UNIVERSITY OF CAPE COAST

LOCATIONAL ANALYSIS OF FUEL STATIONS IN SUNYANI MUNICIPALITY

MARIAN BASSUAH BASSUAH

2019

UNIVERSITY OF CAPE COAST

LOCATIONAL ANALYSIS OF FUEL STATIONS IN SUNYANI MUNICIPALITY

BY

MARIAN BASSUAH BASSUAH

Thesis submitted to the Department of Geography and Regional Planning of Faculty of Social Sciences of the College of Humanities and Legal Studies, University of Cape Coast, in partial fulfilment of the requirements for the award of Master of Philosophy degree in Geography

JANUARY 2019

DECLARATION

Candidate's Declaration

I hereby declare that this thesis is the result of my own original research and that no part of it has been presented for another degree in this university or elsewhere.

Candidate's Signature: ……..Date……

Name: ……..……..

Supervisors' Declaration

We hereby declare that the preparation and presentation of this thesis were supervised in accordance with the guidelines on supervision of thesis laid down by the University of Cape Coast.

Signature: ……Date: ……...

Principal Supervisor's Name: ……..……

Signature:…….Date: ……...…….

Co-Supervisor's Name:……..……

ABSTRACT

Location of fuel stations are regulated by planning principles and standards. However, despite efforts of regulators to ensure that fuel stations are well sited for the safety of lives and properties, entrepreneurs continue to disregard the national standards of siting fuel stations to locate such stations anywhere they find especially in urban areas. This study assessed the locational of fuel stations in Sunyani Municipality. The cross-section research design with mixed method technique was used in this study. In selecting the respondents, cluster and purposive sampling techniques were respectively used for the residents and the regulators. The findings show that an overwhelming majority of the fuel stations are located along the road from Sunyani to Bomso and the stretch from Sunyani to Dormaa. All these fuel stations are mostly setup in and around the Central Business District (CBD) where brisk commercial activities take place. Factors influencing the siting of fuel stations in their present locations were the accessibility of the fuel station to the customers, location's market sales attractiveness, fuel station's location closer to other important facilities, sales revenue and SWOT (strengths opportunities and threats). Among these factors, the most influential ones are the accessibility of the fuel station location to customers and location's market sales attractiveness. The regulators acknowledged that fuel stations bearing brands of major Oil Marketing Companies (OMCs) follow the laid down procedures based on Ghana National Spatial Development Framework (GNSDF) requirement legally acquire plot of land meant for such purposes. It is recommended that the regulators should work to ensure the thorough compliance of Ghana National Spatial Development Framework requirements by the current and potential fuel stations.

ACKNOWLEDGEMENTS

I would like to express my heartfelt gratitude to my supervisors Prof. Barimah Antwi and Dr. Collins Adjei Mensah of the Department of Geography and Regional Planning, College of Humanities of the University of Cape Coast for their guidance and immerse support during the research period, without which I certainly would have fallen short in the process.

My sincere thanks also go to my Parent Mr. and Mrs. Bassuah and my Husband Mr. Barry White whose support, advice and encouragement helped me to complete this programme. I also thank the participants from whom data were collected.

Finally, I wish to thank Dr. Berchie Boakye of University of Energy and Natural Resources, Sunyani for sacrificing so much time to help in data collection process.

DEDICATION

To my husband Mr. Barry White, and my son Laurent Rahebia Barry White

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE

INTRODUCTION

Background to the Study

In the automobile industry, hi-tech advancement combined with high competition has had a momentous impact on the petroleum industry. The significant roles petroleum products play in any economy are well known. Chinambu (2012) acknowledged that, petroleum is a key driver of industrial activities. Besides the industrial development, the transportation sector is presumed to be the major consumer of fuel to facilitate man's movement patterns around the globe (Taylor, Sichinsambwe & Chansa, 2016). Since 1996, statistics show that there has been a rapid increase in the establishment of fuel stations across the world (Table 1). For example, in Asia-Pacific region there are about 17,281 fuel stations compared to 10,938 in 2012 and 342 in 1996 (International Association for Natural Gas Vehicles, [IANGV] 2017). Similar is the story for North America with fuel stations increasing from 47 in 1996 to 1,919 in 2017 (International Association for Natural Gas Vehicles, [IANGV] 2017)

Table 1: Global and Regional Growth - Fuel Stations

		1996	2000	2004	2008	2012	2016	2017
ALL REGIONS	NBV Number	1,132	1,909	2,213	14,550	21,262	28,664	29,083
	increase compared to previous period		68.6%			46.1%	34.8%	1.5%
REGIONAL GROWTH								
ASIA-PACIFIC		342	473	532	6,027	10,938	17,072	17,281
	increase compared to previous period		38.30%			81.5%	56.1%	1.2%
EUROPE		69	190	286	2,973	4,132	4,322	4,382
	increase compared to previous period		175.4%			39%	4.6%	1.4%
NORTH AMERICA		47	72	149	1,204	1,175	1,816	1,919
	increase compared to previous period		53.20%			-2.4%	54.6%	5.7%
LATIN AMERICA		673	1,172	1,244	4,220	4,841	5,278	5,319
	increase compared to previous period		74.1%			14.7%	9.0%	0.8%
AFRICA		1	2	2	126	176	176	182
	increase compared to previous period		100%			39%	0%	3.4%

Source: IANGV 2017, www.ngvglobal.org

Statistics show that between 1996 and 2016, the number of fuel stations across the globe increased astronomically about 2,432% with fuel stations in Africa increasing about 17,500%. The high rise of these fuel stations especially in Africa raises some questions about the kind of land and spaces on which these stations occupy since such stations need to be sited in safe and secured areas. In Ghana, from the same period, the national statistics shows that fuel station numbers have increased from 4,750 in 1996 to 18,500 in 2016, that is, over 389% whilst in Sunyani Municipality the increase has been nearly 318% (National Protection Agency). As a result of this astronomical growth in numbers of fuel stations, more land spaces are being occupied each year by these station without

following the national spatial development framework. It is upon this basis a scientific enquiry needs to be conducted to establish how these fretting phenomena are affecting the implementation and sanctity of the national spatial planning policy.

In most metropolis and urban areas of Ghana, there has been high demand of land for socio-economic activities. This has resulted in scrambling and illegal propose conversion of land away from their intended land uses, leading to haphazard development and deliberate location of fuel filling stations in unsuitable areas that are highly environmentally unsafe (Mshelia, Abdullahi & Dawha, 2015). Increase in vehicles has triggered further demand for fuel and by extension fuel stations to provide fuel services to these vehicles. In Sunyani Metropolis, number of vehicles registered in 2010 stood at 17,947 and projected to increase between 70 to 80 by the year 2035 according to Ghana National Spatial Development Framework document (GNSDF, 2015-2035). This means that savvy entrepreneurs would not lose sight of this obvious opportunities, hence the signs of multiplicity of fuel stations leading to discriminate lands acquisition.

Making a better choice to site a business venture such as fuel stations is very important to entrepreneurs who would want to invest wealth to earn much profit. Among the notable variable factors to consider when selecting location for fuel stations include proximity to populated areas (business centre), distance from neighbouring stations, the easements of using accessible facility, and the magnitudes of environmental pollution parameters (Alesheikh & Golestani, 2011). Additional, factors to take into consideration when making decision regarding the

location of fuel stations and businesses in general include nature of customers, transportation system, economic activities in the neigbourhood, finances and the longer-term business prospect (Oetomo & Sesulihatien, 2012). All these factors make it critical for locational analysis to be done in order to make the best locational decision in siting a fuel station and also know the effects that the location of such stations might have or already having on the neighbourhood(s) that they have been sited.

Statement of the Problem

Urban centres have varying degree of vulnerability, depending on the level of development, coping capacity and the level to which effective development control strategies have been implemented (Njoku & Alagbe, 2015). According to Nieminen (2005), although individual countries through their environmental protection agencies and urban and regional planning institutions have evolved their own planning standards and principles as guidelines, the observed trend in recent times has been the risk associated with the proliferation of many fuel stations and their related health effects. Mshelia, Maina and Aminu (2015), stated that, in locating petrol fuel stations, it is important to take some precautionary measures such as locating them at a required distance from buildings, places of public assembly such as markets, hospitals, schools and areas of high traffic congestions, and residential building. Unfortunately, this seems not to be the practice in many urban areas.

Literature on locations of filling stations (or its synonymous names, i.e., petrol filling station, fuel station, gas station, petroleum outlet), are virtually

scanty. What prevails in the global literature is the paucity of research documentation on the technological remediation of service sites closures due to the environmental risks associated with both soil and underground water pollution (Nieminen, 2005). However, one aspect of literature relevant and very significant for this study is the planning standards and principles, environmental criteria and conditions formulated by national environmental protection and energy regulation institutions.

Studies in recent time both local and global appears to focus on some equally important sectors. For example, Hamid, Iman, Suriatini and Martin (2009) discussed site potentiality for petrol station business based on traffic volume counts using a regression and Geographic Information System (GIS) based spatial system. In a similar vein, another study conducted in Ipoh, Perak, Malaysia attention was focused on analyzing the viable land parcels for installing new petrol filling stations. The geospatial data was collected from Mapping and Surveying Department of Ipoh (Khahro, et al, 2013). Similar to the two GIS based Analysis of the location of Petrol Filling Stations, Mohammed et al (2014), conducted a study in Kano Metropolitan Area in northern Nigeria to establish the compliance of Petrol filling station entrepreneurs to the Physical Planning Standards set by the Department of Petroleum Resources (DPR) (2007). The results produced some unique and significant revelation on the non-compliance of some of the petrol filling stations to the standards. For instance, it was revealed that, only eight (8) stations (4%) out of 192 stations did not meet the criteria of 15 meters minimum distance from road. Njoku and Alagbe (2015) also highlighted on some of the

illegal location of Petrol filling stations in Oyo State using GIS to assess suitability of petrol filling stations.

In spite of this growing body of literature on the phenomenon, none of these studies have been conducted in Ghana specially Sunyani owning to the growing urbanization and increase use vehicles and motorcycle within the Municipality. The study also considered Sunyani Municipality because it was a nodal town where many of these track vehicles transit to move to the north and the southern yet limited information is known about reason for the springing of fuel stations in the municipality. This study, therefore, sought to contribute to the reduction of the dearth of studies on fuel citation and residence perception to reasons for citing fuel station in locations closer to them as well managers compliance level to standards and regulations. This is the apparent gap study tried to fill in the Sunyani Municipality.

Objective of the Study

The main objective of this study is to assess the location of fuel stations in relation to the Ghana National Spatial Framework planning document in the Sunyani Municipality.

Specific Objectives

The following are the specific objectives of the study:

1. Map out the locations of the fuel stations in Sunyani Municipality.
2. Analyse the factors that influence the location of the fuel stations in Sunyani Municipality.

3. Evaluate the compliance of the fuel stations to the location standards of siting a fuel station in Ghana.
4. Assess residents' perceptions of the locations of the fuel stations in terms of health and safety.

Research Questions

1. How are various fuel stations distributed in Sunyani Municipality?
2. What are the factors influencing the siting of the fuel stations in their present locations in Sunyani Municipality?
3. To what extent do the fuel stations comply with the local standards for siting a fuel station in Ghana?
4. How do the residents perceive the locations of the fuel stations in terms of health and safety?

Significance of the Study

Service activities locations in urban areas are guided by planning philosophy and standards expressed in either structure plan or land use development plans (Taylor, Sichinsambwe & Chansa, 2016). Though local authorities are the major overseers for the implementation of approved structure plans based on the advice of Urban Planners and Environmental Protection Agency (EPA), unfortunately, there appears to be sporadic emergence of fuel stations within the Sunyani Municipality that raises questions. The outcome of this study is expected to highlight illegal siting of fuel stations at unapproved locations and also

to inform the Municipal Assembly a need to up their game to control the location of fuel stations within the municipality.

Ultimately, this study is therefore expected to play a major role in creating records database of the location activities of fuel stations in the study, identifying pattern and proposing some solution to problems associated with their locations to enhance health and safety conditions of the general public and socio-economic development of the area.

Organization of the Study

This study is organized into five main chapters. Chapter One, which is the introduction consists of background to the study, problem statement, objectives of the study, research questions, significance of the study, organization of the study and chapter summary. Chapter Two covers the literature review and is organized into theoretical literature review, empirical literature review and conceptual framework. Chapter Three, deal with the research methodology and focuses on s research design, study area, study population, sampling procedure, data collection instruments, data collection procedure, data processing and analysis and chapter summary. Chapter Four, the results and discussion chapter, is made up of various analyses from the processed data obtained from the field and the discussions of the results. In the chapter, respondents' social demographic characteristics, factors influencing the siting of fuel filling stations, and health implication of fuel filling stations were discussed in this chapter. Chapter Five provides the summary of findings, conclusion and recommendations of the whole study, finality of the study

is made up of findings summary and limitations identified that seemingly affected the result during the study.

CHAPTER TWO

LITERATURE REVIEW

Introduction

This study is about locational analysis of fuel stations in Sunyani Municipality. In this chapter, various theoretical and conceptual issues that underlie the study are discussed. The topics reviewed include concept of fuel station location, geographical location analysis, location allocation model, standard for LPG and petroleum products filling outlets in Ghana, and factors that influence upsurge of fuel stations. Other topics reviewed are approaches for addressing illegal siting of fuel stations, theories on the location of fuel stations and the conceptual framework for the study.

Concept of Fuel Station Location

A fuel station is a retail establishment where motor vehicle refueled, lubricated, serviced, and sometimes repaired (Friedman, 1978). Most fuel stations sell petrol or diesel, some carry specialty fuels such as liquefied petroleum gas (LPG), natural gas, hydrogen, biodiesel, kerosene, or butane while the rest add shops to their primary business and convenience stores (The American Heritage Dictionary, 2011). Petrol retailing begun around the turn of the twentieth century in United State. The first concept was underground storage with pump and hose dispensing and curb pumps placed on the streets. Due to problems of congestion in the street stations with off-street fueling, the roadside petrol station started to emerge. Fuel dispensers are brought into play to pump petrol or gasoline, diesel, compressed natural gas CGH2, LPG, liquid hydrogen, kerosene, alcohol fuel, or

other fuel types into the tanks in vehicles and compute the price of the fuel transferred into the vehicle.

In Ghana, under the British colonial administration, fuels were exclusively sold at designated chemical shops in cans. In the early forties (1940s) with emergence of new development, barrels with pumps fixed on top to dispense to fuels were introduced to sell petrol, diesel and kerosene. First fuel station in Ghana was sited at Osu, Accra by Royal Dutch Shell Company in early 1950. By mid1950, additional fuel stations were opened in major cities (Sekondi, Kumasi, Nkwakwa, Swedru, Saltpond and Keta) (Ghana Archives). Besides fuel dispensers, one other major piece of equipment also found at the fuel stations was can refuel container (compressed-air) used to inflate car tyres.

With the passage of times and advancement, many fuel stations in Ghana just like those in the developed countries have incorporated a convenience store to typically sell such as candies, soft drinks, snacks and in some cases, a small selection of grocery items. Conversely, some chain stores, such as supermarkets, food joints, warehouse club, washing bays or traditional convenience stores, have provided fuel stations on their premises.

Geographical Location Analysis

In practice, geographical location analysis has been long in existence, in early centuries, inhabitants may have questioned which cave to live, place to build villages, houses, churches, and other facilities, as it was even unknown to them that they unraveled these dilemmas using some sort of heuristic methods. Conversely, location science understandably begun with Pierre de Fermat (1601-

1665) who used to taunts his contemporary mathematicians with complex problems (Eiselt & Marianov, 2012). Among the pioneers in location analysis are Evangelisca Torriecelli (1608-1647) and Battista Cavallieri (1526-1597) whose studies on basic Euclidean spatial problem of median in early seventieth century, yet name of Weber clouted most in the location science field with model formulation in his book's appendix written by Pick (Eiselt & Marianov, 2012; Onden, Gokgoza & Sen, 2013). According to Revelle and Eiselt (2005) location analysis involves the facilities siting (e.g. fuel station) in a given space with the facilities being "small relative to the space in which they are sited and interaction between the facilities may or may not occur," while in the case of layout problems, the facilities are "fairly large relative to the space in which they are positioned, and interact between facilities is the norm."

