditions										
Yes	45	34.1	13.36	**0.000**	74	75.5	25.51	**0.000**	6.21	**0.000**
At equal (comparable) economical benefits, the preferred fuel										
Gasoline	56	42.4	54.41	**0.000**	81	82.7	108.2	**0.000**	6.16	**0.000**
Diesel	71	53.8			5	5.1			7.76	**0.000**
LPG	5	3.8			12	12.2			2.40	**0.000**
LPG could be recommended										
Economically	110	83.3	365.23	**0.000**	70	71.4	55.21	**0.000**	2.16	**0.015**
Environmentally	3	2.3			2	2.0			0.15	> **0.05**
Healthily	6	4.6			2	2.0			1.06	> **0.05**
Safely	13	9.8			24	24.6			3.02	**0.001**

5.3.7 General practice of the drivers:

Table 5.6 presented the general practice of the 230 drivers, while the specific practice of the LPG drivers toward the use of LPG is mentioned in Table (5.7).

As shown in Table (5.6), the majority of the D/G drivers (65.9 %) and the majority of the LPG drivers (65.3%) check up their car engine only when it impaired. Both D/G and LPG drivers revealed a low level of awareness and attentiveness with regard to safety measures in cars like fire extinguishers and first aid kits. The majority of cars (67.4 %) are working on roads without fire extinguisher, while 83.0 % are did not have first aid kit. It is obvious that the majority of the drivers expressed less attention to the maintenance of their cars, and also to the presence of safety measures that could prevent or minimize the threatens on the car users and the public safety as well. These maintenance and safety items should occupied the attentiveness of the drivers in general, however, responsible authorities must check them when working license is to be renewed.

A significant higher percentage (60.6 %) of D/G drivers revealed a daily driving hours in the range of 7-12 hours, while the significantly higher percentage of LPG drivers (55.1 %) spend less than 6 hours per day in driving. However, the majority of both categories of drivers considered some relax hours during daily driving.

Smoking was found to be allowed by more than half of the drivers. The Smoking inside cars is allowed by (59.8 %) of D/G drivers and by 55.1 % of the LPG drivers, no significant difference was reported between the two categories with regard to allowed smoking, $p > 0.05$.

Table (5.6) General practice of all drivers

	D/G N=132				LPG N=92				Z test	
Item / Question	**N**	**%**	**Chi sq**	**P value**	**N**	**%**	**Chi sq**	**P value**	**Z value**	**P value**
Duration of engine checkup and Safekeeping										
< 6 moths	30	22.7			20	20.4			0.41	>0.05
7-12 moths	14	10.6	130.61	**0.000**	13	13.3	92.49	**0.000**	0.62	>0.05
> 12 months	1	0.8			1	1.0			0.16	>0.05
Only when impaired	87	65.9			64	65.3			0.09	>0.05
Smoke released from exhaust										
Yes	47	35.6	10.94	**0.001**	26	26.5	21.59	**0.000**	1.46	>0.05
Presence of fire extinguisher										
Yes	46	34.8	12.12	**0.000**	29	29.6	16.33	**0.000**	0.83	>0.05
Presence of first aid kit										
Yes	22	16.7	15.52	**0.000**	17	17.3	40.92	**0.000**	0.08	>0.05
Number of daily driving hours										
< 6 hours	44	33.3			54	55.1			3.30	
7-12 hours	80	60.6	58.91	**0.000**	42	42.9	45.39	**0.000**	2.65	
> 12 hours	8	6.1			2	2.0			1.50	>0.05
Relax during daily driving										
Yes	114	86.4	69.82	**0.000**	82	83.7	43.56	**0.000**	0.78	>0.05
Smoking allowed										
Yes	79	59.8	5.12	**0.024**	54	55.1	1.02	**0.312**	0.71	>0.05

In this regard and as LPG is suspicious explosive gas, smoking must be prohibited in LPG cars, otherwise, public safety is vulnerable for dangerous accidents. Different reports and cases showed dangerous accidents due to cigarette smoking behind LPG sources (Chang & Lin, 2006; Brook, 2008; Stokes, 2008) Therefore, direct and powerful measures and restrictions must be applied for smoking in cars especially cars powered by gaseous fuels.

5.3.8 Specific practice of the LPG drivers:

Table (5.7) showed the specific practice of the LPG drivers toward the use of LPG for their car engines. The higher and significant percentage of the drivers were switched their car engine to LPG since 6-12 months, P= 0.001. This could be attributed to the deteriorated economical situation together with the severity of the blockade and scarcity of regular fuel supply in the last year enforced the majority of the drivers of the present study to convert engines to LPG, which is relatively less scarce fuel as it used in household purposes.

A significant percentage (52.0 %, p =0.001) of the LPG drivers utilize weekly 4 or more LPG cylinders of 12 Kg. This amount should be considered well by the Ministry of Transportation and Petroleum and energy authority before authorizing the LPG as car fuel which may affect the household quota of LPG and resulted in LPG shortage for cooking and heating.

Fortunately, the majority of LPG drivers did not report unpleasant odor or unburned gas inside or outside cars, or gas odor on clothes. The vast majority of the drivers (about 93 %) did not report fire or explosive accident while powering engines with LPG. The odorless and the safe status of the cars reported by the LPG drivers may reflect a good methodology in conversion of engine to LPG by the unauthorized motor technicians. Luckily, the majority of LPG drivers did not report criticism upon using LPG as car fuel, which give an early prediction of the acceptability of LPG by the public.

Table (5.7): specific practice of LPG drivers

Item		Number	%	Chi seq	p-value
Using LPG since					
	< 6 months	17	17.4	18.02	**0.000**
	6-12 months	51	52.0		
	13-24 months	30	30.6		
Average weekly consumption of LPG cylinders (12 Kg)					
	One or less	33	33.7	17.60	**0.001**
	2-3	13	13.3		
	4-5	15	15.3		
	> 5	37	36.7		
Unpleasant odor smelling (inside car) during driving					
	Yes	40	40.8	3.31	**0.069**
Unburned gas odor smelling from exhaust					
	Yes	41	41.8	2.61	**0.106**
Fire or explosive accident while using LPG					
	Yes	7	7.1	71.02	**0.000**
Criticism arise by passengers for using LPG					
	Yes	36	36.7	6.44	**0.011**
Gas odor on clothes when return home					
	Yes	17	17.3	40.92	**0.000**

5.3.9 Health status of car drivers:

The health status of the drivers was investigated and the results were shown in Table (5.8). The majority (70.4 %) of LPG drivers expressed no negative changes on their health status after switching to LPG, while the majority of the D/G drivers (59.1 %) reported a negative change in health status due to driving. A significantly higher parentage of D/G drivers (53.0 %) reported headache compared to only 21.4 % of the LPG drivers. The same higher significant percentages are found in D/G drivers when compared to LPG drivers for complains related to blurred vision, and nausea. However, when health complains are related to dyspenea and depression, the differences were non significant, p >0.05.

The health complains score also significantly favors LPG as better fuel on driver health. Kruskal-Wallis test revealed a significant (Chi square = 18.39, p=0.000) difference between the health status (as percentage of complain score) and the type of fuel used by the drivers. Drivers using LPG showed the lowest complains score followed by diesel users, while gasoline users with the highest complain score. The mean ranks were 95.45, and 127.56 and 148.28 respectively.

The health complains score (zero to 100) revealed that a significantly higher proportion of LPG drivers (55.1 %) compared to 28.8 % of D/G drivers reported no complains at all. While highest complains score of 100 was reported significantly in 11.4 % of D/G drivers compared to 2.0 % of LPG drivers. Additionally, a significant (Chi –square = 25.85, p=0.000) differences were reported between the health status (as percentage of complain score) and the measured VOC. Non significant differences were reported in health status of the drivers when tests for the driver age, education level, and experience of the drivers.

Table (5.8): health status of car drivers

	D/G drivers N= 132				LPG drivers N= 98				Z test	
Item / Question	**N**	**%**	**Chi sq**	**P value**	**N**	**%**	**Chi sq**	**P value**	**Z value**	**P value**
Health status changed negatively										
Yes	78	59.1	4.36	**0.037**	29	29.6	16.33	**0.000**	4.32	**0.000**
Headache while driving car										
Yes	70	53	0.485	**0.49**	21	21.4	32.00	**0.000**	4.85	**0.000**
Blurred vision while driving car										
Yes	50	37.9	7.76	**0.005**	12	12.2	55.88	**0.000**	4.34	**0.000**
Nausea while driving car										
Yes	37	28	25.49	**0.000**	13	13.3	52.90	**0.000**	2.67	**0.003**
Dyspenea while driving car										
Yes	42	31.8	17.46	**0.000**	25	25.5	23.51	**0.000**	1.04	> **0.05**
Depression and / or hopelessness while driving car										
Yes	54	40.9	4.36	**0.037**	33	33.7	10.45	**0.001**	1.11	> **0.05**
Health complain score (zero to 100)										
No complains	38	28.8	19.18	**0.002**	54	55.1	110.29	**0.000**	4.03	**0.000**
20	26	19.7			16	16.3			0.66	> **0.05**
40	23	17.4			9	9.2			1.78	**0.038**
60	14	10.6			8	8.2			0.61	> **0.05**
80	16	12.1			9	9.2			0.69	> **0.05**
100	15	11.4			2	2.0			2.69	**0.004**

For drivers using LPG, the Spearman rank correlation coefficient $\boldsymbol{r_s}$ showed a direct and significant correlation between the health complain score and the measured VOC (r_s =0.42, p = 0.000), the age of the car ($\boldsymbol{r_s}$ =0.23, p = 0.022). While no significant correlations were reported between the health complain score and driver experience ($\boldsymbol{r_s}$ = - 0.04, p = 0.70), driver age ($\boldsymbol{r_s}$ =0.09, p = 0.35), and years of education ($\boldsymbol{r_s}$ =0.06, p = 0.59).