The territory layout generally does consider at least one of the following three concepts: balanced of demand, geographical contiguity and compactness. The concept of balance in territory planning indicates building quadrants in which geographic measures or characteristics are related across the quadrants created. Measures or characteristics such as these could be population (significant, for example, in political and fuel station districting), demand, number of buildings or linear kilometers of roads. (Eiselt & Marianov, 2015).

Geographical contiguity indicates that every quadrant is geographically linked. Best solutions to standard *p*-median problems with a metric or distance function between locations have contiguous quadrants. In reality, as the *p*-median objective problem diminishes the amount of distances to each centre, each node is

apportioned to the centre that it is nearer. Hence, the triangular disparity indicates that the line between the spot and the centre it is assigned to must also be a member of the same quadrant, making it contiguous (Daskin, 2013). This is not automatically exact for every objective and especially, optimal solutions to the problem of *p*-centre, where the objective is to decrease the maximal distance to the corresponding centre, need not be contiguous. This because nodes whose distance to more than one centre is smaller than the maximal distance could be assigned to either without changing the objective. An area partitions created by having each node/block allocated to the centre it is contiguous to, for some distance metric. Naturally, such partitions form contiguous quadrants. Conversely, even without applying a distance metric, the geographical contiguity can be implemented through clear linear constraints. These constraints guarantee that for each node allocated to a district, an overall path of node to that centre of district is assigned to the unchanged district. This is done for instance in Williams (2002) for a land acquisition problem and Drexl and Haase (1999) for a deployment of sales force.

There are number of diverse compactness notions that are adopted in planning of territory, which do not represent the standard topological definition. Some of the compactness measures recommended comprise the perimeter to the area ratio, comparisons to a similar compact figure for instance a circle or rectangle, or moment of inertia (Li et al., 2013). As a final point, compactness measures that take into consideration the population are: the moment of inertia of the population (Papayanopoulos, 1973), and the ratio between the district

population and the population existing in the maximum convex figure or circle circumscribed in the district.

In the current study, geographical location analysis appears to undermine by the users of the land locations. Many developers and entrepreneurs do not follow the GNSDF document stated infrastructural designs. Siting of fuel stations everywhere in Ghana are done indiscriminately without regards to the planning of the towns and cities. In Sunyani Municipality, even without 'technical eye', a lot of fuel stations visibly appears to be ill sited and are not following the planning of the city. It worth stated that geographical location analysis in every nation underpins and determines how infrastructural developments are planned for safety purposes and beautification. Through geographical location analysis, a determination can be made whether siting of fuel stations follow the Municipal's planning or not.

Location-Allocation Model

Models of Location-allocation can be drawn on to determine the optimum locations for fresh facilities that offer commodities and services to users, and individuals require those supplies. Putting it differently, location-allocation model is the process that opts for the facility's best locations from a set of competing locations and, concurrently allots demands to these locations in the well-organized way, founded on the demand's distribution. The location-allocation models determine the best locations in utilizing various quantifiers that are derived from travel distance, travel time or other cost functions forms. This technique focuses on getting the suitable sites for facilities locations that can enhance the ease of access

and reduce the overall weighted costs such as distance, time of travelling, or other cost factors.

Location-allocation models have two major elements in solving location-allocation problems processes namely; the allocation rules and the objective functions. The allocation rules stipulate means by which demands are allocated to the competing locations, while the objective functions influence the most favorable location for competing sites. The objective function's aim is about minimizing the costs of transportation incurred as of moving supplies to demands and in unison maximizing the demands ease of access to supplies or maximizing public welfare and services (Keane & Ward, 2002).

The objective functions of location-allocation models that are frequently structured have two important common forms namely; the *p*-median Problem and the Maximal Covering Location Problems (MCLP). Actually, *p*-median problem maximizes the supply or service facilities accessibility by finding a set of facilities' locations that can minimize the distance of total travel or all demands time to get to their nearest facilities. Also, MCLP aim at maximizing the covered demands total number within a maximum service distance or time by locating the competing facilities close to locations having high population density.

Each location-allocation models have three major components: 1) the demand locations; 2) the competing locations for service facilities; and 3) a distance and/or time matrix holding distances or travelling time between services facilities and demands locations. The demand locations represent the people or commodities distribution that look for services or facilities to be allocated.

Moreover, the demand locations may contain attribute information like client locations, population and socio-economic demand locations characteristics. The competing locations for service facilities designate feasible sites suitable for a set of criteria as stated by analysts for subjects for instance the land size, cost and service facilities accessibility. A distance matrix or a time matrix keeps the distance or travel times between service facilities candidates and demand locations by taking into consideration the physical and social barriers such as traffic congestion, administrative units' political structure, services nature and the rest (Keane & Ward, 2002).

In finding the optimal location for new service facilities in addition, location-allocation models become suitable for different functions, both private and public sectors. Yet, distinction exists between making use of the location-allocation models and the private and public sectors. This distinction lies in the nature of the objectives that policy makers are concerned in attaining. Example, the central objective for applying models of location-allocation in private sectors may be to lessen the costs of delivery and maximize efficiency when working on a strategy in a retail or wholesale system of delivery. Alternatively, using those models in private sectors is to lessen the overall distance travelled between all demand locations as well as the new facilities location, such as applying those models for locating retail stores and warehouses, (Algharib, 2011).

The public sector location-allocation models applications seek to optimize the utmost quantity of demands equitable services covered. The goal is to maximizing the demands quantity assigned to each new location of facility and to

minimizing the entire distance travelled to cover, and serve as several demands as feasible in contiguous areas. Location-allocation modeling applications in public sectors incorporate, but not limited to, the following: branches of bank, post offices, hospitals, schools, libraries, day cares, parks, and so on (ibid).

It worth noted, however, that using location-allocation models in identical study area other than unrelated geographic resolution levels may produce dissimilar results because the optimal location explicitly chosen would depend on how the data of demand or service are aggregated geographically. Aggregation of data is presumptuous that every part of demands within each area (or a polygon) is aggregated at to centroid. Hence, the outcomes from applying these models are very receptive to the precision and data representation accuracy for both facilities and demands (Ghosh & Rushton, 1987). The rationale following this problem is that frequently each point is weighted with the entire number of demands of that area the point stands for when applying a centroid to represent the entire geographic area demands, or a polygon. This aggregation is disposed to in excess of oversimplify the geographical distribution of demands, consequently causing several errors. These errors are for the most part significant when the actual distances between demands and facilities have been altered.

Standard for LPG and Petroleum Products Filling Station in Ghana

Petrol Fuel stations

It is recommended that Petrol Fuel stations should serve approximately, 250-500 vehicles per day.

Building Infrastructure and Minimum Plot Requirement

An office block shall not be provided at the outlet. The building shall be simple and attractive sand-crete, concrete, burnt brick structure or other fire-resistant building material with aluminum, galvanized or tiled roof and should incorporate a store, salesroom, toilet and change room facilities.

The following minimum plot requirements shall apply at the outlet:

Table 2: Minimum Plot Requirements

Location	Dimensions (ft)	Dimensions (m)
Along Trunk Roads (Highways)	150 x 70	45 x 21
Along Major Roads (other than Trunk Roads)	100 x 70	30 x 21
Other Roads (Minor Roads)	80 x 70	24 x 21

Source: Field Survey, Bassuah (2017)

Other Infrastructural Requirements (Tanks)

(a) Except under special circumstances as in (b) below, all tanks at the outlet shall be buried not less than 1.5 metres away from any building or boundary. The top of such underground tanks shall not be less than 0.6 metres or more than the diameter of the tank below ground level.

(b) Tanks volume at outlet may exceed 45,000 litres per tank provided all appropriate safety precautions and prevention measures have been put in place.

(c) The minimum length of the vent pipes shall be four (4) metres above ground level, a minimum of four (4) metres away from any dwelling place

as well as a minimum of ten (10) metres away from a loading/discharge point or naked fire.

(d) The life span of an underground storage tank should not exceed thirty (30) years.

(e) The following colour codes shall be adapted to facilities identification, especially during product deliveries into underground storage tanks. Tanks manhole covers and slabs shall have the following colour coding

- Gasoline - Red
- High Octane gasoline - Green
- Kerosene - Blue
- AGO - Black
- High Cetane AGO - Yellow

(f) Above ground fuel storage system such as U-Fuels shall be allowed provided all environmental and safety concerns are met.

Liquefied Petroleum Gas

Siting of Plant

a) The plant should not be located close to or within the proximity of any high tension pylons or cables. The minimum distance shall be 15 metres.

b) There shall not be any aerial obstructions at the site. These obstructions include telecommunication mast etc. and the minimum distance for such obstructions shall be 10 metres.

c) The plants shall not be located near sources of ignition e.g. welding, cutting, grinding, use of impact tools, electrical arcs, hot surfaces, open flames areas. A minimum distance from the fence wall shall be 10 metres.

d) The plant shall not be located near hazardous areas. Flammable liquids etc. shall be stored at least 10 metres from the fence wall.

e) The plant shall not be fenced with wire mesh of height 2 metres and shall have entrance and exit ways.

f) The facilities shall be free from weeds, open drains, depressions etc. weed killers which constitute fire hazard shall not be used to remove weeds at installation point.

Storage of LPG Tanks

1. Bulk storage tanks and cylinders shall be designed and located in accordance with industry guidelines. A datum plant must be available on the tank.
2. Safe distance from building, boundary or fixed source of ignition shall be 15 metres from the installation of storage tanks at filling plants for both car cylinders and domestic cylinders.
3. Distance between storage tanks shall conform to the following:

i.	Storage tanks up to 20 tonnes	- 5m
ii.	Storage tanks 20 to 40 tonnes	- 7.5m
iii.	Storage tanks 40 to 60 tonnes	- 10m
iv.	Storage tanks over 60 tonnes	- 15m

For more details, please refer to the guidelines for the establishment and operation of petroleum product retail outlets in Ghana and guidelines for the establishment and operation of liquefied petroleum gas filling plants in Ghana (Ministry of Environment Science and Technology; Town and Country Planning Department, 2011).

Factors Influencing the Siting of Fuel Stations Location

Over the period of time, geographers have taken several means as they sought to elucidate the different factors that influence the industries and businesses location. In all these times, several identifiable approaches have come to the forefront. These rather distinct approaches to spatial analysis include location theory, least-cost theory and market-area analysis. Furthermore, geographers have progressively more focused on the impacts of human behavior in relation to the analysis of locational spatial patterns.

Location Factor

The location of petrol fuel stations is a very significant issue and needs to consider impact of various relevant parameters such as distance, population and access time on a location (Rana & Garg, 2014). This theory has turn out to be an essential component of economic geography, regional science, and spatial economics. Basically, location theory deals with questions of what economic activities are located where and why. Location theory is the basis for examining how and why the arrangement of cities and markets has come to be and provides the rationale for siting decision making and service allocation. The primary theoretical developments have focused on land use, industrial production, central

places and spatial competition (Murray & Tong, 2009). This theory supports various forms of locational analysis and highlights the significance of spatial proximity. Location theory assumes that agents work for their personal interest. Thus, firms select locations that maximize their profits while individuals select locations that maximize their utility. The location of economic activities can be determined on a broad level such as a region or metropolitan area, or narrow one such as a zone, neighbourhood, city block, or individual site (Encyclopedia Britannica).

At Sunyani Municipal, siting of fuel stations closed to critical locations such as market centres, lorry stations, and commercial enclaves just explain this theory of how the firms and individuals consider locations selection for their businesses which clearly point to profits and utility maximization. Generally, in siting fuel stations per environment regulations required that they should be at reasonable distance from social facilities and residential areas but closer to accessible road.

Least Cost Theory (LCT) Factor

The LCT is a model developed by Alfred Weber which according to him the location for manufacturing establishments primarily is determined by the minimization of three critical expenses:

i. Labour,

ii. Transportation, and

iii. Agglomeration.

This model helps to appreciate why industries and/or businesses are situated where they are. Weber thought that an industry was going to gain more profit when it reduced its transportation cost, labour cost and located in a place that has a cluster of those enterprises (Valdez, 2013).

Weber's assumption in minimizing transportation cost was to be in a site where there is the lowest possible cost of moving raw materials to the factory and finished products to the market. In this theory, the thought is that a factory might do better farther from raw materials and markets if cheaper labour made up for the added transportation costs. In other words, if the labour cost was cheap enough to still make profit even though the transportation cost was high then it will be great for the company. In the case of fuel station, since most of them register and operates under Oil Marketing Companies (OMCs), transportation costs are out of their cost build-ups functions. However, labour, agglomeration and deglomeration costs becomes the major components that have direct effects on their marginal-sales, thus profit levels.

Also, Weber's LCT model conceptualize that if a large number of enterprises cluster in the same area then they can provide assistance to each other through shared talent, services, and facilities. In the fuel station enterprise, clustering number of stations at particular location is seen rather as a disadvantage as sales thrives well in a monopolistic market. Moreover, an excessive agglomeration leads to high rent, higher wages, and circulation problems such as loss of efficiency (Valdez, 2013).

In the LCT theory, there are assumptions of uniform or isotropic plain, operating in one country with a uniform plane and equal transportation paths (topography, climate, technology, and economic system), one finished product considered at a time, and product shipped to a single market location. These assumptions make the theory more applicable to this study and explain the reason for the indiscriminate siting of fillings stations in the manner they are mushrooming everywhere in the Sunyani Municipality.

Market Area Analysis Factor

A market analysis studies the attractiveness and the dynamics of a special market within a special industry. It is part of the industry analysis and thus in turn of the global environmental analysis. Through all of these analyses, the strengths, weaknesses, opportunities and threats (SWOT) of a company can be identified. The market analysis is also known as a documented investigation of a market that is used to inform a firm's planning activities, particularly around decisions of inventory, purchase, workforce expansion/contraction, facility expansion, purchases of capital equipment, promotional activities, and many other aspects of a company.

According to Rodrigue (2016), every economic activity has a location, nevertheless different demands (service, raw materials, labour, parts, and so on) and flows each location creates also have a spatial dimension referred to as a market area. A market area is the surface over which a demand or supply provided at a specific location is articulated. For a factory it takes account of the areas to

where its products are transported whiles for a retail outlet such as fuel station it is the tributary area from which it draws its customers.

Transportation is mainly significant in market area analysis because it impacts on the location of the activities in addition to their accessibility. The market area size is a function of its threshold and range:

Market threshold: Minimum demand essential to back an economic activity such as a service. Given that each demand has a distinct location, a threshold has a direct spatial dimension. The market size has a direct connection with its threshold.

Market range: The maximum distance each demand unit is eager to travel to reach a service or the maximum distance a product can be transported to a customer. The range is a function of transport costs, time or convenience in view of intervening opportunities. To be profitable, a market must have a range higher than its threshold (Rodrigue, 2016).

- Place Brand Factor

Within the branding places domain, Anholt (2010) asserts that the direct brand intent is not delineated by economic benefits rather the brand aspires to accomplish a positive reputation for the place that sequentially will account for economic gains. In line with Anholt, the high merit of this advanced vision of a brand applied to geographical space lies in its flexibility, which derives from its ability to unite market forces and human capital. Lopez-Lita and Benlloch (2005) argue along similar lines, positing, “A brand must serve as the basis for marking out places, thereby promoting differentiation and thus enabling places to highlight anthropological and culture differences, thus transcending their initial purely

economic dimension". Similarly, Fernandez-Cavia (2011) posits that branding strategies are fully integrated into a global process of place development, in line with a prior marketing strategy. As such, the objective of a branding strategy of a place is not limited to projecting and communicating a certain image and reputation beyond its boundaries, rather its differentiating features lies in the specific task carried out with the internal public (local population) in order to promote pride in residing in the area and to create a sense of belonging.

- The Place Brand within Geographical Space

Govers and Go (2009) maintain that it is necessary to deconstruct the old model of place branding, as this is strongly linked to the traditional theory of place image, which is inappropriate due to its failure to link the image of place to aspects of identity and communication of place within a global context of space and time. Unlike the promotion of place, spatial branding is not an activity that can be guided by intuition or change rather it involves a highly integrated and strategic sphere of action. Spatial branding is directly linked to a new urban lifestyle in which visual images and the myths associated with them adopt a special relevance, and within this context image promotion takes on a central role for planners and politicians. Hence, the emergence of spatial marketing and branding becomes a natural consequence of a new form of territorial governance that is geared towards satisfying the needs and desires of a potential public (Kavaratzis, 2005, 2011). Therefore, the division of the terms place promotion, place selling and place branding is a result of the multitude of publics to which these concepts are directed as well as of the attributes and values which each concepts offers.

- The Brand within the Context of Urban and/or Metropolitan Space (City Brand)

The competitiveness of a place currently depends on its integration into global systems of information and communication. It is precisely this competition between cities which underlies the need to promote changes in the public organisation and management of the metropolis, especially in terms of achieving a certain positional goal (Dinnie, 2011). To a large, the city thus leaves behind its function of a cluster of economic relations in order to become a system of competing symbols, especially in the aesthetic ambit (Urry, 2004), in order to attract talent, investment and infrastructure, amongst other factors. The evolution of a city infrastructure towards a city of values, in which abstract and intangible aspects take on an unprecedented leading role, call for new management systems in which the evolution from primary sector to the service sector and information society can be clearly seen.

Indeed, we see a new type of consumption for the contemporary city together with new identities within the highly-charged emotional context required for differentiation. The city is thus transformed into space of use and consumption par excellence, that is, the urban and/or metropolitan space is transformed into a cultural consumption product. The contemporary city is thereby one of the clearest manifestations of an identity space for late capitalism (Eugenio Vela, 2013). The transformation of city is due, in large part, to the reconceptualization of a cultural and knowledge-based vocation for urban space, with the city functioning as the territorial vanguard for everything linked to innovation and creativity.

Central Place Theory (CPT) Factor

Central place theory essentially concerns places that provide a convenient point of focus for consumers for the purchase of goods and services, and centrality is the essence of the point of focus (Gbakeji, 2014, p.93). Centrality refers to a state of high accessibility, the quality of being at the center of the transportation system (Morrill, 1970; Ayeni, 1991; Inyang & Ogbonna, 2001). Thus, it follows that the term central place is a relative one. It describes the relationship between a point and other points in the surrounding region, and the central place is that point which can be most 'easily' reached from other locations in the region. Hence, this is the desire of fuel station operators to locate their businesses at a central place where they can attract motorists. The primary concern of fuel stations' operators is a central place which would minimize the travel costs of the consumers in gaining access to the services they require and at the same time, give them a great exposure to consumers. Centrality implies that consumers generally use service centers that will enable them satisfy their wants with the minimum effort (Gbakeji, 2014).

Siting of fuel station at a central location of a town where entrepreneurs considered as more customers convenience become preferable for business location. Central place theory in this study refers to the business location where an entrepreneur perceives for business attraction due to its centrality to other business activities providing convenience to customers. In case of fuel station set up, an entrepreneur would prefer to locate at a central point where for instance, lorry park, market centre, and other businesses where the because of its economic setting motorists or customers can as well as carried out multiple activities. It is

general believed that such central locations give more sales than isolated ones where fuel purchases are made based on urgency. Based on this theory, siting of fuel stations by the entrepreneurs an attention is given to the centrality in relation to other businesses as optimal location.

Even though fuel stations' operators have locational preferences, it should be understood that, the location of fuel stations generally despite its importance to the economy, is expected to be guided by defined standards (Mshelia, et al, 2015). Bolen (1988) stated that, every location on the earth has its analyzable advantages and disadvantages and according to Mshelia et al (2015), before the planning permission is granted to construct a petrol fuel station, it is a requirement to conduct an Environmental Impact Assessment (EIA). Lawrence (2000) defined EIA as an aid to decision-making; providing a systematic examination of the environmental implications of a proposed action and alternatives before a decision is taken.

Lösch (1954) argued that, a firm seeking to maximize profit (a basic assumption of all economic theory) may choose a certain location to gain a competitive advantage over other firms and locate in a market area that provides the greatest profit. Locating the market area of greatest profit depended on assumptions of equal costs of transportation and population distribution. He argued that, the more competitive the market, the more firms will be inclined to seek and adjust to the maximum profit location. The location selected will depend in part upon such demand factors as:

- Elasticity of product demand.

- Location of competitors.
- Importance of proximity to customers.
- Importance of direct contact with customers.
- Extent of market area (regional, national, international).
- Relative competitiveness of the industry.

Iman, Suriatini and Martin (2009) stated that, location of petrol fuel stations is usually associated with the type and volume of traffic flows passing the site, proximity to a major travel route, visibility from the road, time taken by drivers to slow down to enter the petrol station, general ability to attract customers, road direction or movement, artery types, and distance of catchment areas from residential neighbourhoods. Such physical factors in a site location can make the difference between excellence, mediocrity, or failure in use for service station purposes. With respect to the distance of catchment areas from residential neighbourhoods, site proximity to the surrounding residential neighbourhoods can be expected to exert significant influence on a petrol station business (ibid). This explains the locational preference of petrol fuel stations owners which is based on profit maximization (O'Sullivan, 2005).

Empirical Review

This section reviews literature on related subject materials from previous academic studies. Reviewed literature was principally based on observations and experiments from some previous scientific studies.

Location of Fuel stations

There are considerable numbers of case studies that have been done on location of fuel stations globally. The studies have been conducted to find out the hazards in connection to fuel stations locations. Chan, Padmanabhan and Seetharaman (2004) put forward a structural model to make clear both the geographic gasoline retailers locations in Singapore, and the nature of price competition between the retailers and their geographic locations. Intriguingly, the premise underlying the model development was that, the government of Singapore resolved where to situate stations of gasoline in the city. This was found exceptionally unique as matched up to most capitalist market driven economies. The researchers recapped that, the Singapore government is a *social welfare planner* and therefore her approach to make more efficient the gasoline stations distribution across the city is to lessen aggregate travel price consumers incurred in their endeavors to acquire gasoline in Singapore in 2004).

A further study by Hamid et al (2009) examined location potentiality for business of petrol station dependent on counts of traffic volume using a regression and Geographic Information System (GIS) based spatial system. The researchers emphasized that, location potentiality is a significant factor that influences petrol station business accomplishment which depends on visits of customer. On this note, Kearny (1998) revealed that, it was empirically found in the United States of America that, location of site was the main factor for drivers to prefer a particular petrol station (Hamid et al, 2009).

Similarly, one more study carried out in Ipoh, Perak, Malaysia consideration was spotlighted on assessing the viable parcels of land for installing new petrol fuel stations. The data of geospatial was gathered from Mapping and Surveying Department of Ipoh (Khahro, et al, 2013). The standards applied actually for the site choice for petrol fuel station were gathered from City Planning Department, Ipoh. In addition, a set of questionnaires were designed to obtain the view of stakeholders concerning the petrol fuel stations site selection (ibid). Analytic Hierarchy Process (AHP) was adopted as a technique of Multi-Criteria Decision Making (MCDM). Expert Choice (EC) was utilized to study the qualitative outcomes. Finally, to realize the research major objective, the spatial data was made use of to identify the fitting land parcels for installing new petrol fuel stations using GIS. The public feedbacks were studied to create the land suitability map for location of petrol fuel stations and to authenticate the ultimate land suitability map for petrol fuel station, the technique of overlay was used. The existing petrol fuel stations data layer was created with use of the coordinates. The coordinates were pulled together from the online available source the Malaysian Geospatial Data Infrastructure provided. The coordinates were authenticated by utilizing the hand Global Positioning System (GPS).

Likewise, the two GIS based location Petrol Fuel stations analysis, Mohammed et al (2014), carried out a study in Kano Metropolitan Area in northern Nigeria to determine the Petrol fuel station entrepreneurs' compliance to the Physical Planning Standards set by the Department of Petroleum Resources (DPR) (2007). The outcomes turned out some distinctive and significant exposure

on the non-compliance of some of the petrol fuel stations to the standards. Example, it discovered that, barely eight (8) stations (four percent) out of 192 stations did not meet the 15 meters minimum distance criteria from highway. Also, Njoku and Alagbe (2015) emphasized on several of the unlawful Petrol fuel stations location in Oyo State adopting GIS to appraise petrol fuel stations suitability.

A study conducted in Maiduguri and Jere, Borno State, all in Nigeria, the petrol stations employees as well as the residents living close to the petrol stations have in once or the other experience various health effects in consequence of working in petrol stations or living close (Mshelia, et al, 2015; Afolabi, et al., 2011). The outcomes from Mshelia et al (2015) study revealed that, respiratory problems (infections) had the uppermost percent of 38.05%. This implies that, it was the most common health problems having an effect on both the workers and residents due to the fuel contaminated air inhalation. Besides, skin and sight problems together with other health complications were matters of concern. If the state of affairs persists subsequently, such could bring about effects of narcotics with symptoms such as headache, nausea, dizziness and mental confusion (Mshelia, et al, 2015). From the outcome so far, barely twenty-six percent (26%) were placed in keeping with the standards and guidelines. The study moreover showed that some of the petrol stations were detached by a wall or thin lane. One major exposure from the study was that, number of the petrol stations was sited much earlier prior to formulation of environmental guidelines and regulations. Likewise, some of the residential houses were built up near to petrol fuel stations.

Alternatively, city planners as well fail to put into action measures of physical development control to pin down prospective landlords to build in close juxtaposition to petrol fuel stations (ibid).

The subject of entrepreneurs' location preferences as well features within the literature (Afolabi et al., 2011; Mohammed et al., 2014; Njoku & Alabge, 2015). Njoku and Alagbe stated that, in as much as petrol fuel stations have to be situated where they can be easily accessible; the discomfort had been that there has been large number within one geographical area and haphazard locations within Oyo town and Nigeria in general (Afolabi et al., 2011). The examined movement within the literature is that, some proprietors decide to opt for the optimum location to place their petrol fuel station on the principle of profit maximization. Nkoju and Alagbe (2015), revealed that, the Commissioner of Physical Planning and Urban Development stated that, "the *Government of the Republic of Nigeria had sometime before the year 2015, imposed a three-year ban on major marketers of petroleum products in the State of Oyo due to their nonchalant attitude and failure to comply with national government's call to desist from erecting illegal petrol fuel stations".*

Compliance of Fuel Stations to Planning Standard

Ioj and Tudor (2011) studied the temporal adjustments in residential land use closeness to fuel stations in Bucharest suburban, Romania. The stations coordinates were acquired through GPS, aerial shots and Google earth imageries were used to digitize the areas of residence. Buffer zones were generated in map to observe the residential areas encroachments. The study results showed that twenty-

one gas stations were situated in residential areas and thirty-nine gas stations sited in non-residential area. There were ten gas stations (half of the overall twenty-one) situated in residential areas. The study nonetheless narrowed itself largely to buffer analysis and just one land use (residential), fuel stations distance to other contradictory land use for instance public buildings, such as schools, hospitals, libraries and the likes were unanalysed by the study.

Ujjwal and Sokhi (2006) used GIS for petrol station susceptibility evaluation in New Delhi, India. In the study, land utilization within the radius of 200 meters from each fuel station was marked with high resolution IKONOS image and the station coordinates were captured using GPS. Stations were grouped into classes of vulnerability on the strength of the use, density and population with 200 meter buffers.

Nwanjo and Ojiako (2007) examined the latent petrol stations health hazards on attendants in Owerri, Nigeria. Attendants from twenty (20) fuel stations were evaluated in the vicinity and another twenty that were unexposed to its vapour were used as control. The outcome demonstrated a considerable enhancement in the alkaline phosphates, aniline and aspartame amino transfer assess activities for those exposed to patrol vapour from 6-10 years. In addition, the serum urea concentrations, creatinine and urinary protein for those exposed to petrol vapour were significant founded on the study. The study concluded that these outcomes are directly associated with the exposure duration. However, the study did not consider the role of distance in determining the concentration those

chemical which may give another interesting picture, since not only attendants are exposed to petrol vapour, but in addition the neighbor of the stations.

Challenges of Operational Risk for Fuel Stations

Operational Failure

At the time the banking industry was brazen out with this "boundary issue" coupled of years ago, the Basel Committee ruled that losses of credit driven by operational failure were to be treated as losses of credit for capital adequacy intentions. This compromising ruling founded on historical precedence and experience, had the unintended effect of reducing the operational risk significant, not only in banking but across every industries. Under this slender definition, operational risk is linked to low capital charge, thus, a lot of banks viewed it as an issue of low-priority. Not just did this redirect resources and management attention away from this major risk, other than it also covered the underlying roots of many of the largest losses (Khan, 2008).

Whatever fuel station type one operates, procedures are required to deal with emergencies by this notion employees are given adequate training to deal with them. Some of these examples include: cut-off operations of fueling and return nozzles to their housings; clear-up spills without delay; disconnect the electrical supply from malfunctioning equipment; get in touch with the emergency services where required; and do not restart dispensing fuel until slipups affecting safety have been fixed or other incidents appropriately attended to (Health and Safety Executive, 2014).

As stated by Yerevan (2008), petrol spillages when dispensing activities are taking place are predictable happenings and control measures and equipment should be ready to take care of such happenings. Past revealed that spillages can be put into three general categories in the order of rate of recurrence: Blow-backs from the fuel tank or container when the level of liquid is getting to filled capacity. As a result of the safety features designed into the dispenser nozzle, this spillage type will normally only involve a little quantity of petrol which most will quickly evaporate on the forecourt surface; a leak from the vehicle faulty fuel tank being refueled. This spillage kind can arise out of the abrupt and disastrous failure of the fuel tank following the full contents being discharged onto the forecourt. The quantity can be approximately 50 litres if the failure takes place when the tank is filled; and the hose failure coupling or a leak from a hose that vandals' have hacked or stabbed. Potentially, this is the most serious kind of leak as it can give rise to the customer being splashed with petrol. In a most terrible-case situation, there is the likelihood of a customer being 'bathed' with petrol if, for instance, there is a coupling or hose failure on a 'high hose' dispenser (Yerevan, 2008).

Loss of spillage is made up of contributions from drip of pre-fill and post-fill nozzle in addition to spit-back and overflow from the vehicle's fuel tank filler pipe for the period of filling. The sum of loss of spillage can depend on a number of variables, which includes service station business characteristics, tank configuration, and operator techniques. Staff ought to be tutored in how to attend to such a situation and there should be facilities on hand for a customer to wash the affected parts of their body and get rid of contaminated clothing (Health and Safety

Authority, Dublin 2013). Means to decrease the waste amount generated in the first place, alongside the re-use and wastes recycling have to be considered. There is scope for significant savings, as the products and waste disposal costs keep on rising (ERC, 2012).

Underground Tanks

Underground tanks have to be selected, located and bedded in so that the leakage risk is minimized to the lowest amount that is plausibly workable. Tanks are required to be fitting for the prevailing conditions of the ground and properly protected from oxidization and premature chemical attack degradation. Generally, leaks from underground tanks cannot be detected openly and are, hence, more tricky to observe than leaks from tanks mounted above ground. There was an instance a fuel station in a municipality, whose fifty (50) year old tanks were discovered to have seeped out petrol into the basement of close by apartments. Fortunately, the petrol was found earlier than the vapor had built up to a hazardous level. Ignition sources were gotten rid of and the apartments vacated. An assessment of the tanks risks leaking should have been made which, alongside an appropriate inventory or system of leak detection, could have uncovered the leakage before becoming a public risk. The risk assessment results will enable the manager to decide the control level required to identify and manage petrol leaks. Several leak prevention and methods of leak detection exist (Health and Safety Authority, Dublin 2013).