On the other hand, drivers using D/G, the Spearman rank correlation coefficient rs showed a direct and significant correlation between the health complain score and the measured VOC ($\boldsymbol{r_s}$ =0.32, p = 0.000), while no significant correlations were reported between the health complain score and the age of the car ($\boldsymbol{r_s}$ =-0.03, p = 0.76).driver experience ($\boldsymbol{r_s}$ = - 0.06, p = 0.49), driver age ($\boldsymbol{r_s}$ =-0.085 , p = 0.33), and years of education ($\boldsymbol{r_s}$ =0.01, p = 0.88).

The relatively good health of the LPG drivers is concomitant with the published reports about the safety of LPG on driver health which mainly due to the less emissions produced by burning of LPG compared to gasoline and diesel. In this study, we also reported a significant correlation between the health status of the drivers and the measured VOC (Ristovski *et al.,* 2005; IANGV, 2007; Yang *et al.,* 2007).

5.4 Measurements of the volatile organic compounds (VOC)

Table (5.9) was assigned to present the amount as part per million (ppm) of the volatile organic compounds that recorded inside the cars of the present work.

Both categories of cars showed more or less degree of VOC inside car, the higher percentage of D/G cars (53.0 %) and LPG cars (49.0 %) recorded 20 ppm of VOC. While

6.1 % of LPG and 1.5 % of D/G cars recorded 50 ppm of VOC. Fortunately, higher concentrations of VOC > 50 ppm were not reported in any of the cars of the present study.

Table (5.9): VOC measurements of cars

	D/G cars (N= 132)				**LPG cars** (N= 98)			
Voc (ppm)	**N**	**%**	**Chi sq**	***P* value**	**N**	**%**	**Chi Sq**	***P* value**
0	**7**	**5.3**	**103.21**	**0.000**	**1**	**1.0**	**73.02**	**0.000**
20	**70**	**53.0**			**48**	**49.0**		
40	**53**	**40.2**			**43**	**43.9**		
50	**2**	**1.5**			**6**	**6.1**		

A significant (Chi –square = 12.31, *p*=0.002) difference between the measurements of VOC and the type of fuel used by the drivers was reported using Kruskal-Wallis test. The lowest amount of VOC was recorded in diesel based engines, followed by LPG based engines, while gasoline based engines showed the highest VOC score, the mean ranks were respectively: 103.99, 122.24, and 151.72.

Although of the non significant correlation between the amount of VOC and the age of LPG cars (r_s = - 0.06, p = 0.58), however direct and significant correlation was reported in D/G cars (r_s = 0.31, p = 0.000).

Different studies and repots mentioned the impact of vehicle emissions (VOC, CO_2, CO, NO, PM) on the health and environments of the people in different countries. These studies illustrated that LPG vehicles produces at least 20 % less CO_2, 60 % less CO and 20 % less NO than gasoline or diesel (Yang *et al.*, 2007; Gasca *et al.*, 2004). In our study the statistical analysis revealed lowest VOC emissions to diesel cars followed by LPG and the higher emissions to gasoline cars. The relatively higher emissions of LPG cars than diesel cars could be attributed to random and unauthorized and unchecked conversion pipes and system. This explanation is also supported by the insignificant correlation between the amount of VOC and the LPG car age, while VOC amount was significantly correlated to of D/G car age. Performing conversions under the full supervision and authority of Ministry of transportation and by authorized motor technicians is expected to reduces the emissions of the LPG cars and hence protect and keep the advantages of LPG on public health and environment valid.

The present study which was performed in the different governorates of the Gaza Strip emphasizes a considerable percentage of LPG cars that are working in the Gaza Strip. All engine conversions to LPG were performed by unauthorized technicians. The overall evaluation of knowledge, attitude and practices of the drivers toward the use of LPG as alternative fuel demonstrated relatively unsatisfactory results. The public health and environmental soundness of LPG as engine fuel were not among the concerns or approach of the majority of the drivers who are forced to LPG switching either due to scarcity or elevated prices of traditional fuels. Low levels of awareness attentiveness were concluded for the practice of the drivers. However, the unchanged health status of the LPG drivers may encourage other drivers to believe in and switch their car engine to LPG. Last but not least, if the responsible authorities are indented to approve and permit the car engine switching to LPG, a comprehensive informative, awareness and advertising programs should be organized very well and aiming at the enhancement of the people to LPG switching with more concentration on public health and environmental considerations.

Chapter 6

Conclusions and Recommendations

6.1 Conclusions

This present study, which conducted in the five governorates of the Gaza Strip, was designed as cross sectional study and aimed at the investigation of the health status of the car drivers in relation to type of fuel they used, meanwhile it further aimed at the evaluation of the knowledge, attitude and practices of vehicle drivers toward the use of LPG as a alternative car fuel in Gaza Strip. Also it aimed at the recommendation of preventive measures that could improve the new experience in using the LPG as car fuel in the Gaza Strip. Up to our best knowledge and available published resources, our study could be considered as the first ever study that address the topic of LPG switching in Arab world. Close ended questionnaire was the main tool of the present study. Additionally, the researcher measured the level of VOC using the C-21 VOC Gas Sensor which is suitable to relatively quantify the amount of the leakage of VOC of LPG, diesel, and gasoline inside the car space.

Appreciatively, 230 of 255 drivers filled the questionnaire which indicated a total response rate of 90.2 %. Our data showed an acceptable and satisfactory levels of randomness which were verified by performing the runs test on the age and years of experience of the drivers. The following paragraphs summarize the outcomes of the study.

Non of the car engines was authorized to work on LPG. However, 42.6 % of the car engines are currently work on LPG, 48.7 % on diesel, and only 8.7 % on gasoline. Valid license and insurance were reported in 78.7 % and 50.0 % respectively of the overall cars, while 50.0 % of the overall cars were both licensed and insured. All the respondent drivers revealed a knowledge about the use of LPG as car fuel, while the majority of them have knowledge about the methodology for LPG switching, with car technicians were the major source of knowledge. The vast majority of the drivers knew that LPG is not an authorized car fuel yet in the Gaza Strip, also drivers showed good knowledge that all LPG switching occurred with unauthorized ateliers.

Despite of the its health, and environmental soundness, however, the vast majority of the drivers attributed the LPG switching to the economical impacts of the LPG compared to diesel or gasoline. Unfortunately, low percentages of the drivers showed correct knowledge about the healthy and environmentally advantages of LPG. The vast majority of the drivers expressed their anxious and worries about public safety due to LPG switching under the current way and conditions. The drivers showed a good knowledge with regard to the increased injuries and impairments of the LPG engine as well as to the negative change of the LPG engine mechanical power compared to diesel or gasoline engines. While, nearly half of the drivers expected a reduction of 20-60 % in fuel costs when switching to LPG. The majority of D/G drivers and LPG drivers are considering diesel and gasoline respectively as best fuel for their cars.

Significantly high percentage of LPG drivers supported the introduction of LPG as car fuel and they greatly preferred it to be introduced under legal and official conditions, while the majority of D/G drivers did not support the LPG as car fuel even under legal and official conditions. The environmental and health positive impacts of LPG were not among the attitude of the drivers for advertising and recommending LPG as car fuel, where the majority of drivers supported the economical point of view in recommending LPG as car fuel. The majority of the drivers check up their car engine only when it impaired. They also revealed a low level of awareness and attentiveness for safety measures in cars like fire extinguishers and first aid kits. Surpassingly, smoking was found to be allowed by the majority of the drivers.

Fortunately, the majority of LPG drivers did not report unpleasant odor or unburned gas inside or outside cars, or gas odor on clothes. The vast majority of the drivers did not report fire or explosive accident while powering engines with LPG. The majority of LPG drivers expressed no negative changes on their health status after switching to LPG, while more than half of the D/G drivers reported a negative change in health status due to driving. A significantly higher parentage of D/G drivers reported headache/ blurred vision/ nausea compared to the LPG drivers. The health complains score percentage significantly favors LPG as better fuel on driver health. Drivers using LPG showed the lowest complains score percentage followed by diesel users, while a gasoline user with the highest complains score percentage.

All categories of cars showed more or less degree of VOC emissions, however the majority of the cars revealed the lowest emission level of 20 ppm. Fortunately, higher concentrations of VOC > 50 ppm were not reported in any of the cars of the present study. The lowest amount of VOC was recorded in diesel based engines, followed by LPG based engines, while gasoline based engines showed the highest VOC score. For all drivers, direct and significant correlation was found between the health complains score percentage and the measured VOC.