Effectively, the method one opt for have to either prevent a petrol release or provide early warning of a leak to make possible corrective actions to be taken

swiftly so that people are not put at risk. The fuel station operator also has to consider risks to the environment from a petrol leak. If the site is located in an area where a petrol leak would be a serious risk to public safety or a serious contamination risk to groundwater, the operators has to set up leak prevention controls rather than leak detection as the latter will merely give warning after petrol has drifted from the containment system (ibid).

Once a leak is presumed, for whatever cause, it must be in detail investigated. This could entail taking a tank out of service and examining it or conducting a precision tank test. Various testing techniques exist; vacuum, volumetric, and low pressure. The examination has to take into account bases other than leaks, which can cause wet stock differences prior to tank testing is performed. A suggested chain of investigation is: verify the figures of reconciliation to make sure the calculation is correct and that every single deliveries as well as extra stock movements have been accounted for; verify the wet stock control processes are properly performed and whether forecourt staffs need extra instruction; check for any noticeable leaks from pipe joints in manhole compartments, electrical channels, drainage systems and around the base of dispenser; check for any petrol scents increases. Consider any information or complaints from neighbors; have the dispensers tested out for correctness; test out the measuring system of tank contents. Check the dunk stick for damage or the gauging system for precise operation. Test out whether tank gauges have to be recalibrated or serviced; test out the tanks for water entrance; have the pipe-work checked for leak; and consider fraudulent activities or undersized deliveries. The

most suitable method of check will depend on the installation type at the site. Sooner than deciding on a particular check find out whether it has third party authorization, if so for what levels of load, sizes of tank and ullage volumes; the check takes account of the water table; the ullage space is examined; there are any safety features; and the operators have been well trained (Health and Safety Authority, Dublin 2013).

Emergency Plans

The emergency plan objective is to reduce the effects of any tragedy that arises at premises where larger quantities of hazardous goods are stockpiled and handled. The emergency plan should be up to managing the most terrible-case scenario. Still, thorough planning should focus on the more probable events. The emergency plan should in addition be acceptably flexible to guarantee that an emergency response can be varied based on the rigorousness and dangerous occurrence type or near miss. (The MITRE Institute, 2007).

The emergency plans contents be required to communicate to each and every one person who may be exposed to a risk in consequence of an emergency, comprising: employees; contractors and sub-contractors; and persons in control of contiguous premises. The emergency plan has to be tested when initial developed, after each adjustment and periodically. Simulated emergencies and other workouts should methodically attempt to include all individuals probable to be caught up in a precarious occurrence or near miss. These workouts should take account of practical drills. Emergency plans have to be updated each time: there is a change of

state of affairs on or off the premises; revised information turns out to be available; dearth in the plan is identified (Health and Safety Executive, 2014).

The greater part of fuel service stations are small in sizes with some facilities operating 24 hours. They are frequently sited in or near urban settings or along major transport routes. This trend is changing in Ghana as fuel stations are now being put up in rural communities as well. The chief products used by the retail petroleum industry are kerosene, gasoline and diesel, although other fuels such as liquefied petroleum gas (LPG) may also be provided (ERC 2012).

Best Practice of Managing Operational Risk for Fuel Station

Operational Risk Management

To effectively deal with this risk, institutions are supposed to apply a top-down risk based view, assigning unambiguous responsibility for every single major operational risk. Also, effective governance obliges that enough talent is primed, covering all major operational risk and devoid of impeding execution of business (Mckinsey, 2012).

Health and Safety Authority, Dublin (2013), asserts that to effectively manage the risks connected to the storage and hazardous goods handling. The owners of fuel station have to involve their members of staff and any other persons engaged to do piece of work at the station when planning and implementing risk control measures that are possible to be affected by the hazardous goods.

The Primary Duty to Eliminate or Control Risk

The proprietors of station or operators have an obligation to make sure that any risk connected to the storage and handling of hazardous goods at the station is

controlled, that is if keeping out is impracticable, the risk have to be minimized so far as is feasible. In addition, the Regulations place several specific duties on proprietor or operator to control risks associated with particular portions of storage and hazardous goods handling. Giving effect to these specific duties does not shift their universal responsibility to control risk (Health and Safety Authority, Dublin 2013).

To be acquainted with hazards one require to comprehend operations of their site, its surroundings, and the age, make as well as equipment type installed. Members of staff or safety delegates may be capable to assist fill in any spaces in this knowledge. Also, a site plan may prove valuable when conducting the risk evaluation. Looking for spots where fuel vapour may possibly build up is a way of determining where vapours may arise and is a legal requirement (Yerevan, Armenia USAID 2008).

For every single activity, settle on whether and how petrol for instance could escape. Consider how much could spill or seep, what path it might take and where it would collect. Inquire about possible ignition sources. Take into consideration human error and the reality that people do not at all times follow orders or act in a responsible manner. Examples, purchasers may park badly and block delivery tankers or emergency routes of escape. Besides, they may attempt to fill inapt containers with petrol, or smoke when filling their cars. Think about all activities including maintenance, cleaning, and those other activities, which only come to pass occasionally. Consider the utmost number of people who could be affected by a fire or outburst. Take account of those who work at the fuel station;

come to the site to purchase fuel; call the site for other bases, such as contractors or customers making use of a forecourt shop or car wash; those who dwell in adjacent property; and share and/or operate different business on the site. In each scenario, consider what could ensue or what could be unsuccessful and fit in the most and slightest possible events to take place. Include the most terrible events that could come about and those where operator may have no visible sign or warning. Consider what could be the possible effects in all these scenarios given. This will help the operator later in the assessment (Yerevan, Armenia USAID 2008).

Safety Measures

In any situation, the operator has done all that the law requires in ensuring safety of the people, then it rests on the operator to look at the precautions the station already have in place. Although a particular occurrence possibility may be small, it is still required to consider the costs, if something does go wrong. Already, if the risks are low enough the operator should not have to initiate any additional measures. However, if concludes that operator should do more, operator have to look at other alternatives for controlling or reducing the risk. No two sites are very similar, so it is unfeasible to provide a clear-cut list of what operator ought to do. Solicit for guidance if need be, and operator has to keep in mind that the station is responsible for seeing that the risk assessment is sufficiently carried out. Some alterations like relocating vent pipes may require some appreciable time to achieve and need temporary steps to be taken to reduce the risk. When operator decides what to do and takes the suitable action, operator needs to ensure that the

measures are effective. How this is accomplished will vary according to the nature of the changes operator makes (ibid).

Significant findings records of the risk assessment have to be kept. The information type recorded must contain the noteworthy hazards, that is, those which pose a severe risk to workforce or the neighborhood whose safety might be affected if something goes wrong; the people who may be affected; and existing control measures and the extent to which they control the risk, this need not replicate details more wholly illustrated in documents such as instructions of the manufacturer, health and safety policy statement or procedures, rules of company and the like but operator should refer to them if the station intend to depend on them (Yerevan, Armenia USAID 2008).

Petrol Leaks and Spills Prevention

Petrol is most certainly to leak from tanks and pipe-work if equipment is badly fitted, poorly maintained, or aged. Where the storage system reliability cannot be guaranteed, for instance by the secondary containment provision, it can be improved in several methods such as: measurement of wet-stock and reconciliation or by fitting a system of leak detection. Furthermore, intermittent testing for the water presence in underground tanks may point to (by water ingress) a breakdown in the tank shell, gaskets sealing the tank closure or connections of pipe-work. The method(s) fuel station employs will pivot on the risk level at the station. Spillages have to be cleared up promptly. The station can handle small leaks and spills by using dry sand or other spongy materials. But materials applied in this manner will be polluted with petrol so operator should take care they are

safely disposed, if need be by a harmful waste disposal expert. If the fuel stations seek to store polluted material before disposal, they have to make use of a safe place such as a secured container or other storage bin, which has been properly stickered. Other materials polluted with petrol, like clothing, rags or soil, must be cared for in a comparable manner (Health and Safety Authority, Dublin 2013).

In line with Energy Regulation Commission, ERC (2012), national health, pollution prevention, safety and environmental goals matches with the economic interests of Oil Industry. Companies have strong motivation to minimize the toxicity and sheer amount of the waste they create. A business with a thriving, continuing pollution deterrence arrangement may well be the lowest-cost operator and have a momentous competitive edge. Companies minimize their civil and criminal liability risk by decreasing the amount and the likely vapor toxicity, liquid, and solid releases they produce. Companies are supposed to observe all waste types, not only those that are currently classified as harmful. Since definitions of toxicity and regulations vary, minimizing the wastes volume in all categories is a sound long-term management strategy (ERC, 2012).

Fuel Offloading

The number of road tanker cubicles discharged all together into tanks should not be beyond: the number that can be securely handled at any one time; or the highest number permitted to reach acceptable vapour balancing. Even if the fuel station have taken practical moves to avert an incident, a spillage can still take place, example if a delivery hose connection cataclysmically fails. Operator is required to have procedures to apply and equipment on hand if unexpected

happens. The procedures should be in written form and accessible always to personnel on site, including the delivery driver. Tanker standing vicinities should have features of design to take care of spillages like diversionary controls, slope to a secure area, drainage grids/channels and interceptor or constructed wetland systems (Health and Safety Authority, Dublin 2013).

It is imperative to frequently examine underground storage tank (UST), containing petroleum products, in particular if the tank is over twenty (20) years old. Modern USTs should have a detecting leaks system. Opt for the tank site cautiously to ensure ease of installation and selected leak-detection reliability methods. Periodically, test the tank for leaks and gauge the tank stock on regular basis to help identify leaks sooner than major problems upsurge (ERC, 2012).

Testing of tank should be backed with documented procedures and operator is supposed to make sure that the test is done by persons who are expert in the particular test applied operation. Depending on levels of ground water it is possible for tests to present false confidence, that is, a tank may leak but pass the test. Significantly, it should, however, be remembered that periodic leak testing is not a substitute for having a documented and suitable leak detection method in operation. Tanks and their connected equipment, comprising leak detection plus overfill prevention systems, fill pipes including the drop tube, entrance chambers and their covers, are major areas where maintenance is very important. This assists to ensure the tanks and safety, and emergency devices effectiveness. For example, work on petrol tanks is basically dangerous and safety measures should take account of the combustible contents, particularly once the tank or cubicle is

supposedly empty. Repairs, modifications and maintenance should be carried out only by personnel who have the skilled to perform this type of work (Yerevan, Armenia USAID 2008).

Operation Methods

The dispensing provision can function in varied approaches; from attended service, where site personnel refuel vehicles of customers through to locations that are unmanned and where customers refuel their own vehicles without any on-site supervision or assistance from the site operator. Some fuel stations are yet to function on an alternating system where the site is operated as attended self-service at busy periods and unattended self -service at quiet periods (that is late evening and through the night). The decision with regard to the mode of forecourt operation is one for the site operator to take on a commercial basis but after taking safety concerns into consideration. The precautionary considerations must be based on a site-specific risk assessment. Regardless of the mode of operation, forecourt attendants should not be under the age of sixteen years and no one under the age of eighteen years should be left in sole charge of a fuel station (Health and Safety Executive 2014).

Every dispenser has special safety features to prevent petrol discharges. Modern dispensers are designed and licensed to a superior standard than older ones with features such as cut-off or limiting devices and cut loose couplings. To observe the regulation requirements, site operators will require to make sure that petrol is dispensed safely (Health and Safety Executive 2014).

Mobile Telephones

In general, mobile cell phones are not designed and certified for use in explosive environments. Their use can moreover create a heinous distraction for personnel executing dispensing activities. Radio transmissions from personal mobile phones are usually too low to stimulate harmful electric currents in close by equipment and the incentives parking risk from the battery is low, however, they should not be used in the unsafe areas that exist when in fact dispensing fuel. Neither should they be used in the unsafe areas around the fill and vent pipes during petrol deliveries. Mobile telephones should also not be used by customers or forecourt staff whilst in reality dispensing petrol into fuel tanks or containers (Health and Safety Executive 2014).

The use of radio equipment fitted on emergency vehicles and citizen band (CB) radios may create an ignition risk. These types of transmitting equipment do have a power out-put sufficient to induce dangerous electrical currents in nearby fixtures and they should not be allowed to be used at the dispensing points or in the vicinity of the road tanker when unloading. It should be noted that the radio equipment mounted on most emergency vehicles is under automatic interrogation from the base station. This means that radio messages are being received and transmitted without anyone speaking into a hand set (Yerevan, Armenia USAID 2008).

Approaches for Addressing Illegal Fuel Stations

In Ghana, laws and regulations used to address siting of fuel stations are vested in some state institutions such as Environmental Protection Authority

(EPA), National Petroleum Authority (NPA), Town and Country Planning Department, and Municipal and District Assemblies (MDAs). Before any fuel station is setup in the locality, approval and authorization of the location are first sought at the Town and Country Planning Department, and Assemblies. Afterwards, EPA carries out environmental impact assessment of the location to determine its locational suitability for the intended purpose. When all these processes are completed, NPA carries out knowledge tests assessment for the operator/owner and subsequently issue approval certification upon satisfactorily performance. Ideally, all these processes are meant to address illegal siting of fuel stations. Also, before an enactment of comprehensive laws and regulations for siting of fuel stations in Ghana in 2010, many fuel stations were in existence. Some of them were wrongly sited, while others followed old spatial order though not back by laws and regulations. Due to these flaws, some international best practices in addressing illegal fuel stations are reviewed in the study.

Petrol exudes very much flammable vapour even at very low temperatures. Due to the petrol vapours flammability, fuel or service stations bear a risk of fire or explosion unusual to other retail outlets types. Petrol vapours ignition can ensue if vapour gets into contact with a source of heat capable of igniting it. Spark of an ignition might originate from an electrical switch, a cigarette or a static electrical discharge. Vapour of petrol is heavier than air and tends to submerge to the lowest possible level of its environs and may draw together in tanks, drains, cavities, pits or other low points and will move across the ground because of gravity (down-hill) or may be carried in the wind direction.

To avoid the ignition risk, the fuel station must be zoned by reason of an explosive vapour mixture forming probability. Hazardous areas, as created in the area of a fuel station, are classified into three categories as showed in Table 3.

Table 3: Hazardous Area Zoning of Fuel Stations

Zone Classification for Vapour	
Zone 0	That hazardous area part where a flammable atmosphere is continually present or present for long periods.
Zone 1	That hazardous area part where a flammable atmosphere is possible to occur in normal operation.
Zone 2	That hazardous area part where a flammable atmosphere is improbable to occur in normal operation and, if it occurs, will exist for a short period.

(Source: Health and Safety Authority, Dublin, 2013)

The fuel station zoning should be carried out by specialist who is skilled to do it. The zones should be marked visibly on fuel station drawings which must be accessible at any given time at the station.

The zones are in three measurements so the designs will require specifying plans and elevations, to illustrate their complete scope. These diagrams of zoning should be included in a document named an Explosion Protection Document (EPD).

Any electrical equipment (or mechanical equipment up to generating sufficient high temperature to result in ignition) is required to be properly rated and certified earlier than they can be installed in a hazardous zone within the station. To guarantee the electrical installation quality, every single fuel station must have

its electrical installation checked and certified every three years by a skilled electrician conversant in explosive atmospheres (Health and Safety Authority, Dublin, 2013).

Moreover, petrol is hazardous to the environment, harmful to aquatic life and hands down a particular risk to supplies of drinking water. At any time petrol leaks or seeps out from pipelines or an underground storage tank it can move significant distances dependent on whether there is a high water-table or underground river in the area. Even though diesel and kerosene are not as combustible as petrol and thus do not pose a major intrinsic flammability risk, they are hazardous to the surroundings and any these fuels leakages could pose a danger particularly to groundwater in the area (Health and Safety Authority, Dublin, 2013).

As good number of fuel is stored in underground storage tanks, if there are leaks, it is easier for it to enter the underground water system and pollute the groundwater which in many cases becomes source of drinking water to neighboring communities. Given the considerable risks to people and the environment health & safety, the petrol storage at retail & private stores is controlled by specific legislation which needs such storage to be licensed (in the case of petroleum spirits only) and such license conditions in general necessitate every workable steps to be taken to prevent fire accident, explosion or petrol seep out (Health and Safety Authority, Dublin, 2013).

Likewise, the Prevention of Pollution of Groundwater Regulations, S.I.9 of 2010, proscribes the hazardous substances input into groundwater. The risk level

from the storage and motor fuels dispensing enhances when fuel stations are sited in urban vicinities, as they are within private or commercial premises. Hence the need for regular and perfect monitoring of petrol delivered, stored and dispensed at any petrol station to detect leaks from each underground tank and connected pipeline system, is crucial.

These guidelines of best practice provides practical advice and information to assist operator to develop and preserve an effective Wetstock Inventory Management System for station site(s), and to keep to legislative requirements as all fuel station operators will be required to perform a risk assessment for their operation and make sure that enough controls are establish. All operators of petrol station will be required to meet a wetstock control basic standard to detect likely leaks, mostly from underground storage tanks. The method of controlling wetstock levels is referred to as “Wetstock Reconciliation”. In all these approaches tailored to address illegal siting of fuel stations, adherence to laws and regulations, coupled with its enforcement is the ideal way to achieve success. Enforceability of the rules and regulations, by all the statutory bodies tasked must be probed by oversight body.

Theories of Fuel Station Locations

Location theory has suggested that firms situate in order to minimize costs and look for locations that maximize their opportunities to arrive at markets and, therefore maximize profits. A great deal of the attention has been on labour costs, transport costs, other production costs, scale of operation, in addition to agglomeration economics. The transportation and telecommunications technology

evolution has caused to be distance (time and costs) less of an obstruction, making possible industry to develop into more footloose, and changing organisation modes of production are emphasizing the business networks importance, strategic alliances and systems of just-in-time delivery. Furthermore, increasingly intangibles such as facilities and business environment are seen as essential determinants in the firms and managers location decision making. Eventually, the prominence in location theory has altered from minimum cost/profit maximizing or optimizing type posture to satisfying posture and the uncertainty issue as it effects industry costs, efficiency, output as well as profits.

In local and regional economic development strategy formulation and plan execution, an appreciation of the postulates of location theory is significant, principally in terms of understanding locational locality or region merit or demerit for particular industries types and firms sizes regarding the input of resource and labour requirements, proximity requirements, market size requirements for local targeted sales, for infrastructure planning, and for intangible factors assessment in industry attraction and business retention. Location theory offers the basis for the concentration and industries dispersal, plant size efficiency, the new technologies impacts on things such as transport costs, labour and non-labour costs, and externalities impacts such as congestion.

The Central Place by Walter Christaller (1933) posed the question “are there laws which determine the size, number and distribution of central places?” The idea is that urban centres are set in a hierarchical central places pattern of diverse size and functional complexity, and that there is an orderly spatial

arrangement across a large region in the distribution pattern of central places (urban settlements). The diverse functions central places provided reflect the economic activities diversity that serves their surrounding populations. The central place theory focus is on the retail and other central place service functions rather than manufacturing type activities. The specific function trade area is determined by several factors especially the inter-relationships between the piece of the good or service, the travel cost for a consumer to gain access to purchase it, the aggregate time level required to back the business providing it, and the regularity with which it is bought. Hence, two major considerations are the good or service range, which sets a spatial limit beyond which people will not travel to access it, and the good or service threshold, which refers to the least aggregate consumption that the good or service requires to pay for the costs of pay for the producing costs or offering the good or service.

The theory continue to argue that central places hierarchical arrangement reflects the functional complexity and order of the goods or services being provided, with levels in the central places hierarchy being defined by the maximum order of good or service being provided. Low order goods or services that are regularly bought and for which fairly small populations are needed within their market areas. Therefore, those goods or services will be provided regularly and at several locations. Those functions will define the low level centres in the central places hierarchy, which will be characterized by a small number of fairly simple populations. They include functions such as a local convenience store or an auto fuel station. The higher levels of the central place hierarchy will be defined by

high order goods and services which are relatively expensive and are consumed by people relatively infrequently, and which require large populations in extensive market areas to generate the high aggregate levels of consumption needed to cover the high costs of providing the good or service.

Conceptual Framework for the Study

Following the review of literature and theoretical expositions from different authors, a conceptual framework was developed vis-a-vis the integration of Environmental Impact Assessment, Location Theory, Least Cost Theory, Market Area Analysis, Place Brand Theory and Central Place Theory and the Standards and Criteria in order to carry out effectively the assessment of public's perception on location of filling stations so as to effectively assess the location of fuel stations in the Sunyani Municipality.

The consideration of the determinants for locating filling stations was considered to be very important to assist in assessing public's perception on location of filling stations. Figure 1 shows the conceptual framework for the research, outlining the relationship between the main locational determinants and the location of filling stations. The determinants (Elasticity of product demand, Location of competitors, Importance of proximity to customers, Importance of direct contact with customers, Extent of market area (regional, national, international), Relative competitiveness of the industry and standard and regulation are conceptualized to play a significant part in the location of petrol filling stations. These determinants vis-à-vis also influence resident's perception to why these stations are cited in these locations where they reside. These perceptions dual on

residence health and their safeties. In view of this, a negative perception to the reasons for citing the stations negatively affects the health and safety of residence as seen in figure 1. on the same vain, these factors if fail to follow laid down regulation can also be iminical to the health of residence.

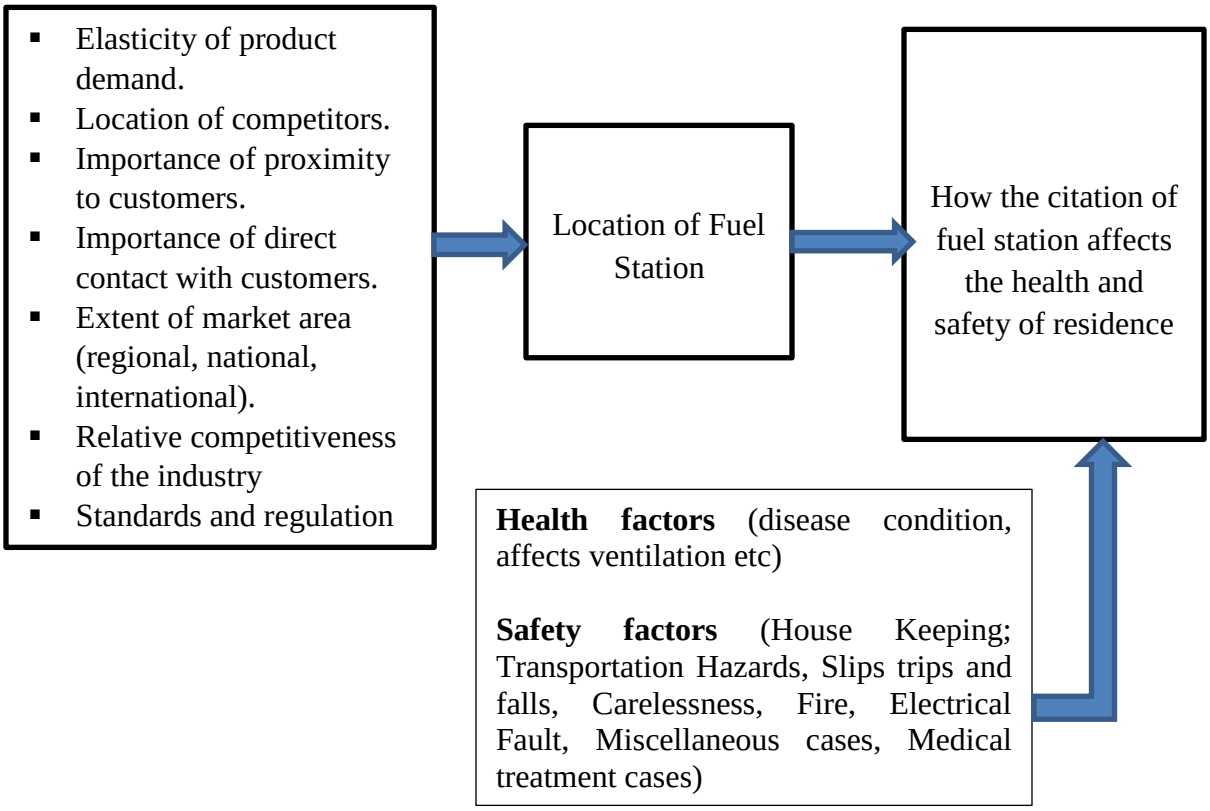

Figure 1: Conceptual Framework Guiding the study

Source: Authors Construct

Summary of the Chapter

In the chapter, theoretical background of siting of fuel stations has been elaborated and subsequently builds on to develop a conceptual framework to analyse the fuel station location in Sunyani Municipality. The predictor variables

identified in the conceptual framework are location factor, least cost factor, market area factor,-place brand factor and central place factor while fuel station location is the outcome variable.

The implication for developing this research lies in its potential and capacity to combined theories and applications to unravel the obscurity surrounding the indiscriminate siting of fuel stations in the municipality. Significantly, the outcome of this study is meant to implicate any organization or individual, but to contribute in solving the problems on hand. The theories in the study basically look at the factors influencing owners/entrepreneurs to site fuel stations in manner they do. The next chapter provides the methodology and design used in capturing data for analyses.

CHAPTER THREE

RESEARCH METHODOLOGY

Introduction

This chapter presents the methodological approach that the study followed. It presents various techniques that were used to select the respondents and also used to collect and analyze the study's data. The chapter describes the research design, study area, population, sampling procedure, data collection instruments, data collection procedures, data processing and analysis, and ethical consideration that guided the study. The chapter ends with a discussion on the field challenges.

Research Design

Guided by the pragmatic philosophy that is the combination of qualitative and quantitative, the study utilized a cross sectional study design to understanding role institution play in fighting the menace of legal mining. According to Kothari, (2004), a cross-sectional study is a research tool used to capture information based on data gathered for a specific point in time. The data gathered is from a pool of participants with varied characteristics and demographics known as variables. Age, gender, income, education, geographical locations, and ethnicity are all examples of variables. Cross-sectional studies are usually relatively inexpensive and allow researchers to collect a great deal of information quite quickly. Data is often obtained using self-report surveys and researchers are then able to amass large amounts of information from a large pool of participants(Creswell, 2013:2014). While cross-sectional studies cannot be used to determine causal relationships, they can provide a useful springboard to further research Some criticisms have

been levelled against the use of mixed method approach. For example, Creswell, (2013), described the use of mixed method as time consuming, while Sarantakos (2012) observed that mixed method is difficult to replicate, and therefore advised that it is not more valuable than the single-method procedure, which can be more suitable, useful and meaningful to answer certain questions. Despite the criticisms, several authors (Esmail, 2017; Latifatu, 2017: Iqbal, Zakar, Zakar & Fischer, 2017; Newton-Levinson, Leichliter & Chandra-Mouli, 2016) support the use of the mixed method as a study approach because it is especially useful in understanding contradictions between quantitative results and qualitative findings. Using mixed methods give a voice to study participants and ensure that study findings are grounded in participants' experiences. Again, mixed method approach has great flexibility and is adaptable to many study designs such as observational studies and randomized trials to elucidate more information than can be obtained in only quantitative research (Creswell & Clark, 2017). Based on the strength exhibited by the mixed method approach, this study will therefore adopt the mixed method approaches to help answer the study objective.

In using the mixed method technique Creswell and Plano-Clark (2011) have identified various forms of mixed method that can be applied in a study. In this study the convergent parallel mixed methods were adopted. This type of mixed method design allowed the study to converge or merge quantitative and qualitative data in order to provide a comprehensive analysis of the research problem. In this study, both interview schedule (quantitative method), and in-depth interview and observation (qualitative methods) were used to collect data from the field.

Study Area

In the Brong Ahafo region, Sunyani Municipality is one of the twenty-seven administrative districts. It became Municipality on March 10, 1989 by a legislative instrument (LI) 1473 at time the Ghana adopted the concept of District Assembly. Generally, the goal was to speed up growth and development in the Municipality. On the November 2007, the Sunyani West District was carved from this Municipality (GSS, 2014).

Size and Location

The Sunyani Municipal Assembly covers 506.7 Km^2 total land area. It is located at the centre of Brong Ahafo Region lying between Latitude $7^0$20'N and $7^0$05'N and Longitudes $2^0$30'W and $2^0$10'W. It is surrounded on the north by Sunyani West District; west by Dormaa East District south by Asutifi District and east by Tano North District (Figure 2).

Climate, Vegetation and Drainage

The Sunyani Municipality situated within the Wet Semi-Equatorial climatic zone of Ghana. The monthly temperatures oscillate between 23ºC and 33ºC with the lowest around August and the highest around March and April. The average rainfall is 88.99cm. The district experiences double maxima rainfall pattern with the main rainy season between March and September and the minor between October to December. The relative humidity averaging between 75% and 80% during the rainy seasons and below 70% during the dry seasons is ideal for luxurious vegetative growth.

Sunyani Municipality falls largely within the Moist-Semi Deciduous Forest Vegetation Zone containing most of the valuable timber species. The two major forest reserves are the Yaya and Amoma forest reserves. Cocoa and citrus thrive well in the vegetation type in the district. The water bodies including the Tano, Amoma, Kankam, Benu, Yaya and Bisi rivers are seasonal.

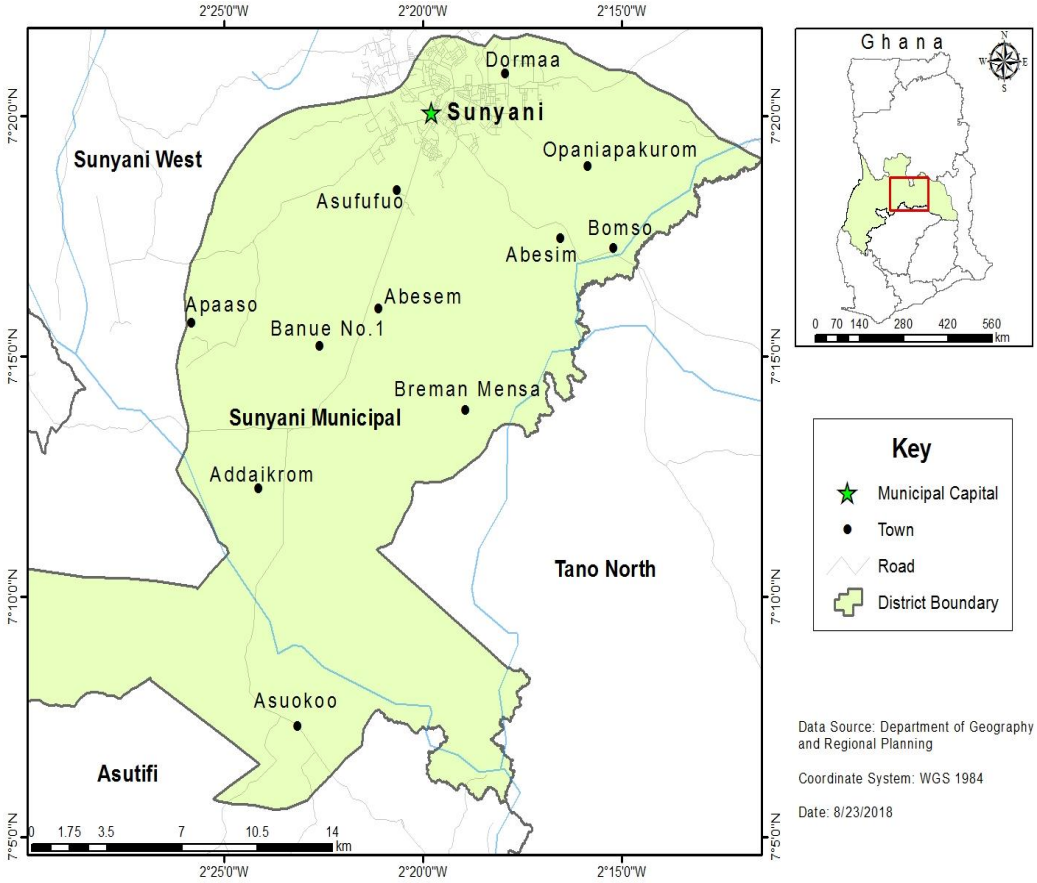

Figure 2: Map of Sunyani Municipality

Source: Data Analysis, (2018)

The Municipality has fifty assembly members consisting of the Municipal Chief Executive, the Member of Parliament, thirty-four elected and fourteen government appointees. Besides the political administration and appointees, culturally the Sunyani Traditional Council is made up of twenty-two divisional and

sub-chiefs headed by Omanhene (paramount chief). The Municipality has different ethnic background and largely inhabited by the Akans. Other tribes that can be found in the municipality include diverse Northern tribes, ewes, and Ga-Dangme which has the least population (GSS, 2010).