In conclusion, the present study emphasizes a considerable percentage of LPG cars that are working in the Gaza Strip. All engine conversions to LPG were performed by unauthorized technicians. The overall evaluation of knowledge, attitude and practices of the drivers toward the use of LPG as alternative fuel demonstrated relatively unsatisfactory results. The public health and environmental soundness of LPG as engine fuel were not among the concerns or approach of the majority of the drivers who are forced to LPG switching either due to scarcity or elevated prices of traditional fuels. The unchanged health status of the LPG drivers may encourage other drivers to believe in and switch their car engine to LPG. Last but not least, if the responsible authorities are indented to approve and permit the car engine switching to LPG, a comprehensive informative, awareness and advertising programs should be organized very well and aiming at the enhancement of the people to LPG switching with more concentration on public health and environmental concerns.

6.2 Recommendations

According to the deteriorated economical situation at the Gaza Strip together with the scarcity or elevated prices of traditional fuels, a considerable number of car drivers illegally switched their vehicle engine to LPG instead of gasoline or diesel. Among the aims of the present study was the recommendation of safety, preventive, and operative measures that could improve the LPG switching experience in the Gaza Strip. Therefore, the researcher, hereby, provides some recommendations that could help in improving new experience of LPG cars. These recommendations are formulated based on the results of the present study and on public health and environmental concerns.

6.2.1 Recommendations for ministries, authorities and official parties:

- Organizing open and direct workshops and media meetings with officials, experts and environmental and public health committees for the advantages and beneficial effects of LPG as vehicle fuel.
- Full and comprehensive discussions among the responsible parties with the Palestinian Energy and petroleum authority for a comprehensive action plan that identify and calculate the actual needs of LPG according to the number of authorized LPG cars.
- Full and detailed LPG switching guidelines preferred to suggested and approved by the Palestinian measurements and standards authority. The approved guidelines should be implemented and checked carefully before the authorization or renewal of an expired LPG-based car operation license.
- Activation and implementation of the 2006 ministry council resolution about approving LPG as an authorized vehicles fuel in Palestine.

- Declaration of the LPG approval decision in the official newspapers with attractive advertising titles that could draw the public attention about the LPG as vehicle fuel.
- General health checkup for drivers should be performed periodically for all drivers at their car license renewal.
- Safety measures and engine mechanical validity that include VOC measurements should be performed regularly and unexpectedly on operating cars.
- LPG switching license should be provided for ateliers and car technicians after comprehensive assessments, and LPG cars can be authorized only if switching is performed by an authorized ateliers and car technicians.
- The drivers syndicate could play a major role in promoting drivers for LPG car switching.
- LPG filling stations should be authorized and established which will provide the drivers with safer way for filling the LPG tanks.
- Reducing the license renewal fees for LPG vehicles could enhance the public for LPG switching.

6.2.2 Recommendations for future studies:

- Other researchers should investigate the effects of the different fuels on the general health of the drivers that include clinical and biochemical laboratory investigations.
- Other researchers should investigate the knowledge, attitudes and practices of passengers toward using of liquefied petroleum gas as a car fuel.
- Other researchers should investigate the toxicological effects of the different fuel fumes and emissions on the biochemical, immunological and hematological parameters of the drivers.

References:

Armstrong R. (1980): "The Role of L.P.G. in Fuel Conservation". technical report produced by Institution of Engineers, Australia, Engineering Conference, **no. 80/2**. 63-67.

Astbury, G. (2008): "A review of the properties and hazards of some alternative fuels, Process Safety and Environment Protection". Ecotoxicol Environ Saf., **44**, doi:10.1016/j.psep.2008.05.001.

Ausma S, Edwards GC, Fitzgerald-Hubble CR, Halfpenny-Mitchell L, Gillespie TJ, and Mortimer WP. (2002): "Volatile hydrocarbon emissions from a diesel fuel-contaminated soil bioremediation facility". J Air Waste Manag Assoc., **52**(7). 769-780.

Australian LPG association (ALPGA) Liquefied Petroleum Gas as an Automotive Fuel (1998): An Environmental and technical Perspective, Report produced by Parsons Australia Pty Ltd for the Australian Liquefied Petroleum Gas Association, Sydney, Australia.

Bahaoddini A, Mohabbatkar H, Rivaz M, Saadat M., (2007): "ECG alteration due to prolong exposure to natural gas leakage containing sulfur compounds in polluted areas of Masjid-I-Sulaiman". Ecotoxicol Environ Saf **31**, doi:10.1016/j.ecoenv.2007.12.014.

Burkett and Randy (2007): Switching system. findarticles.com, Canada. (http://findarticles.com/p/articles/mi_qa5410/is_200709/ai_ n21300798?tag=content;col1, Propane Canada , 22.07.2008).

Cackette TA and Lloyd AC (2001): "Diesel engines: environmental impact and control". J Air Waste Manag Assoc; 51(6):807-8.

California Energy Commission (2006a): Types of natural gas. ENSTERGY QUE, USA. (http://www.ca.gov/transportation/index.html, 12.04.2008).

California Energy Commission (2006b): Propane as alternative fuel. ENSTERGY QUE, USA. (http://www.energyquest.ca.gov/transportation/LNG.html#LPG , 1.04.2008).

Caprino L., Togna G. (1998): "Potential Health Effects of Gasoline and Its Constituents". A Review of Current Literature (1990-1997) on Toxicological Data, Environmental Health perspectives, **106**(3). 115.

Chevron Products Company (2007): Diesel fuel (technical report, 4332 06/07). Chevron Corporation. San Ramon.

Chevron Products Company (2008): what is gasoline.
(http://www.chevron.com/products/ourfuels/mrgas/?&aID=1&cID=11, 15.06.2008).

Chih-Chung C., Jiunn-Guang L., Jia-Lin W. (2001): "Assessment of reducing ozone forming potential for vehicles using liquefied petroleum gas as an alternative fuel". Atmos. Environ., **35**.6201–6211.

Christine & Scott Gable (2008): vehicle fuel. USA.
(http://alternativefuels.about.com/sitesearch.htm?terms=fuel&SUName=alternativefuels&TopNode=99, 9.6.2008).

Cicolella A, (2007): "Volatile Organic Compounds(VOC), definition, classification and properties". Rev Mal Respir, **25**(2). 155-163.

Colling Wood School (2003): Advantages of Using Natural Gas. UK.
(http://www.collingwood.sutton.sch.uk, 04.04.2008).

Consumer Energy Center (2007): LPG as alternative fuel. California.
(http://www.consumerenergycenter.org/transportation/afvs/lpg_propane.html, 22.07.2008).

Corvalán RM, Galecio JI, Salim JA. (2003): "Effectiveness in the use of natural gas for the reduction of atmospheric emissions, industrial sector in the metropolitan region of Santiago". J Air Waste Manag Assoc, **53**(8). 971-975.

Dab W, Ségala C, Dor F, Festy B, Lameloise P, Le Moullec Y, Le Tertre A, Medina S, (2001): "Air pollution and health: correlation or causality? The case of the relationship between exposure to particles and cardiopulmonary mortality". J Air Waste Manag Assoc, **51**(2):220-235.

Dakhel N, Pasteris G, Werner D, Hohener P. (2003): "Small-volume releases of gasoline in the vadose zone". Environ Sci Technol **15**, 37(10). 2127-2133.

Daniel W. (1991): a foundation for analysis in the health sciences. 5th ed. New York: John Wiley and Sons; 1991. p. 576-624.

Di Pascoli S, Femia, A, Luzzati T. (2001): "Natural Gas, Cars and the Environment: A Relatively Clean and Cheap Fuel Looking for Users". Ecological Economics, **38**. pp179–189.

Economopoulou AA., Economopoulos AP., (2002): "Air pollution in Athens basin and health risk assessment". Environ Monit Assess.; **80**(3):277-99.

Engine Mechanics, (2008): what is gasoline and diesel. USA. (http://www.tpub.com/content/engine/14081/css/14081_26.htm, 11.6.2008).

Environmental Protection Agency (1997): "Control of emission of air pollution from Nonroad Diesel Engines". Federal Register Online via GPO Access, Volume 62, Number 185. pp. 50151-50219.

Environmental Protection Agency (2002): Electric fuel. USA**.** (http://epa.gov/otaq/consumer/fuels/altfuels/420f00034.htm., 11.07.2008).

Environmental Protection Agency (2008): Organic gases (Volatile Organic Compound). Washington. (http://www.epa.gov/iaq/voc.html#content, 25.6.2008).

Fernandez, D., Lieberman, D., Robinson, R. (2004): "U.S. Natural Gas STAR Program Success Points to Global Opportunities to Cut Methane Emissions Cost-Effectively". Oil and Gas Journal **102**:26.

Firmusens Energy (2007): Uses of natural gas. UK. (http://www.firmusenergy.co.uk/ publisher/index.jsp?1nID=93&2nID=100&nID=130, 11.03.2008).

Free Patents Online. (2008): Switching to LPG. USA. (http://www.freepatentsonline.com/4721078.htm, 15.6.2008).

Fuel economy (2007a): Alternative fuel. USA. (http://www.epa.gov/oms/consumer/fuels/altfuels/altfuels.htm, 11.07.2008).

Fuel Economy (2007b): biodiesel fuel. USA. (http://www.fueleconomy.gov/Feg/biodiesel.shtml, 15.07.2008).

Fuel Economy (2007c): Ethanol Fuel. USA. (http://www.fueleconomy.gov/feg/ethanol.shtml, 15.07.2008).

Gamas ED, Magdaleno M, Díaz L, Schifter I, Ontiveros L, Alvarez-Cansino G. (2000): "Contribution of liquefied petroleum gas to air pollution in the metropolitan area of Mexico City". J Air Waste Manag Assoc, **50**(2).188-198.

Gasca J., Ortiz E., Castillo H., Jaimes L., Gonz!alez U. (2004): "The impact of liquefied petroleum gas usage on air quality in Mexico City". Atmospheric Environment, **38**. 3517–3527.

Getbus (2008): toxicity of natural gas. (http://www.getbus.org/stories/storyReader$82, 20.03.2008).

Glenn I. (2003): Determining sample size. Program Evaluation and Organizational Development, IFAS, University of Florida. PEOD-6; p.1-5.

Goho A.(2007): How investigate toxicity of diesel in the body**?**. Canada. (http://findarticles.com /p/articles/mi_m1200, 1.03.2008).

Harris, W. (2008): Advantages and Disadvantages of Natural Gas Vehicles. HowStuffWorks Inc., Atlanta. (http://auto.howstuffworks.com/ngv2.htm , 15.3.2008).

Hougaard KS, Jensen KA, Nordly P, Taxvig C, Vogel U, Saber AT, Wallin H, (2008): "Effects of prenatal exposure to diesel exhaust particles on postnatal development, behavior, genotoxicity, and inflammation in mice". Part Fibre Toxicol; **5**(1). 3-11.

IANGV (2007): Natural gas vehicle statics Internationa Association for Natural gas Vehicles. Australia. (http://www.iangv.org/ngv-statistics.html, 25.5.2008).

Jamall IS and Willhite CC. (2007): "Is benzene exposure from gasoline carcinogenic". Monit. Environ J; **10**(2).176-187.

James F. (2007): Uses of natural gas. Seeking Alpha, China. (http://seekingalpha.com/article/42269-china-accelerating-use-of- natural-gas-vehicles, 22.03.2008).

Jeff S. (2007): Biodiesel: fat to fuel. EPA R9 Waste Mgmt., USA. (http://www.epa.gov/region09/waste/biodiesel/index.html, 15/07/2008).

Kaliyaperumal, K. (2004): "Guideline for Conducting a Knowledge, Attitude and Practice (KAP) Study". Community Ophthalmology, **4**(1).7-9.

Kangende KO. (2004): Gasoline Blending Options. Policy Dialogue on Biofuel, Renewable Energy for public Health and enterprise Development, energy regulation board center, USA.

Karamangil I. (2007): "Development of the auto gas and LPG-powered vehicle sector in Turkey: A statistical case study of the sector for Bursa". Energ. Policy, **35**(1). 640-649.

Katsuaki S, Teruaki M, Yasuhiro Y, Teruo T. (1999):" Development of Valve Seat Material for Gas Fueled Engine". Honda R&D Tech Rev, **11**(1).149-156.

Kayne R. (2008): what is natural gas. wisegeek.com, USA. (http://www.wisegeek.com/what-is-natural-gas.htm, 3.4.2008).

Khouzondar, M., (2008): Type of natural gas uses in Gaza. Personal Communication.

Kimihiko A., Akira M., Akio Y. (2000): " Development of Hardfaced Valve and Sintered Valve Seat for Gas Fueled Engines". Proc. JSAE Annu. Congr, **56**.1-4.

Lagorio S, Forastiere F, Lipsett M, Menichini E. (2000): "Air pollution from traffic and the risk of tumors". Ann Ist Super Sanita, **36**(3).311-329.

Leea K, Ryub J. (2005)"An experimental study of the flame propagation and combustion characteristics of LPG fuel". Fuel, **84** (9). 1116-1127

Lena TS, Ochieng V, Carter M, Holguín-Veras J, Kinney PL.(2002): "Elemental carbon and PM(2.5) levels in an urban community heavily impacted by truck traffic". Environ Health Perspect, **110**(10).1009-1015.

Lepow ML, Bruckman L, Rubino RA, Markowtiz S, Gillette M, Kapish J, (1974): "Role of airborne lead in increased body burden of lead in Hartford children". Environ Health Perspect, **7**. 99-102.

Li C, Takahashi S, Taneda S, Furuta C, Watanabe G, Suzuki AK, Taya K. (2007): " Impairment of testicular function in adult male Japanese quail (Coturnix japonica) after a single administration of 3-methyl-4-nitrophenol in diesel exhaust particles " J Endocrinol, **189**(3):555-64.

Liang Y, Zhan L, Zhang Z, Zhang H, Zeng X, Gou X, Lin C, Cai C, Shao X, Shao G, Wu D. (2005): "Genotoxicity comparison between gasoline- and methanol-fueled exhaust by TK gene mutation assay". Journal of biomedical engineering, **22**(2).347-350.

Liu Y, Shao M, Zhang J, Fu L, Lu S., (2005): "Distributions and source apportionment of ambient volatile organic compounds in Beijing city, China". J Environ Sci Health A Tox Hazard Subst Environ Eng, **40**(10).1843-1860.

Loren A, Hallbeck L, Pedersen K, Abrahamsson K. (2001): "Determination and distribution of diesel components in igneous rock surrounding underground diesel storage facilities in Sweden". Environ Sci Technol,**15**,35(2).374-378.

LP Gas Association (2004): definition of propane. USA. (http://www.lpga.co.uk/fr_ab_lp.htm, 2.4.2008).

Mamessier E, Nieves A, Vervloet D, and Magnan A.(2006): "Diesel exhaust particles enhance T-cell activation in severe asthmatics and Allergy". Scand J Work Environ Health, **61**(5).581-588.

Mashi SA, Yaro SA, and Galadanci KM, (2005): "Lead accumulation in surface soils and components of Balenites aegyptica specie in a Katsina urban area, Nigeria". Biomed Environ Sci, **18**(1).15-20.

McKenzie C.H. Lima, Godwin A. Ayokoa,_, Lidia Morawskaa, Zoran D. Ristovskia,E. Rohan Jayaratnea, and Serge Kokotb (2006): A comparative study of the elemental composition of the exhaust emissions of cars powered by liquefied petroleum gas and unleaded petrol. International Laboratory for Air Quality and Health, School of Physical and Chemical Sciences, Queensland University of Technology, Brisbane, QLD 4001, Australia.

Mudipalli A. (2007): "Lead hepatotoxicity & potential health effects". Indian J Med Res, **126**.518-527.

Naoya H, Masakazu S, Akinori M, Akira N, Kunihiko H. (1999): "Development of Fuel Injection Type Lean Burn LPG Engine for Medium-Duty Trucks". Proc. JSAE Annu. Congrs,**73**.1-4.

National Institute on Deafness and Other Communication Disorders (2002): A gas detector can be an important tool to help protect you and your family. USA. (http://www.nidcd.nih.gov/health/smelltaste/gasdtctr.asp, 15.03.2008).

Natural Gas Organization, (2004): Enhances and Promotes to Use of Natural Gas (NG) as Alternative of Fuel. naturalgas.org, USA. (http://www.naturalgas.org/index.asp, 25.03.2008).

Natural Gas Organization (2007): Natural Gas Issues and Trends, USA, (http://www.naturalgas.org/environment/naturalgas.asp,18.03.2008).

Olsgard ML, Bortolotti GR, Trask BR, Smits JE, (2008): "Effects of inhalation exposure to a binary mixture of benzene and toluene on vitamin a status and humoral and cell-mediated immunity in wild and captive American Kestrels". J Toxicol Environ Health A, 71(16). 1100-1108.

Olvera, J. (2008): 5 Things You Need to Know About Liquid Petroleum Gas (LPG). green car journal, summer issue, (http://www.greencar.com/article/liquid-petroleum-gas-lpg, 20.06.2008).

Orange County Convention Center (2001): "Diesel Engines: Environmental Impact and Control— A Critical Review Introduction J Air Waste Manag Assoc, **51**. 52-55.

Ostro B, Chestnut L, Vichit-Vadakan N, Laixuthai A,(1999): "The amount of particular matter exit from diesel vehicles". J Air Waste Manag Assoc, **49**.100-71.

Palestine Ministry of Transportation (2006): Approving and authorizing the LPG as an alternative (Annual Report/2006). Palestinian National Authority. Gaza, Palestine.

Palestine Ministry of Transportation (2007): Number of Cars in Gaza (Annual Report/2007). Palestinian National Authority. Gaza, Palestine.

Palestinian Central Bureau of Statistic (2007): Geographical Information. www.pcbs.gov.ps, Palestine. (http://www.pcbs.gov.ps/Default.aspx?tabID=1&lang=en, 05.01.2008).

Peretz A, Sullivan JH, Kaufman JD, Trenga CA, Allen J, Carlsten C, Aulet MR, and Adar SD. (2008): "effect of PM on heart". Environ Res, **61**(5). 581-588.

Peterson B and Saxon A. (1996): "Global increases in allergic respiratory disease the possible role of diesel exhaust particles". Ann Allergy Asthma Immunol, **77**(4). 263-268.

Pranjić N, Mujagić H, Nurkić M, Karamehić J, and Pavlović S. (2002): "Assessment of health effects in workers at gasoline station". Bosn J Basic Med Sci**, 2**(1-2).35-45 .

Propane council (2008): propane as alternative fuel. propanecouncil.org, USA. (http://www.propanecouncil.org/trade/fleet/index.cfm, 22/07/2008).