Economy of Sunyani Municipality

Brong-Ahafo region employs nearly a tenth of Ghana's total economically active labour force and generates a little under nine percent of the nation's GDP. The region is the fourth highest regional contributor to the national GDP (GSS PHC, 2010). The region's economic structure is dominated by the agriculture sector, which employs sixty-three percent of the total workforce and generates more than half of the region's GDP. Between 2000 and 2010, agricultural employment increased by seventy-seven percent reflected as additional 296,000 jobs in the sector. The region employs over a tenth (13%) of all agricultural workers in the country (NSDF Study 2014).

Sunyani Municipal, the regional capital and administrative centre, has the highest GDP per worker value of GH₵ 5,041 compared to the regional average of GH₵3,613. The neighbouring MMDAs of Sunyani West and Asutifi North also have relatively high value addition per worker, as does Asutifi South; due to gold mining in the district (GSS PHC, 2010). The choice of Sunyani Municipal for the were based on the following considerations: (i) improvements in economic potentials and the growing population. Due to high GDP per worker value, more people are owning cars and therefore creating high demand for fuel products with springing up more fuel stations. Also, due to high population growth, more

residential facilities are springing up thereby creating competition for the use of the land spaces, (ii) as the Sunyani Municipal happens to be the regional capital and administrative centre, more commercial activities are linked to it and the savvy entrepreneurs would want to catch on this opportunity of high demand for fuel products by way establishing stations to meet these demands.

Data and Sources

In order to achieve the objectives of the study primary data supplemented with some secondary sources of data were used to obtain the required data to address the research objective. Primary data were collected using self-administered questionnaire and interview guide (see Appendices I, II, and III). The supplemented secondary sources were also obtained from books, articles, journals, newspaper, reports, the internet, and conference and working papers that were relevant to subject under study.

Study Population

Population refers to the large general group of many cases from which a researcher draws a sample and which is usually stated in theoretical terms (Neuman, 2003). Polit and Hungler (1998) defined a study population as that population which reflects the entire aggregate of cases that meet designated set of criteria for a given study. According to Amedahe (2004), the target group about which a researcher is interested in gaining information and drawing conclusions is what is known as the population. It is a group of individuals who have one or more

characteristics in common that are of interest to the researcher. Thus, the study population consists of the following categories:

i. Fuel station managers in the Sunyani Municipal
ii. National Petroleum Authority (NPA) representative/officer
iii. Environmental Protection Agency (EPA) representative/officer
iv. Town and Country Planning Department (TCPD) representative/officer
v. Residents (churches, schools, health facilities, tenants and other businesses) within the catchment area.

The total population size of the Municipality was 123,224 as at 2010 (last population census) with average population growth rate of 3.69 percent per year (GSS, 2010). The projected population of the Municipality as at 2017 stood at approximately 158,800. However, in the case of this study, population which is directly close to the siting of fuel stations was approximately 7,550 (Town and Country Planning Department, 2017). The Fuel station managers (46) in the Sunyani Municipal provided information on factors influencing the siting of fuel stations based on the location theories. Information on their experience and knowledge on regulations of siting fuel stations were also obtained. The NPA representative(s) provided information on requirements on setting up fuel stations and problems they are facing with fuel station operations in the study area while the EPA provided information on location suitability for siting fuel stations and the consequences of the activities of fuel stations on the environment. Town and Country Planning Department on the other hand provided spatial information on the areas within the Municipality allocated for siting of fuel stations and the

compliance of planning regulations in the area. The residents were involved to provide information on how the locations of the fuel stations pose threats to them.

Sample Size for the Study

In finding appropriate sample size for the study, the Fisher, Laing, Stoeckel and Townsend (1998) formula for determining sample size was used. This formula is given as:

$$n_f = \frac{n}{1 + \frac{n}{N}}$$

where:

n_f = the desired sample size (when population is under 10,000),

n = the desired sample size (when population is above 10,000),

N = the estimate of the target population size.

In other to get n, Fisher et al. (1998) provided another formula, which is

$$n = \frac{z^2 pq}{d^2}$$

where:

n = the desired sample size (when the population is above 10,000)

z = the standard normal deviation, usually set at 1.96 which corresponds to 95 percent confidence level,

p = the proportion of the target population have particular characteristics,

q = 1.0 – p, and

d = the degree of accuracy desired, this is usually set at 0.05

With (z) statistic being 1.96, degree of accuracy (d) set at 0.05 percent and the proportion of the target population with similar characteristic (p) at 90 percent which is equivalent to 0.90, then "n" is:

$$n = \frac{(1.96)^2(0.90)(0.10)}{0.05^2}$$

A calculated n = 138 was obtained, this constitutes number of residents directly affected by siting of fuel stations. Substituting this figure into the formula, the sample size for the residents gives:

$$n_f = \frac{138}{1 + \frac{138}{7{,}550}}$$

$$= 136$$

Furthermore, all the forty-six (46) fuel station managers in the municipality were used as sample for the study. In addition, each representative of NPA, EPA, and Town and Country Planning Department was included in the sample, thus making the overall sample size of the study 185.

In choosing this formula, much considerations were given to its suitability that includes the use of descriptive statistics involving means, frequencies, and percentages of the population for analyses. Another consideration given to the formula's suitability is about the sampling techniques adopted. This formula is much simpler to use for more complex design where two or more sampling techniques such as cluster and purposive are being applied.

Assumptions of the Formula

i. An assumption of a 95% confidence level and p = .5

ii. With (z) statistic being 1.96, degree of accuracy (d) set at 0.05 percent,

iii. the proportion of the target population with similar characteristic (p) at 90 percent which is equivalent to 0.90, and

iv. the proportions used assume a dichotomous response for the attributes being measured.

All these assumptions were met in the determination of this formula for the sample size, hence its consideration for the study.

Table 4: Total Sample Population for the Study

Respondent	Sample Size
Residents (churches, schools, health facilities, tenants and other businesses)	136
Fuel Station Managers	46
NPA	1
EPA	1
Town and Country Planning Department	1
Total	185

Source: Field Survey, Bassuah (2017)

Sampling Procedures

In selecting the 185 respondents, both probability and non-probability sampling techniques were used. Specifically, the cluster, census and the purposive sampling techniques were used. Below are how various respondents for the study were selected

i. Residential Respondents

In selecting the respondents cluster sampling technique was used. This procedure was used because respondents located at different geographic areas within the municipality. Such spread of respondents required that the sample is divided into clusters and primary data collected from each cluster in the municipality. This sampling technique is deemed best for the study because of large sample size used and also increased the level of accessibility to the study respondents.

ii. Other Respondents

The purposive samplinge was used to select forty-six (46) fuel station managers as well as one representative each from NPA, EPA, and Town and Country Planning Department. For these respondents the purposive sampling technique best suited their selection because it enabled the inclusion of those who served the purpose of the study to acquire the required information from them to achieve the study's objectives.

Research Instruments

In conformity with the mixed method design, self-administered questionnaire and interview guide were developed to gather the primary data from the field (see Appendices I, II, III, IV and V). The appropriateness of these instruments was considered under the following cursors:

1. Self-administered questionnaire was used base on its advantages of building good rapport, creating relax and healthy atmosphere in which respondents easily cooperate, answer questions, and clear misapprehension

about any aspect of a study (Kumekpor, 2002). Furthermore, due to the large size of the respondents in Sunyani Municipality the use of questionnaire was necessary to help collect much information from a large number of people in a short period of time and in a relatively cost-effective way. This instrument also helped to collect data from some respondents who were uncomfortable in disclosing some information through verbal interactions.

For the measurement of the variables in the questionnaire, Likert-scale was used where 5 represents strongly agree, 4-agree, 3-neither agree nor disagree, 2-disagree and 1-strongly disagree.

2. Interview guide was used to collect data from four (4) other respondents namely, fuel station managers, NPA, EPA, and Town and Country Planning Department officials. The interview guide were in semi-structured format which was in line with the view of Hockey, Robinson and Meah (2008) that semi-structured interviews are flexible, and they allow for the exploration of emerging themes and ideas. In other words, this instrument provide some scope for asking for more relevant information through additional questions often noted when it prompts the interviewer.

Table 5 illustrates the summary of sampling techniques and research instruments used in the study. Each unit of the was selected based on its contribution to the analysis for the study's objectives. In selecting the residence to respond to the questionnaire, cluster sampling technique was used due to the homogeneity of the population. In this technique, the residents selected were first grouped according to

geographical location, and then from each group individuals selected using systematic random sampling. In the process of the systematic random sampling, each other two houses was selected and residents randomly given questionnaire to respond. The advantage of cluster sampling is its feasibility, that is, able to take large population into account. Since these groups are so large, deploying any other sampling plan would be very costly. Additionally, the questionnaire application in the cluster sampling in selecting the residents afforded the study to reached out to large groups constituting the population easily and economically.

In looking for information on attraction of the fuel station location from the fuel station owner/mangers, purposive sampling technique was used using interview guide. The purposive sampling technique afforded the study an opportunity to sourced required information from particular respondents who are centre of the phenomenon. Also, in collecting information from the EPA, NPA, and Town and Country Planning Department Respondents on respective regulations and compliance, purposive sampling techniques and interview guide instrument were used. The use of purposive sampling technique in collecting information from the regulators is to take advantage of numerous qualitative research designs available. Thus, choice made it appropriately to combined qualitative and quantitative to designed the mixed methods for this study. Interviews were used in collecting data from the regulators due to its suitability for qualitative data collection for social research. They are mainly useful in cases where there is need to attain highly personalized data, as well as in cases where there are opportunities for probing to get underlying factors. They also become a

viable option where there are limited respondents and a good return rate is important, and also where respondents are not fluent in the native language of a country, or where they have difficulties with written language (Gray: 2004).

Table 5: Summary of Sampling Techniques and Research Instruments

Unit of Analysis	Information Sought	Sampling Technique	Research Instrument
Residence	-Nuisance of fuel stations' operations to activities -Personal safety of lives and properties	Cluster	Self-administered questionnaire
Fuel Station Managers	-Attraction of the fuel station location -Fuel station siting considerations	Purposive	Interview guide
EPA Respondent	-Role played in issuance of fuel station license -Requirement for setting-up of fuel stations in Ghana - Challenges facing the organisation in enforcing regulations	Purposive	Interview guide
NPA Respondent	-Role play in issuance of fuel station license -Requirements for setting-up fuel stations -Challenges facing the organisation to enforce regulations.	Purposive	Interview guide
Town and Country Planning Department Respondent	-Role play in issuance of fuel station license in the municipality - Municipal locations designed specifically for fuel stations -Challenges facing the organisation to execute its mandates	Purposive	Interview guide

Source: Field Survey, Bassuah (2017)

Reliability and Validity of Research Instruments

In the study, two major methods were used to pretest the instruments to check their reliability as well as validity. Fifteen (15) persons were selected in Cape Coast where similar fuel stations are sited to pretest the questionnaire. For the questionnaire reliability, Cronbach's Alpha was used which measured 0.87 greater than acceptable standard level of 0.7. The validity of questionnaire was checked by applying Kaiser-Meyer-Olkin Measure (KMO) of Sampling Adequacy and the Bartlett's Test of Sphericity. The measurements were strived to measure the KMO at >=0.70 and the Bartlett's significance at 0.005. The KMO assesses the assumptions whether there appears to be some underlying (latent) structure in the data. The Bartlett's test of sphericity was employed to test the items in the *questionnaire correlation matrix* to determine if some items are uncorrelated, based on the strength of the *p*- values, $p< 0.001$ (Balogun et al., 2010). By selecting a *p*-value, $p < 0.005$, the research proved that the correlation matrix does not have an identical matrix (Field, 2017). Thus, the validity of the instrument proved authentic. Table 20 in Appendix V shows the results.

For the testing of reliability and validity of structured interview questions, experts were contacted to review the questions relating to the subject matter to reduce ambiguities, leading questions, emotive questions and stressful questions from the guide. Also, for the reliability of the interview questions, interview structures which had been used in similar research studies elsewhere were compared to observe the similarities and differences to correct all the minor flaws.

Data Processing and Analysis

The data collected from the field were first cross-checked, screened and edited to ensure that there were no errors in the responses and thus information given were correct. The data were then coded and fed into the computer. The statistical product for service solution (SPSS version 20) was employed to process and analyse the questionnaire. The interviews were analysed manually. The data from interviews were first transcribed, categorized under specific themes and used for the analysis. Frequencies, percentages, averages and diagrams were used to presents the results. Descriptive statistics technique in the form of measure of relative position was used to analyse the factors influencing the hysterical siting of fuel stations in the Sunyani Municipality. The relative position indicates how well one variable perform on a test relative to other variables.

A five-point Likert scale was used to explored the standard and compliance standards as well as perception residence living closer to fuel station have toward the citation of the fuel station closer to them with respect to their health and safety issues. Their overall means and standard deviation were used as based to defined the compliance rate as well as positive or negative perception residence living closer to fuel station hold to the citation of the stations

Ethical Considerations

During the data collection, proper permissions were obtained from the participating institutions and organisations as well as residents of Sunyani Municipality. In administering the questionnaire, the purpose of the study was explained to the residents. Similarly, during the interview sections fuel station

managers and institutions were briefed about purpose and the nature of the study. All the participants in the study were not coerced in any way to provide information on any subject matter rather they willingly offered what seem necessary to them. Respondents' anonymity was properly esteemed. During the fieldwork all forms of identification including names, addresses, and telephone numbers of respondents were avoided. For formality sake, all the information acquired and their processes were carried out with the use of introduction letters obtained from the University.

Fieldwork Challenges

Almost all the participated institutions of the study were initially reluctant to grant interview with common excuse that the safety of the data cannot be guaranteed because if not well handled will have its far-reaching implications on them. Data were only released to the researcher after an assurance with signed undertaken that no part of the data will be given to any third party. For the residents, cautious explanations were given in assurance before data were given. Due to this development, it took the researcher much more time to collects the required data from the residents.

Chapter Summary

This chapter highlighted on the study area, and the procedures followed to collect data from the field. The research design, population, sampling techniques, research instruments, and the data processing and analysis have been described in this chapter. The chapter following this one presents the results and the discussion

on the locational analysis of fuel stations Sunyani Municipality in Brong-Ahafo region of Ghana.

CHAPTER FOUR

RESULTS AND DISCUSSION

Introduction

The study aimed at assessing the locational of fuel stations in Sunyani Municipal. The chapter covers six main areas namely the respondents' socio-demographic characteristics, locational mapping of fuel stations, building infrastructure, minimum plot requirement, analysis of factors influencing the location for fuel stations, compliance of fuel station to location standards of siting fuel station in Ghana, and residents' perceptions about the locations of the fuel stations in terms of health and safety.

Socio-Demographic Characteristics of Respondents

Although, the study was not geared towards the description of the personal characteristics of respondents, but it was imperative to highlight some of the variables that had been found to be generally associated with residents facility located close to the fuel stations. The socio-demographic variables covered in the study included type of residents, age, sex, residents' religion, number of years residents lived close to fuel station, years fuel station has been in the location, and Oil Marketing Companies (OMC) the company franchised.

Residents have been considered as an important variable in the analysis of physical landscape for the siting of fuel stations. This is particularly significant because per the EPA's regulations some residential facilities and public places such as schools, hospitals, stadia, churches, mosques are not allowed to be sited lesser than 15 metres close to siting of fuel stations. The residents refer to the

individual tenants or occupants of homes, churches, mosques, schools, businesses, and health facilities. Table 6 presents the type of residents living close to the fuel stations.

Table 6: Residential facilities Close to Fuel Stations

Type of Residential facilities	Frequency	Percent
Home	72	52.9
Church	1	.7
Mosque	2	1.5
School	5	3.7
Business	55	40.4
Health facility	1	.7
Total	136	100.0

Source: Field survey, Bassuah (2018)

Table 6 illustrates that out of 136 residential facilities close to fuel stations 72 (52.9%) are homes followed by businesses, 55 (40.4%). Overall, type of resident distribution showed that an overwhelming majority were homes while the least are the public facilities such as health facilities and churches. The distribution shows that few schools and mosques are close to fuel stations, thus flouting some international regulations on siting of fuel station that states any public or private development sited near the fuel station regardless of type or location should be at a distance that has received prior approval from the Council (Executive By-Law for The Environment Protection Law, Issued vide the Decree Law No. 30 for the Year 2002, Article 4). However, in Ghana the planning standards require that LPG plant

should be 15 meters away from buildings which is also applicable to fuel filling station.

Age Distribution of Respondents

Age is an important characteristic of a person. It does not only determine the individual's physical and mental maturity, but also portrays his/her life experiences. Table 7 shows that majority of residents within 28-32 age bracket constituted 31.6 percent and followed by those within the 33-37 years (20.6%).

Table 7: Age Distribution of Residential Facilities of Respondents

Age (years)	Frequency	Percent
18-22	8	5.9
23-27	11	8.1
28-32	43	31.6
33-37	28	20.6
38-42	6	4.4
43-47	9	6.6
48-52	18	13.2
53 years and above	13	9.6
Total	136	100.0

Source: Field Survey, Bassuah (2018)

Generally, the age distribution showed that most of the residents were young adults, majority falling between the ages of 23 – 37 years (60.3%). This is consistent with the findings of Taylor, Sichinsambwe and Chansa, (2016) on locational analysis of fuel stations in the city of Kitwe which showed that residents

living close to fuel station are young adults. This finding invariably confirms the 2010 National Population Census of Ghana which revealed that young adult between the age of 23-37 years constitutes the majority within the Ghana's population.

Sex of Respondents

Generally, females have been identified as the main gender group plying their trade around fuel stations. Out of the 136 respondents, male constituted 48.5 percent while 51.5 percent were females (Table 8). The distribution conforms to the 2010 Population and Housing Census of the Municipality where proportion of females outnumbered that of the males. The sex ratio was 5.1 females to 4.9 males. Out of every ten respondents, there were 5.1 females and 4.9 males.

Table 8: Distribution of Residential Facilities of Respondents by Sex

Gender	Frequency	Percent
Male	66	48.5
Female	70	51.5
Total	136	100.0

Source: Field Survey, Bassuah (2018)

The observed high percentage of female residents as compared to males in the Municipality was probably due to thriving business around the fuel stations as they are mainly considered as major operators or self-employed businesses undertaken by females. Hence causing the females to dominate in numbers around the locations of fuel stations.

Religious Background of Respondents

Religion is a set of beliefs, symbols and practices based on the idea of the sacred and which bonds believers in a community (Durkheim, 1976). The distribution showed that Christianity religion in the municipality especially among communities close to fuel stations (Table 9). Among the respondents involved in the study, Christians were 91 (66.9%), Muslims 26 (19.1%), Traditionalists 18 (13.2%) while residents with no religion constitute the lowest (0.7%).

Table 9: Distribution of Residential Facility of Respondents by Religion

Religion	Frequency	Percent
Christian	91	66.9
Muslim	26	19.1
Traditional	18	13.2
Others	1	.7
Total	136	100.0

Source: Field Survey, Bassuah (2018)

The dominance of Christian residents may be due to the general reflection of the Ghanaian societies where Christians have always been outnumbering the other religions. This outcome is in conformance with GSS 2010 Population and Housing Census document that indicated similar figures for Christians, Muslims, Traditional religion believers and others (Christians: 71.7%, Islam: 12.6%, Traditionalist: 0.3%, No Religion: 3.6%).

Number of Years Residents Lived Close to the Fuel Station

This discussion was done in order to know how long the respondents have lived close to fuel stations, and their experiences for living in such location which have some effects on the health and safety conditions of residents of the study area.

Table 10: Number of Years Distribution of Residential Facility Lived Close to Fuel Station

Years Resident Lived Close to Fuel Station	Frequency	Percent
Less than 1 year	9	6.6
1-5yrs	46	33.8
6-10yrs	33	24.3
11-15yrs	9	6.6
16-20yrs	17	12.5
21yrs and above	22	16.2
Total	136	100.0

Source: Field Survey, Bassuah (2018)

Table 10 shows that majority of the residents which constituted 33.8 percent have lived close to fuel stations between 1 to 5 years; followed by those who have lived for 6 – 10 years (24.3%) and, 21 years and above (16.2%). This outcome shows that majority of the residents close to fuel stations have not lived beyond 10 years. Noticeably, residents who have lived 21 years and above were quite significant a number indicating that locations where these fuel stations are sited are not entirely new.

Background Information of Fuel Station

Under this section the years fuel stations have been in their present location and their OMC company franchised were focused on. The distribution indicates that majority of the fuel stations, 36 percent have been in their present location between 6 – 10 years (Table 11).

Table 11: Demographic Information of Fuel Station

Years fuel station has been present in location	Frequency	Percent
	4	9
1 - 5 yrs	6	14
6 - 10 yrs	16	36
11 - 15 yrs	9	21
16 - 20 yrs	5	11
Over 20 yrs	4	9
OMC the company franchised		
Shell	11	25
Goil	8	18
Total	9	20
Allied Oil	2	5
Other	14	32

Source: Field Survey, Bassuah (2018)

Clearly, the result shows that for the last ten (10) years there has been more fuel stations located in the Sunyani Municipality which were previously eleven (11) in number. This shows that for the last ten years, averagely the rate at which

fuel stations spring up in the municipality is 2.6 (59%) per year. An indication that number of vehicles are increasing at considerable rate in the municipality with corresponding demand on the fuel products, hence the entrepreneurs using these opportunities to site many fuel stations in the study.

Table 11 further show that out of forty-four (44) fuel stations that the study covered, eleven (25%) of them are franchised to Shell Oil Marketing Company (OMC), eight (18%) are Goil franchised, nine (20%) are Total Ghana franchised, two (5%) Allied Oil franchised, and fourteen (32%) are franchised to others oil marketing companies. This shows that cumulatively more fuel stations are franchised to other OMCs in the Municipality than each of the well-noted brand ones such as Shell, Total, Goil and Allied Oil. With the well noted brand fuel stations, Shell was observed to be the most visible one having more outlets. This finding can be as a result of Shell being in the country (long time) compared to others.

Nature and Location of Fuel Stations in the Study Area

This section analyses the nature and spatial distribution of fuel stations within the Sunyani Municipality. It aims at mapping out the locations of the fuel stations in Sunyani Municipality which addresses the first research question of the study:

Research Question one: How are various fuel stations distributed in Sunyani Municipality?

In the process of mapping out the fuel stations for my study, I collected a GPS device from the Town and country planning Department. Once I get to the

fuel station, I used the device to pick coordinates of the fuel stations. After the data collection, the coordinates and names of the fuel stations were entered in excel and saved as CSV. This file format was to aid easy access and processing with ArcGIS. After the entering the names and coordinates of the various fuel stations, the CSV file was sent to ArcGIS version 10.1 to help display the coordinates spatially. This was done by referencing the coordinates to WG 1984. The spatially displayed data was exported to be available to save it permanently. Other spatial data such as road, districts and towns were added to make the attached map below.

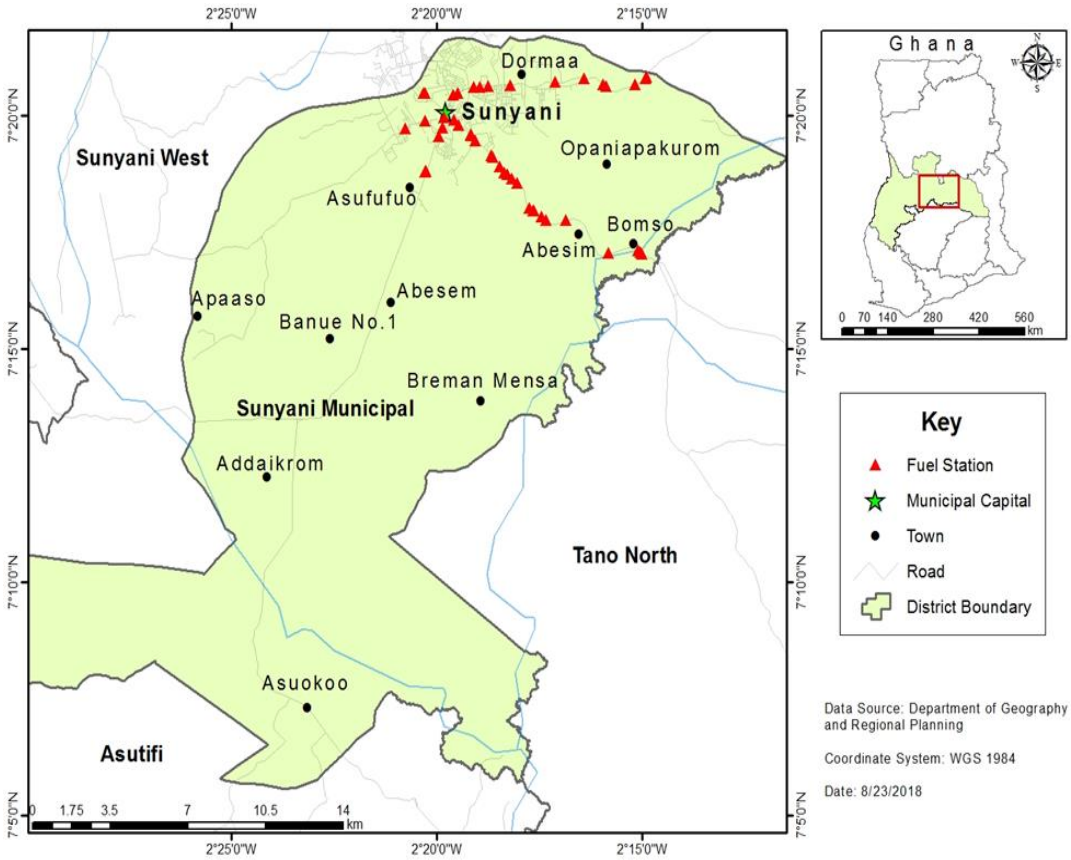

Figure 3: A map of the Sunyani Municipal Area showing the distribution of fuel stations within the Municipality

Source: Field Survey, Bassuah (2018)

The map (Figure 3) shows that most of the fuel stations are located along roads especially the road from Sunyani to Bomso and further road stretches from Sunyani to Dormaa. It was observed that most of the fuel stations are located in the Central Business District (CBD) where most of the commercial activities take place. The locations of these fuel stations apparently pose great threats to businesses, and other facilities close to them particularly during the peak periods and offloading of fuel products.

Further exploration was made to know the various types of fuel stations within the study area. Out of the forty-four (44) fuel stations within the study area 10 constituting 23% combine both LPG and petrol fuel whereas the remaining thirty-four (34) constituting 77% operate only petrol fuel.

This (Figure 4) indicates that gas fuel stations in the municipality are comparably few in number considering population size of the municipality which is about 158,800. Hence looking at the ratio between gas fuel stations and the population of the study area it can be said that every single (1) gas fuel station, serve approximately about 15,880 individuals in the municipality. This distribution in the study area generally reflects the trend in Ghana where the number of oil fuel stations are far more than that of gas fuel stations.

To further have enough information to achieve the objective one of study, pattern analysis was carried out using spatial statistics tools in ArcMap to identify the location pattern of fuel stations in the area.

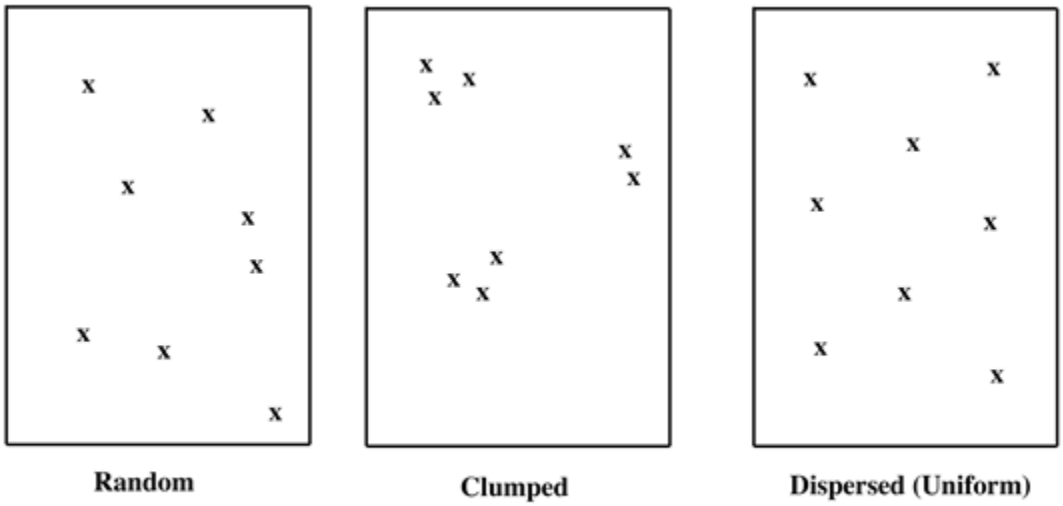

Figure 4: Summary of Distribution Pattern of Fuel Stations

Source: Field Survey, Bassuah (2018)

In Figure 4, each of the three patterns has the same density (number of fuel stations per area). Rn is a measure of the observed spacing pattern relative to a random pattern. Rn ranges from 0 to 2.1491, with random spacing having an Rn of 1. An R <1 means clustered while Rn > means dispersed. Rn as the ratio of the observed average nearest neighbour distance to the expected average nearest neighbor distance, gives density. In calculating the nearest neighbor index, Rn the following data were collected:

N = number of fuel stations who had a nearest neighbor measurement taken,

r = nearest neighbor distance

p = density of fuel stations (in the same units as neighbor distance)

where

rA = the average nearest neighbor distance = (SUM of r)/N

rE = the expected average nearest neighbor distance IF population was random

= 1/(2*(sqrt(p))

Rn = spacing measure = rA/rE

sigma rE = standard error of mean distance IF population was random

= 0.26136/(sqrt(Np))

c = standard variate of normal curve = (rA – rE)/sigma rE

If c is bigger than 1.96 or less than –1.96 then the chance of the observed departure from random happening by chance is less than 5%. The result revealed that distribution pattern of the fuel stations in the Sunyani Metropolis are perfectly clustered as the nearest neighbour index (Rn) value is less than 1 and *Z*-value is -13.56, less than -1.96. Moreover, there is significant difference between the fuel stations distribution in the area and random distribution at both 95 and 99 per cent since the *p*-value is less than 0.001. It is imperative however to note that nearest neighbour analysis is just a method that clarifies a phenomenon distribution but cannot elucidate comprehensively the cause of the distribution (Wongh, 2007). The purpose for clustered distribution in the area may be linked to the factors influencing the managers in setting up fuel stations and the fact that fuel stations are required to locate by road side. It showed that most of the fuel stations were concentrated at the highways and major roads, that is, distributed along the Bomso-Sunyani-Dorma stretch of roads.

Distance between the Fuel Stations Locations

Distances between fuel stations in the area were ascertained in ArcMap environment using proximity operation of the analysis tool. The results showed that longest distance between neighbouring fuel stations was approximately 4,200 metres that was found between Total Ghana and Shell along the Sunyani and Dorma highways. Besides this two, the average distance between neighbouring fuel stations was about 420 metres. The shortest distance of less than a metre was observed as well as neighbouring stations lying back to back. Similarly, the findings showed that more than half of the fuel stations were less than 400 metres apart. Yet, about 35% of the fuel stations according to international standard could not meet the minimum distance of 400 metres from their neighbours, without road separation (Health and Safety Authority, Dublin, 2013). However, in Ghana, the standard regulating the distances between fuel stations and residences require a distance of 15 metres.