Propane Education & Research Council, (2008): LPG as alternative fuel. USA. (http://www.usepropane.com/climateOUNCI. USA, 22/07/2008).

Quan Z., Junichi Y., Masahiro K. (2004): Accurate measurement method for the residues in liquefied petroleum gas (Technical report 2004/ 140-0002). Engineering Co., Ltd. 5-8, Higashi-Shinagawa, Japan.

Ristovski ZD, Jayaratne ER, Morawska L, Ayoko GA, Lim M, (2005): "Particle and carbon dioxide emissions from passenger vehicles operating on unleaded petrol and LPG fuel". Sci Total Environ, **345**(1-3).93-98.

Roux K, Marra P, (2007): "The presence and impact of environmental lead in passerine birds along an urban to rural land use gradient". Arch Environ Contam Toxico, **l53** (2).261-268.

Saadat M and Bahaoddini A. (2004): "Hematological changes due to chronic exposure to natural gas leakage in polluted areas of Masjid-i-Sulaiman". Ecotoxicol Environ Saf, **58**(2). 273-276.

Saadat M, Aminollah B, Samad N. (2004): "Alterations in blood pressure due to chronic exposure to natural sour gas leakage containing sulfur compounds". Biochem Biophys Res Commun, **313**(3).568-569.

Saadata, M, Zendeh-Boodi Z, Goodarzi M. (2005): "Environmental exposure to natural sour gas containing sulfur compounds results in elevated depression and hopelessness scores". Ecotoxicol Environ Saf, **65**(2). 288-291.

Saha A, Rao NM, Kulkarni PK, Majumdar PK, Saiyed HN. (2005): "Pulmonary function and fuel use: a population survey" Respir Res, **31**(2). 361-372.

Schifter I, Magdaleno M,Díaz L, Melgarejo LA, Barrera A, Krüger B, Arriaga JL, López-Salinas E. (2000a): "Contribution of LPG-derived emissions to air pollution in the metropolitan area of Guadalajara City". J Air Waste Manag Assoc, **50**(10).1857-1864.

Schifter I, Díaz L, López-Salinas E, Rodríguez R, Avalos S, Guerrero V. (2000b): "An evaluation of the LPG vehicles program in the metropolitan area of Mexico City". J Air Waste Manag Assoc, **50**(2). 301-309.

Sehili KH , Abaza O. (2006): The impact of traffic congestion and public transportation on air pollution. Road and environmental safety center, West Bank, Palestine.

Sidney D. (1998): characteristics of gasoline. Agency for toxic substance and disease registry, Atlanta. (http://www.eoearth.org/article/Public_Health_Statement_for_Automotive_Gasoline, 22.3.2008)

Silva RL, Barra CM, Monteiro TC, Brilhante OM. (2002): "Groundwater contamination with organic fuels and potential public health impact in Itaguaí, Rio de Janeiro State and Brazil". Cad Saude Publica, **18**(6).1599-1607.

Song Y, Shao M, Liu Y, Lu S, Kuster W,Goldan P, Xie S.,(2007): "Source apportionment of ambient volatile organic compounds in Beijing". Environ Sci Technol.**15**, 41(12).4348-4353.

Spitzer W, Dales R, Schechter M, Suissa T, Tousignant P, Steinmetz N, Hutcheon M., (1989): "Chronic exposure to sour gas emissions: meeting a community concern with epidemiologic evidence". Canadian Medical Association Journal, **141**,7.685-691.

SPSS Inc. (2004): SPSS13 FOR WINDOWS- Statistical package for the social sciences. Chicago, USA. (www.spss.com 15/08/2008*).*

Srivastava A, Joseph AE, More A, Patil S. (2005): "Emissions of VOCs at urban petrol retail distribution centres in India (Delhi and Mumbai)". Environ Monit Assess, **109**(1-3). 227-242.

Stefano Di Pascoli a, Aldo Femia b, Tommaso Luzzati c. (2001): "Natural gas, cars and the environment. A (relatively) 'clean' and cheap fuel looking for users". Ecological Economics, **38**.179–189.

Sugie, H., Sasaki, C., Hashimoto, C.,Takeshita, H., Nagai, T., Nakamura, S., Furukawa, M., Nishikawa, T., Kurihara, K. (2004): "Three cases of sudden death due to butane or propane gas inhalation: analysis of tissues for gas components". Forensic Sci Int.**16**, 143(2-3). 211-214.

Ugwoke CC, Nwobodo ED, Unekwe P, Odike M, Chukwumai ST, Amilo G. (2005): "The reproductive dysfunction effects of gasoline inhalation in albino rats". Niger J Physiol Sci, 20(1-2).54-57.

Ulfvarson U, Alexandersson R, Aringer L, Svensson E, Hedenstierna G, Hogstedt C, Holmberg B, Rosén G, Sorsa M. (1987): "Effects of exposure to vehicle exhaust on health". Scand J Work Environ Health, **13**(6). 505-512.

USA Department of Energy (2007): hydrogen Fuel. USA. (www.fueleconomy.gov/feg/hydrogen.shtml, 15.6.2008).

United States Marine Corps (2008): definition of fuel. USA. (http://mcdetflw tecom.usmc.mil/MTIC/VRC.SNCOIC M970/CHAR.FUELS/.SLP.doc., 22.6.2008).

Van Thuijl, E., Roos, C., Beurskens, L. (2003) An overview of biofuel technologies, markets and policies in Europe. Report of the Energy Research Center of Netherlands ECN-C--03-008: 1-64.

Vanzella TP,Colus IM, Martinez CB. (2007): "Genotoxic and mutagenic effects of diesel oil water soluble fraction on a neotropical fish species". Mutat Res, **10**, 631(1).36-43.

Vouillamoz J, Milke MW, (2001): "Effect of compost in phytoremediation of diesel-contaminated soils". Water Sci Technol, **43**(2). 291-295.

Wikimedia Foundation, Inc,(2008a): Environment effects of Gasoline. U.S.A. (http://en.wikipedia.org/wiki/Gasoline, 22.05.2008).

Wikimedia foundation, Inc. (2008b), LPG as alternative fuel. U.S. A. (http://en.wikipedia.org/wiki/Propane, 1.04.2008).

William E. (2001): type of vehicle fuel(OCS Report/ MMS 2001- 096). Department of the interior Minerals Management Service, USA.

Yang HH, Chien SM, Cheng MT, and Peng CY. (2007): "Comparative study of regulated and unregulated air pollutant emissions before and after conversion of automobiles from gasoline power to liquefied petroleum gas/gasoline dual-fuel retrofits". Environ Sci Technol. **15**, 41(24). 8471-4876.

Zielinska B, (2005): "Atmospheric transformation of diesel emissions". Exp Toxicol Pathol, **57** Suppl, 1:31-42.

Annex (1)

8-AUG-06 TUE 10:13 COUNCIL OF MINISTERS FAX NO. 00972 8 2822222

بسم الله الرحمن الرحيم

السلطة الوطنية الفلسطينية

مجلس الوزراء

قرار مجلس الوزراء رقم (9 /10/16/م.و/ إ.هـ) لسنة 2006
بشأن إعتماد الغاز الطبيعي كوقود بديل للمركبات

بناءً على الصلاحيات المخولة لنا قانوناً

وتنسيب لجنة الاقتصادية الوزارية الدائمة

وبناءً على مقتضيات المصلحة العامة

وبعد الإطلاع على محضر إجتماع اللجنة الاقتصادية الوزارية الدائمة
رقم (07) المنعقدة بتاريخ 2006/07/10

فقد قرر مجلس الوزراء في جلسته المنعقدة بمدينة غزة بتاريخ (2006/07/18) ما يلي:

مادة (1)

المصادقة على إعتماد المشروع المقدم لترخيص المركبات للعمل بنظام الغاز البترولي المسال وتحويل المركبات لتعمل بالوقود التقليدي إلى مركبات تعمل بالغاز البترولي المسال.

مادة (2)

تكليف مؤسسة المواصفات والمقاييس سرعة إصدار مواصفة فلسطينية في هذا المجال.

مادة (3)

على جميع الجهات المختصة تنفيذ هذا القرار كل فيما يخصه، ويعمل به اعتبارا من تاريخ صدوره، وينشر في الجريدة الرسمية.

صدر في مدينة غـــزة بتـــاريــخ 2006/07/18 م
الثاني والعشرين من جمادى الآخرة من عام 1427هـ

إسماعيل هنية

رئيس مجلس الوزراء

Annex (2)

السلطة الوطنية الفلسطينية
وزارة النقل والمواصلات
الإدارة العامة للحاسوب وتكنولوجيا المعلومات

PALESTINIAN N. AUTHORITY
MINISTRY OF TRANSPORT
General department of computer info technology

تعداد السيارات والسائقين في المحافظات الجنوبية كما هو الحال لشهر مارس 2007

المنطقة	المنطقة الشمالية			المنطقة الجنوبية			الوكالة			المجموع		
نوع المركبة	الجملة	الغي	مسجل	الجملة	الغي	مسجل	الجملة	الغي	مسجل	الجملة	الغي	مسجل
درجة نارية	180	-	-	39	-	-	1	1	-	220	1	-
أجرة / ملك	586	-	-	615	-	-	-	-	-	1201	-	-
أجرة / تأجير	1622	24	6	856	-	-	-	-	-	2478	24	6
ملاكي عادى	20318	13	40	7408	-	-	6	-	-	27732	13	40
ملاكي جيب	329	-	-	315	-	-	-	4	-	644	4	-
ملاكي استعمالين	11386	1	46	2035	-	-	101	27	-	13522	28	46
تجاري حتى 4 طن	4165	3	14	1634	-	-	10	-	-	5809	3	14
تجاري حتى 15 طن	2462	-	31	200	-	-	10	-	-	2672	-	31
تجاري فوق 15 طن	632	2	-	110	-	-	4	-	-	746	2	-
تجاري قلاب	484	-	1	180	-	-	4	-	-	668	-	1
ساندة ، جر	330	-	-	43	-	-	2	-	-	375	-	-
مستندة ، مجرور	274	-	1	22	-	-	1	-	-	297	-	1
مركبة تخليص (ونش)	9	-	-	2	-	-	-	-	-	11	-	-
مركبة تجارية برافعة	96	-	-	45	-	-	15	-	-	156	-	-
خلاط باطون	167	-	-	51	-	-	-	-	-	218	-	-
أتوبيس	217	-	1	13	-	-	62	-	25	292	-	26
إسعاف	45	-	-	7	-	-	6	8	-	58	8	-
تراكتور	563	-	2	543	-	-	7	-	4	1113	-	6
أنواع أخرى	402	-	1	58	-	-	20	-	19	480	-	20
جملة المركبات	44267	43	143	14176	-	-	249	40	48	58692	83	191
جملة السائقين	107877	-	274	52848	-	126	-	-	-	160725	-	400

.INI N.AUTHORITY
/ISTRY OF TRANSPORT
al department of computer info technology

السلطة الوطنية الفلسطينية
وزارة النقل والمواصلات
الإدارة العامة للحاسوب وتكنولوجيا المعلومات

أعمال دائرة الترخيص في المحافظات الجنوبية لشهر مارس سنة 2007

التاريخ	فحص إشارات	فحص عملي	فحص سيارات	سائقين جدد	تسجيل سيارات	إلغاء سيارات	إيقاف سيارات	نقل ملكية	ملاحظات
1	-	-	-	-	-	-	-	-	
2	-	-	-	-	-	-	-	-	
3	26	39	25	25	5	3	-	27	
4	30	25	23	18	8	2	-	33	
5	45	47	22	20	3	1	-	38	
6	46	25	15	20	3	-	-	29	
7	42	36	25	26	6	3	-	29	
8	-	-	-	-	-	-	-	-	
9	-	-	-	-	-	-	-	-	
10	19	55	28	12	8	3	-	48	
11	55	20	17	20	7	2	-	34	
12	38	58	30	22	11	4	-	40	
13	45	36	21	20	9	3	-	26	
14	46	35	21	43	10	1	-	33	
15	-	-	-	-	-	-	-	-	
16	-	-	-	-	-	-	-	-	
17	31	41	19	5	8	3	-	28	
18	46	29	25	18	10	3	-	32	
19	47	49	25	13	4	-	-	37	
20	35	39	21	30	7	-	-	31	
21	47	37	21	33	6	1	-	34	
22	-	-	-	-	-	-	-	-	
23	-	-	-	-	-	-	-	-	
24	30	32	36	4	13	4	-	39	
25	30	33	25	18	8	5	-	38	
26	10	51	18	25	6	3	-	26	
27	49	47	17	7	4	-	-	24	
28	50	30	23	20	7	2	-	38	
29	-	-	-	-	-	-	-	-	
30	-	-	-	-	-	-	-	-	
31	-	-	-	-	-	-	-	-	
المجموع	767	764	457	400	143	43	-	664	

الإدارة العامة للحاسوب وتكنولوجيا المعلومات - غـــــــــــــــــزة / ت 829135 / 829138 /07 / 07/ فاكس / 07/2825285

التاريـــــخ	2007/4/9

إحصائية بالمركبات الحكومية في المحافظات الجنوبية

لشهر مارس سنة 2007

نوع المركبة	مسجل	الغي	الجملة
درجة نارية	-	-	161
ملاكي عادى	-	12	1228
مزدوجة الاستعمال	-	-	768
تجاري	-	2	1676
شاحنات	-	2	232
أتوبيس	-	-	75
إسعاف	-	-	158
تراكتور	-	-	37
أنواع أخرى	3	-	115
جملة المركبات	3	16	4450

Annex (3)

Palestinian National Authority
Ministry of Health
Helsinki Committee

السلطة الوطنية الفلسطينية
وزارة الصحة
لجنة هلسنكي

Date: 15/8/2008

التاريخ:١٥/٨/٢٠٠٨

Name: Mohammed Abu Rahma

الاسم: محمد أبو رحمة

I would like to inform you that the committee has discussed your application about:

نفيدكم علماً بأن اللجنة قد ناقشت مقترح دراستكم حول:-

Health Consequences of Using Liquefied Petroleum Gas as an Alternative Fuel in Gaza Governorates: KAP of Car Drivers

In its meeting on August 2008
and decided the Following:-
To approve the above mention research study.

و ذلك في جلستها المنعقدة لشهر أغسطس ٢٠٠٨
و قد قررت ما يلي:-
الموافقة على البحث المذكور عاليه.

Signature
توقيع

Member
عضو

Member
عضو

Chairperson

Ministry of Health Helsinki Committee

Conditions:-

- Valid for 2 years from the date of approval to start.
- It is necessary to notify the committee in any change in the admitted study protocol.
- The committee appreciate receiving one copy of your final research when it is completed.

Gaza Etwam – Telefax 972-7-2878166

Annex (4)
Consent form (Arabic)

الرقم: -----------

التاريخ: / / 2008

عنوان البحث

معرفة وسلوك وممارسات السائقين في مجال استخدام الغاز الطبيعي بدل البنزين أو الديزل كوقود بديل

في محافظات غزة

الأخ الكريم:

سائق المركبة ، لطفاً أود أن أخبركم [أنه وقع عليكم الاختيار لتكونوا جزء من دراستي البحثية بعنوان " معرفة وسلوك وممارسات السائقين في مجال استخدام الغاز الطبيعي بدل البنزين أو الديزل كوقود بديل في محافظة غزة " كجزء من متطلب برنامج ماجستير الذي تديره جامعة القدس – برنامج الصحة العامة. مركبتكم من ضمن التي وقع عليها الاختيار كمصدر للمعلومات اللازمة لتعبئة الاستبانة.

وأعلمكم بأن جميع المعلومات التي سيتم الحصول عليها هي خاصة بالبحث فقط وستكون في سرية كاملة وإن مشاركتكم في هذا البحث مهمة وأي معلومات معطاة منكم لن تلحق بكم الضرر أبدا.

جزيل الشكر لحسن تعاونكم

الباحث

محمد أحمد أبو رحمة

الدرج عيادة الصوراني ت / 2801323

....

إقرار بالموافقة

التاريخ / /2008

أنا الموقع أدناه/.. بصفتي سائق المركبة بمحافظات غزة /.. ،قد تفهمت جيداً أهداف هذا البحث وكل المتطلبات لتعبئة الاستبيان.

وأنني أعلم أن معلومات البحث ستكون محل السرية التامة ولن يتم استعمالها إلا بهدف المعرفة العلمية البحثية لغرض التخطيط الصحي والاقتصادي

التوقيع :

رقم الاستبيان:.............. التاريخ: ....

البيانات الشخصية الخاصة بالسائقين

1) العمر:..................
2) الجنس: 1 ذكر 2 أنثى
3) عنوان السكن: 1 محافظة الشمال 2 محافظة غزة 3 محافظة الوسطى 4 محافظة خانيونس 5 محافظة رفح
4) عدد سنوات التعليم: ....
5) هل لديك رخصة قيادة 1 نعم 2 لا
6) إذا كان نعم ما نوع الرخصة 1 ملاكي 2 عمومي 3 تجارى 4 أخرى حدد
7) عدد سنوات الخبرة في مجال قيادة المركبات: 1 1-5 ، 2 6-10 ، 3 11-20 ، 4 21-30 ، 5 أكثر من 30
8) ما هي مهنتك الأساسية: 1 سائق ، 2 فني ، 3 عامل ، 4 موظف حكومي ، 5 موظف غير حكومي، 6 غير ذلك

معلومات خاصة بالمركبة

9) سنة إنتاج المركبة: قبل: 1 1970، 2 1970-1979، 3 1980-1989، 4 1990-1999، 5 2000 أو ما بعد
10) نوع ترخيص المركبة 1 ملاكي 2 عمومي 3 تجارى
11) ترخيص المركبة ساري المفعول؟ 1 نعم 2 لا
12) تامين المركبة ساري المفعول؟ 1 نعم 2 لا
13) محرك المركبة مرخص رسميا للعمل باستخدام الوقود 1 غاز 2 بنزين 3 سولار
14) الوقود المستخدم فعليا في المركبة؟ 1 غاز 2 بنزين 3 سولار

معرفة السائق حول استخدام الغاز كوقود

15) هل تعرف بأن غاز الطبخ يستخدم كوقود للمركبات ؟ 1 نعم 2 لا

16) إذا كانت إجابة السؤال السابق بنعم، فهل تعرف آلية و كيفية استخدام غاز الطبخ كوقود للمركبات ؟ 1 نعم 2 لا

17) حسب اعتقادك, ما هو الوقود المفضل للمركبة: 1 غاز 2 بنزين 3 سولار 4 أخرى حدد

18) هل استخدام الغاز كوقود للمركبات مصرح رسميا و يتم ترخيص المركبة من جهة رسمية؟1 نعم 2 لا

19) من وجهة نظرك سبب استخدام السائقين لغاز الطبخ كوقود للمركبات ؟ 1 اقتصادي 2 صحي 3 بيئي4 أخرى

20) هل عملية تحويل محرك المركبة للعمل بغاز الطبخ تتم بمعرفةجهة فنية متخصصة و معتمدة رسميا؟ 1 نعم 2 لا

21) هل تعتقد إن استخدام الغاز كوقود للمركبات مفيد للبيئة أكثر من المحروقات الأخرى 1 نعم 2 لا

22) هل تعتقد إن استخدام الغاز الطبيعي بالطريقة الحالية هو آمن علي السلامة العامة؟ 1 نعم 2 لا

23) عند استخدام الغاز هل تعتقد إن الأعطال الميكانيكية للمركبة 1 تزيد , 2 تنقص

24) تقديرا كم يوفر استخدام الغاز كوقود للمركبات؟1 20% أو اقل 2 30-40% 3 50-60% 4 >60% 5 لا يوفر

25) هل تعتقد بوجود فرق واختلاف في عزم/فعالية/قوة المحرك عند استخدام الغاز 1 ايجابي 2 سلبي 3 لا فرق

26) باعتقادك و بقيمة نقدية ثابتة تسير السيارة أكثر كيلومترات في حالة استخدام؟ 1 الغاز 2 السولار 3 البنزين

27) باعتقادك أفضل وقود هو ؟ 1 السولار 2 البنزين 3 الغاز

توجهات السائقين

28) هل تؤيد استخدام الغاز كوقود بديل ؟ 1 نعم 2 لا

29) هل الغاز هو الوقود الأفضل للمحركات ؟ 1 نعم 2 لا

30) هل تؤيد استخدام الغاز كوقود بديل بالطريقة المستخدمة حاليا؟ 1 نعم 2 لا

31) هل تؤيد استخدام الغاز كوقود بديل بالطرق القانونية و الرسمية ؟ 1 نعم 2 لا

32) لو تساوت الفائدة الاقتصادية للمحروقات ماذا تفضل استخدام ؟1 بنزين 2 سولار ؟3 غاز

33) ما هي الميزة التي من خلالها يمكن الترويج و الترغيب لاستخدام الغاز 1 اقتصاديا 2 بيئيا 3 صحيا4 السلامة

ممارسات السائقين

34) يتم صيانة المحرك: 1 ستة شهور أو أقل 2 7–12 شهر 3 أكثر من سنة 4 عند وجود عطل في المحرك

35) هل ترى أدخنة تخرج من المحرك أو العادم (الاوكزوست): 1 نعم 2 لا

36) هل يوجد وسائل أمان في المركبة مثل طفاية الحريق 1 نعم 2 لا

37) هل يوجد مجموعة للإسعاف الأولي في المركبة 1 نعم 2 لا

38) عدد ساعات قيادتك للسيارة يوميا؟ 1 6 ساعات أو أقل 2 7–12 ساعة 3 أكثر من 12 ساعة

39) هل هناك فترة راحة أثناء القيادة؟ 1 نعم 2 لا

40) هل تسمح بتدخين السجائر في المركبة 1 نعم 2 لا

جزء خاص بسائقي المركبات المشغلة بالغاز

41) منذ متى تستخدم الغاز للمركبة؟ 1 <6شهور 2 6–12شهر 3 13–24شهر 4 أخرى

42) ما هو معدل استهلاكك الأسبوعي لاسطوانات الغاز (12 كجم) ؟ 1 1 2 2–3 3 4–5 4 أكثر من 5

43) هل تشم رائحة الوقود (الغاز) داخل المركبة إثناء قيادتك للمركبة؟ 1 نعم 2 لا

44) هل تشم رائحة الغاز تخرج من عادم (الاكزوست) المركبة؟ 1 نعم 2 لا

45) فترة استخدامك للغاز كوقود بديل هل تعرضت إلي حادث مثل حريق أو انفجار 1 نعم 2 لا

46) هل تواجه أو واجهت أية اعتراضات وانتقادات من الركاب إذا علموا بان المركبة تعمل بالغاز الطبيعي 1 نعم 2 لا

47) عند عودتك للبيت هل يوجد رائحة للغاز على ملابسك 1 نعم 2 لا

الأسئلة الصحية لجميع السائقين

48) هل هناك فروق علي صحتك نتيجة لقيادتك المركبة 1 نعم 2 لا

49) هل تشعر بصداع عند قيادتك لمركبتك 1 نعم 2 لا

50) هل تشعر بعدم وضوح الرؤية(زغللة في العينين)إثناء القيادة 1 نعم 2 لا

51) هل تشعر بغثيان أو دوار أو دوخة إثناء القيادة 1 نعم 2 لا

52) هل تشعر بضيق أو بصعوبة في التنفس إثناء القيادة 1 نعم 2 لا

53) هل تشعر بالإحباط أو الضيق او الانزعاج عند قيادتك المركبة 1 نعم 2 لا

54) قياس VOC: __________

Annex (5)

Panel of expert

The questionnaire were examined by a group of experts. Some items were added, modified or excluded as a results of their comments.

1- Dr. Abed AllH Basheer
2- Dr. Nahedd Al-laham
3- Dr. Emad Abu El- Khir
4- Dr. Rawia Al- Shawa
5- Dr. Fuad Radwan

Annex (6)

PEOD6

UNIVERSITY OF FLORIDA

IFAS EXTENSION

Determining Sample Size[1]

Glenn D. Israel[2]

Perhaps the most frequently asked question concerning sampling is, "What size sample do I need?" The answer to this question is influenced by a number of factors, including the purpose of the study, population size, the risk of selecting a "bad" sample, and the allowable sampling error. Interested readers may obtain a more detailed discussion of the purpose of the study and population size in *Sampling The Evidence Of Extension Program Impact*, PEOD-5 (Israel, 1992). This paper reviews criteria for specifying a sample size and presents several strategies for determining the sample size.

SAMPLE SIZE CRITERIA

In addition to the purpose of the study and population size, three criteria usually will need to be specified to determine the appropriate sample size: the level of precision, the level of confidence or risk, and the degree of variability in the attributes being measured (Miaoulis and Michener, 1976). Each of these is reviewed below.

The Level Of Precision

The *level of precision*, sometimes called *sampling error*, is the range in which the true value of the population is estimated to be. This range is often expressed in percentage points, (e.g., ±5 percent), in the same way that results for political campaign polls are reported by the media. Thus, if a researcher finds that 60% of farmers in the sample have adopted a recommended practice with a precision rate of ±5%, then he or she can conclude that between 55% and 65% of farmers in the population have adopted the practice.

The Confidence Level

The *confidence* or *risk level* is based on ideas encompassed under the Central Limit Theorem. The key idea encompassed in the Central Limit Theorem is that when a population is repeatedly sampled, the average value of the attribute obtained by those samples is equal to the true population value. Furthermore, the values obtained by these samples are distributed normally about the true value, with some samples having a higher value and some obtaining a lower score than the true population value. In a normal distribution, approximately 95% of the sample values are within two standard deviations of the true population value (e.g., mean).

In other words, this means that, if a 95% confidence level is selected, 95 out of 100 samples will have the true population value within the range of precision specified earlier (Figure 1). There is always a chance that the sample you obtain does not represent the true population value. Such samples with extreme values are represented by the shaded areas in Figure 1. This risk is reduced for 99% confidence levels and increased for 90% (or lower) confidence levels.

1. This document is PEOD6, one of a series of the Agricultural Education and Communication Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Original publication date November 1992.Reviewed June 2003. Visit the EDIS Web Site at http://edis.ifas.ufl.edu.

2. Glenn D. Israel, associate professor, Department of Agricultural Education and Communication, and extension specialist, Program Evaluation and Organizational Development, Institute of Food and Agricultural Sciences (IFAS), University of Florida, Gainesville 32611.

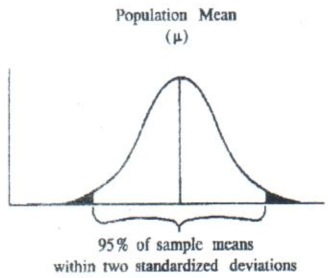

Figure 1. Distribution of Means for Repeated Samples.

Degree Of Variability

The third criterion, the *degree of variability* in the attributes being measured refers to the distribution of attributes in the population. The more heterogeneous a population, the larger the sample size required to obtain a given level of precision. The less variable (more homogeneous) a population, the smaller the sample size. Note that a proportion of 50% indicates a greater level of variability than either 20% or 80%. This is because 20% and 80% indicate that a large majority do not or do, respectively, have the attribute of interest. Because a proportion of .5 indicates the maximum variability in a population, it is often used in determining a more conservative sample size, that is, the sample size may be larger than if the true variability of the population attribute were used.

STRATEGIES FOR DETERMINING SAMPLE SIZE

There are several approaches to determining the sample size. These include using a census for small populations, imitating a sample size of similar studies, using published tables, and applying formulas to calculate a sample size. Each strategy is discussed below.

Using A Census For Small Populations

One approach is to use the entire population as the sample. Although cost considerations make this impossible for large populations, a census is attractive for small populations (e.g., 200 or less). A census eliminates sampling error and provides data on all the individuals in the population. In addition, some costs such as questionnaire design and developing the sampling frame are "fixed," that is, they will be the same for samples of 50 or 200. Finally, virtually the entire population would have to be sampled in small populations to achieve a desirable level of precision.

Using A Sample Size Of A Similar Study

Another approach is to use the same sample size as those of studies similar to the one you plan. Without reviewing the procedures employed in these studies you may run the risk of repeating errors that were made in determining the sample size for another study. However, a review of the literature in your discipline can provide guidance about "typical" sample sizes which are used.

Using Published Tables

A third way to determine sample size is to rely on published tables which provide the sample size for a given set of criteria. Table 1 and Table 2 present sample sizes that would be necessary for given combinations of precision, confidence levels, and variability. Please note two things. First, these sample sizes reflect the number of *obtained* responses, and not necessarily the number of surveys mailed or interviews planned (this number is often increased to compensate for nonresponse). Second, the sample sizes in Table 2 presume that the attributes being measured are distributed normally or nearly so. If this assumption cannot be met, then the entire population may need to be surveyed.

Using Formulas To Calculate A Sample Size

Although tables can provide a useful guide for determining the sample size, you may need to calculate the necessary sample size for a different combination of levels of precision, confidence, and variability. The fourth approach to determining sample size is the application of one of several formulas (Equation 5 was used to calculate the sample sizes in Table 1 and Table 2).

Table 1. Sample size for ±3%, ±5%, ±7% and ±10% Precision Levels Where Confidence Level is 95% and P=.5.

Size of Population	Sample Size (n) for Precision (e) of:			
	±3%	±5%	±7%	±10%
500	a	222	145	83
600	a	240	152	86
700	a	255	158	88
800	a	267	163	89
900	a	277	166	90
1,000	a	286	169	91
2,000	714	333	185	95
3,000	811	353	191	97
4,000	870	364	194	98
5,000	909	370	196	98
6,000	938	375	197	98
7,000	959	378	198	99
8,000	976	381	199	99
9,000	989	383	200	99
10,000	1,000	385	200	99
15,000	1,034	390	201	99
20,000	1,053	392	204	100
25,000	1,064	394	204	100
50,000	1,087	397	204	100
100,000	1,099	398	204	100
>100,000	1,111	400	204	100

a = Assumption of normal population is poor (Yamane, 1967). The entire population should be sampled.

Formula For Calculating A Sample For Proportions

For populations that are large, Cochran (1963:75) developed the Equation 1 to yield a representative sample for proportions.

$$n_0 = \frac{Z^2pq}{e^2}$$

Which is valid where n_0 is the sample size, Z^2 is the abscissa of the normal curve that cuts off an area α at the tails ($1 - \alpha$ equals the desired confidence level, e.g., 95%)[1], e is the desired level of precision, p is the estimated proportion of an attribute that is present in the population, and q is 1-p. The value for Z is found in statistical tables which contain the area under the normal curve.

Table 2. Sample size for ±5%, ±7% and ±10% Precision Levels Where Confidence Level is 95% and P=.5.

Size of Population	Sample Size (n) for Precision (e) of:		
	±5%	±7%	±10%
100	81	67	51
125	96	78	56
150	110	86	61
175	122	94	64
200	134	101	67
225	144	107	70
250	154	112	72
275	163	117	74
300	172	121	76
325	180	125	77
350	187	129	78
375	194	132	80
400	201	135	81
425	207	138	82
450	212	140	82

To illustrate, suppose we wish to evaluate a state-wide Extension program in which farmers were encouraged to adopt a new practice. Assume there is a large population but that we do not know the variability in the proportion that will adopt the practice; therefore, assume p=.5 (maximum variability). Furthermore, suppose we desire a 95% confidence level and ±5% precision. The resulting sample size is demonstrated in Equation 2.

$$n_0 = \frac{Z^2pq}{e^2} = \frac{(1.96)^2(.5)(.5)}{(.05)^2} = 385 \text{ farmers}$$

Finite Population Correction For Proportions

If the population is small then the sample size can be reduced slightly. This is because a given sample size provides proportionately more information for a small population than for a large population. The sample size (n_0) can be adjusted using Equation 3.

$$n = \frac{n_0}{1 + \frac{(n_0 - 1)}{N}}$$

Where n is the sample size and N is the population size.

Suppose our evaluation of farmers' adoption of the new practice only affected 2,000 farmers. The sample size that would now be necessary is shown in Equation 4.

$$n = \frac{n_0}{1 + \frac{(n_0 - 1)}{N}} = \frac{385}{1 + \frac{(385 - 1)}{2000}} = 323 \textit{ farmers}$$

As you can see, this adjustment (called the finite population correction) can substantially reduce the necessary sample size for small populations.

A Simplified Formula For Proportions

Yamane (1967:886) provides a simplified formula to calculate sample sizes. This formula was used to calculate the sample sizes in Tables 2 and 3 and is shown below. A 95% confidence level and P = .5 are assumed for Equation 5.

$$n = \frac{N}{1 + N(e)^2}$$

Where n is the sample size, N is the population size, and e is the level of precision. When this formula is applied to the above sample, we get Equation 6.

$$n = \frac{N}{1 + N(e)^2} = \frac{2000}{1 + 2000(.05)^2} = 333 \textit{ farmers}$$

Formula For Sample Size For The Mean

The use of tables and formulas to determine sample size in the above discussion employed proportions that assume a dichotomous response for the attributes being measured. There are two methods to determine sample size for variables that are polytomous or continuous. One method is to combine responses into two categories and then use a sample size based on proportion (Smith, 1983). The second method is to use the formula for the sample size for the mean. The formula of the sample size for the mean is similar to that of the proportion, except for the measure of variability. The formula for the mean employs σ^2 instead of (p x q), as shown in Equation 7.

$$n_0 = \frac{Z^2 \sigma^2}{e^2}$$

Where n_0 is the sample size, z is the abscissa of the normal curve that cuts off an area α at the tails, e is the desired level of precision (in the same unit of measure as the variance), and σ^2 is the variance of an attribute in the population.

The disadvantage of the sample size based on the mean is that a "good" estimate of the population variance is necessary. Often, an estimate is not available. Furthermore, the sample size can vary widely from one attribute to another because each is likely to have a different variance. Because of these problems, the sample size for the proportion is frequently preferred[2].

OTHER CONSIDERATIONS

In completing this discussion of determining sample size, there are three additional issues. First, the above approaches to determining sample size have assumed that a simple random sample is the sampling design. More complex designs, e.g., stratified random samples, must take into account the variances of subpopulations, strata, or clusters before an estimate of the variability in the population as a whole can be made.

Another consideration with sample size is the number needed for the data analysis. If descriptive statistics are to be used, e.g., mean, frequencies, then nearly any sample size will suffice. On the other hand, a good size sample, e.g., 200-500, is needed for multiple regression, analysis of covariance, or log-linear analysis, which might be performed for more rigorous state impact evaluations. The sample size should be appropriate for the analysis that is planned.

In addition, an adjustment in the sample size may be needed to accommodate a comparative analysis of subgroups (e.g., such as an evaluation of program participants with nonparticipants). Sudman (1976) suggests that a minimum of 100 elements is needed for each major group or subgroup in the sample and for each minor subgroup, a sample of 20 to 50 elements is necessary. Similarly, Kish (1965) says that 30 to 200 elements are sufficient when the attribute is present 20 to 80 percent of the time (i.e., the distribution approaches normality). On the other hand, skewed distributions can result in serious departures from normality even for moderate size samples (Kish, 1965:17). Then a larger sample or a census is required.

Finally, the sample size formulas provide the number of responses that need to be obtained. Many researchers commonly add 10% to the sample size to compensate for persons that the researcher is unable to contact. The sample size also is often increased by 30% to compensate for nonresponse. Thus, the number of mailed surveys or planned interviews can be substantially larger than the number required for a desired level of confidence and precision.

ENDNOTES

1. The area α corresponds to the shaded areas in the sampling distribution shown in Figure 1.

2. The use of the level of maximum variability (P=.5) in the calculation of the sample size for the proportion generally will produce a more conservative sample size (i.e., a larger one) than will be calculated by the sample size of the mean.

REFERENCES

Cochran, W. G. 1963. *Sampling Techniques*, 2nd Ed., New York: John Wiley and Sons, Inc.

Israel, Glenn D. 1992. *Sampling The Evidence Of Extension Program Impact*. Program Evaluation and Organizational Development, IFAS, University of Florida. PEOD-5. October.

Kish, Leslie. 1965. *Survey Sampling*. New York: John Wiley and Sons, Inc.

Miaoulis, George, and R. D. Michener. 1976. *An Introduction to Sampling*. Dubuque, Iowa: Kendall/Hunt Publishing Company.

Smith, M. F. 1983. *Sampling Considerations In Evaluating Cooperative Extension Programs*. Florida Cooperative Extension Service Bulletin PE-1. Institute of Food and Agricultural Sciences. University of Florida.

Sudman, Seymour. 1976. *Applied Sampling*. New York: Academic Press.

Yamane, Taro. 1967. *Statistics, An Introductory Analysis*, 2nd Ed., New York: Harper and Row.