The fuel stations that were not able to meet the international standards (of 400 metres from the nearest fuel stations) were found on most roads. Many of such fuel stations were observed at Sunyani central business district (Figure 4). The possible reason for this problem may be because of commercial viability linked to the markets and lorry parks. Entrepreneurs take advantage to this to site fuel stations in the area. In Ghana, there is no available specific law that could be relied on to address this anomaly (NPA).

Building Infrastructure and Minimum Plot Requirement

According to NPA, the minimum plot requirements to site fuel station along trunk roads (highways) is 45metres by 21metres, 30metres by 21metres for other trunk roads, and 24metres by 21metres for minor roads. Table 10 shows the distribution of various fuel stations status in terms of meeting the minimum size of plot requirement.

Table 12: Minimum Plot Requirements

Plot Location	Frequency	Percent (%)	Met Requirements	Below Requirement
Highways	24	54.5	24	0
Major Road	12	27.3	10	2
Minor Roads	8	18.2	5	3
Total	44	100	39	5
Percent (%)			88.6	11.4

Source: Field Survey, Bassuah (2018)

Table 12 showed that out of 44 fuel stations 39 (88.6%) of them met the minimum plot requirements while the 11% were below the plot required standards. The result further showed that fuel stations located along the highways completely or fully comply with this minimum plot requirement standards but some of those located at along the major and minor roads were not. This finding was found to be as a result of enough availability of lands at the highways that assist proprietors of the fuel stations to meet this requirement whereas scarcity of land along the major and minor roads makes it difficult for fuel stations in those areas to acquire large parcel of land for such purposes. In reality, the elements of location-allocation model use in determining the optimum locations for new facilities seem to be one

of the key reasons several fuel stations along the major and minor roads were not able to meet this basic plot requirements (Keane and Ward, 2002).

Factors Influencing the Location of Fuel Stations in the Study Area

The objective of this analysis is to determine the factors that influence proprietors' choice of locating fuel stations in the municipality. It addresses the second research question of the study which is stated below as follows:

***Research Question Two*:** What factors influenced the siting of the fuel stations in their present locations?

Different factors have been identified in the literature to influence the location of fuel stations. These factors are underpinned by theories such as the least cost, market area, place brand, and central place theories. To empirically ascertain the factors responsible for the location of fuel stations in Sunyani Municipality, a number of factors as captured in the conceptual framework of the study were presented to the respondents (owners or proprietors of fuel stations) to indicate the extent to which those factors influenced them to site their fuel stations at present locations in the municipality. In all, 24 factors (Table 13) were presented to the respondents and factor analysis (Principal Component Analysis) was employed for the analysis.

Table 13: Variables Influencing the Fuel Station Location Choice

Place Brand Factor (PBF)
1. Customers' accessibility
2. Sales attraction
3. Location's special place brand
4. Place brand of the location
5. The location's specific attraction
Central Place Factor (CPF)
6. Location's access to other services
7. Other key services besides the purchase of fuel
8. Facilities considered most appropriate to be closed to the location:
9. Fire hydrant
10. Police station
11. Accessed road
12. Electricity
13. Market centre
14. Location's consideration appeared relevant to the station:
• location of competitors,
• importance of proximity to customers,
• elasticity of product demand,
• extent of market area,
• relative competitiveness of the industry
Market Area Factor (MAF)
15. Sales revenue
16. Brisk economies activities
17. How brisk economic activities maximize sale revenue?
SWOT analysis on location
18. Strength
19. Weaknesses
20. Opportunities
21 Threat
Least Cost Factor (LCF)
22. Consideration for labour, transportation costs, and benefits of clustered enterprises
23. Prime cost factors
24. Reason(s) for the choice of least cost factor

Source: Field Survey, Bassuah (2018)

The 24 factors were analysed by PCA through the means of Statistical Product for Service Solutions (SPSS) version 20. Before carrying out the PCA, the data appropriateness for the factor analysis was checked. The correlation matrix evaluation showed the presence of various coefficients of 0.3 and above.

The Kaiser-Meyer-Oklin (KMO) Measure of Sampling Adequacy was 0.794 that surpassed the recommended value of 0.60 (Adjei Mensah as cited in Pallant, 2005) while the Bartlett's test of sphericity was statistically significant at 0.000, supporting the factorability of the correlation matrix. The PCA performed demonstrated the presence of five (5) components with eigenvalues exceeding one (1). The five components together explained 84.36 percent of the total variance (Appendix VI).

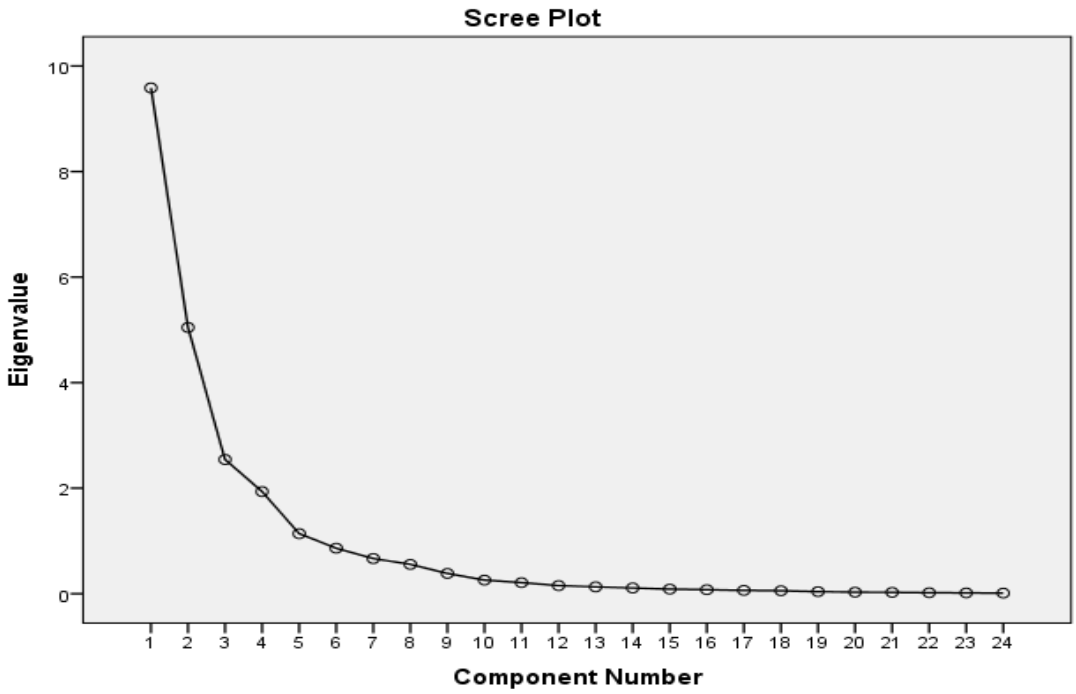

Figure 5: Scree Plot Illustrating Number of Components to be Retained

Source: Data Analysis, Bassuah (2018)

The scree plot shown in Figure 6 reveals a clear break after components five (5). That is the scree plot begins to level off after components five (5) indicating that all the five components had to be retained.

To facilitate easy interpretation of the five components, a verimax rotation was carried out (Table 14). Fourteen variables were deleted from the original 24 variables. The reasons were that these variables either did not load well or did load significantly on more than one scale. Each of the remaining 10 variables had a factor loading of 0.3 and above, which according to Fraser, McRobbie and Giddings (1998) is acceptable.

Table 14: Rotated Component Matrix Showing Factor Loadings and Amount of Variance Explained the Proprietors' Decision for the Choice of Location

Variable	Component				
	1	2	3	4	5
Place Brand Factor (PBF)					
PBF02	.694				
PBF03	.548				
Central Place Factor (CPF)					
CPF01		.817			
CPF03		.323			
Market Area Factor (MAF)					
MAF01			.388		
SWOT Analysis					
Strengths				.374	
Opportunities				.341	
Threats				.379	
Least Cost Factor (LCF)					
LCF01					.864
LCF02					.506
% of variance explained	32.3	18.0	17.9	8.7	7.4
Total variance explained:	84.4%				

{Factor loadings less than 0.3 have been omitted}
Source: Field Survey, Bassuah (2018)

The Fourteen (14) variables deleted by the PCA included the following: under the Place Brand Factor (PBF), deleted factors were 'customers' accessibility', 'place brand of the location', and 'the location's specific attraction'. Under the Central Place Factor (CPF), deleted factors were 'other key services besides the purchase of fuel', 'police station', 'accessed road', 'location's consideration appeared relevant to the station'. Furthermore, under the Market Factor (MAF), deleted factors were 'brisk economic activities', and 'how brisk economic activities maximize sale revenue?' and under the SWOT Analysis, deleted factor was 'weakness'. Under the Least Cost Factor (LCF), deleted factor was 'reason(s) for the choice of least cost factor'.

The findings showed that place brand factor has a significant influence on proprietors' decision to site their fuel stations, particularly factors such as sales attraction of the location and the location's special place brand. This result is consistent with the PBF theory by Anholt (2010) which states that the direct brand objective is not defined by economic benefits but rather the brand aspires to accomplish a positive reputation for the place and eventually translate into economic gains. Place brand is very essential to the establishment of fuel stations as it has been indicated by Urry (2004) that location with brand has added advantage to attract infrastructure, talents, investment, sales and gains.

The findings further showed that under the central place factor, 'location's access to other services' and 'facilities considered most appropriate to be closed to the location' have influence on the proprietors' choice to site fuel station at a given place. This follows the central place theory which indicates that central business

location provides a convenient point of focus for consumers (Gbakeji, 2014). This finding is consistent with Ayeni's (1991) and Inyang & Ogbonna (2001) observations that high accessibility and the quality of being at the centre of transportation system often influence the location of fuel stations.

With respect to market area factor, 'sales revenue consideration', and 'SWOT analysis on location' with strengths, opportunities, threats as key variables came out at the principal factors. This finding supports Rodrigue's (2016) theoretical perspective that every economic activity has a location, and locations have their strengths, weaknesses, opportunities and threats. In the SWOT analysis, it was found out that strengths, opportunities and threat were the significant influences on the proprietors' decisions to locate their fuel stations which imply that weaknesses and threats considerations are not much of a worry to the proprietors as far as siting of fuel stations is concern.

The findings revealed that prime cost factor under the least cost factor (LCF) was the main factor that influences proprietors to site fuel stations in the study area. It showed that proprietors of fuel stations are much concern about labour costs, transport costs and would want to be at locations where there are cluster of enterprises as opined by Valdes (2013). The five theories under which the ten variables (factors) emerged to explain the location of fuel stations in the study area have been explained in Table 15.

Table 15: Description of theories/factors and their link to Proprietors/Managers Locational Choice

Theory/Factor	Description
Place Brand	This is about a place of eminence where certain class of people would always want to be to transact business.
Central Place	This essentially concerns places that provide a convenient point of focus for consumer for the purchase of goods and services.
Market Area	This concerns the attractiveness and dynamics of a special market within a special industry.
Market Analysis SWOT	In this context, SWOT is carry out to identify strengths, weaknesses, opportunities and threats of the setup within the industry at the location
Least Cost	This consideration is in relation with minimum costs business incur in establishing at a location.

Source: Field Survey, Bassuah (2018)

Evaluating the Compliance of the Fuel Stations to Locational Standards of Siting Fuel Stations in Ghana

The objective of this section is to analyse how well proprietors of fuel stations comply with the locational standards of setting-up fuel stations in the study area as well as the threats their activities pose to lives and properties in the Municipality. This is in line with the third research question of the study.

***Research Question three*:** To what extent do fuel stations comply with the local standards for siting their facilities in Ghana?

To ascertain the level of compliance of the fuel stations to locational requirements, perspectives of residents living close to the fuel stations in the municipality were sought using a five-point Likert-scale questionnaire.

Table 16: Level of Compliance of Fuel Stations to Locational Requirements of Setting-up Fuel Stations in Ghana

Code	Statement	Mean	SD
RPS01	The operators of the fuel station in my personal view do not comply with the standards of the regulators.	4.04	1.13
RPS02	Fuel station operators appear to follow standards when off-loading fuel from the tankers	2.95	1.61
RPS03	Due to lack of proper supervision of fuel stations by the regulators spillage of fuel frequently pose threats to residents here.	3.83	.94
RPS04	I hardly see the fuel station undertaking simulation exercise to test their preparedness in case of fire outbreaks.	4.50	.90
RPS05	Ghana National Fire Service do not undertake any routine checks on the facilities of fuel stations in this area.	4.56	.93
Average Means		3.98	1.10

Source: Field Survey, Bassuah (2018)

The results in Table 16 show that statements ‘Ghana National Fire Service do not undertake any routine checks on the facilities of fuel stations in this area’, ‘fuel station manager hardly seen undertaking simulation exercise to test their preparedness in case of fire outbreaks’ and ‘the operators of the fuel station do not

comply with the standards of the regulators' had the highest mean scores (M = 4.56, 4.50 and 4.04; SD = 0.93, 0.90 and 1.13 respectively). These were followed by the following responses 'due to lack of proper supervision of fuel stations by the regulators spillage of fuel frequently pose threats in the area' (M = 3.83; SD = 0.94). It was further found out that 'fuel station operators appear to follow standards when off-loading fuel from the tankers' (M = 2.95; SD = 1.61). It could be concluded that generally residents living close to the fuel stations indicated that fuel stations comply with the local standards for siting their facilities in Ghana.

To have a fair idea about the level of compliance of fuel stations to the locational standards of siting a fuel station in Ghana, additional set of information were obtained from the three key state institutions (regulators) mandated by laws of Ghana to enforce regulation using interview guide. Each institution was made to provide information based on its statutory functions on the siting and supervision of fuel stations in Ghana. Table 17 shows standards of the regulators which the fuel stations have to comply and the extent to which the fuel stations have complied with at present.

Table 17: Standards and Compliance Rate

Regulator	Location Requirement	Compliance Rate (%)
TCPD	Follow the Ghana National Spatial Development Framework	48
	Located along highways	100
	Located along trunk (major) road	83.3
	Located along minor road	37.5
	Not nuisance to the society	64
EPA	No objection letter from NPA and Ghana National Fire Service	82
	Block plan	92
	Site plan	85
	Zoning status letter from District Assembly	55
NPA	Sand-crete concrete	92
	Fire resistance materials	72
	Galvanized or tiled roof	98
	Store, salesroom, toilet and change room facilities	88
	Underground tank with specification	96

Source: Field Survey, Bassuah (2018)

In Table 17, the findings revealed that concerning the TCPD location requirements out of 44 fuel stations forty-eight percent (48%) followed the Ghana National Spatial Development Framework while fifty-two (52%) did not, an indication that development document guiding the siting of fuel stations is

seriously undermined. For the location requirements, the findings showed that those sited along highways had 100% compliance level, stations sited along trunk (major) road had 83.3% compliance level with 16.7% not complying with the standards. Only 37.5% stations sited along minor road complied with the regulation as 72.5% did not. This also indicates that fuel stations sited along the highways are most compliant to siting of fuel stations while those along the minor roads are the least compliant. The finding further shows that 64% of the fuel stations met the TCPD 'not nuisance to the society' compliant requirement while 36% did not and pose nuisance to the society. In general, it was found out that for most complied TCPD's location requirements, fuel stations located along highways, followed by those located along trunk (major) roads, standard for 'not nuisance to the society', followed the Ghana National Spatial Development Framework and location along minor roads respectively.

Regarding the EPA location requirements, the findings show that 82% of the fuel stations were able to meet the requirement on 'no objection letter from NPA and Ghana National Fire Service' with only 18% fallen short of the requirement. In addition to this, 92% of the proprietors provided a block plan while the 8% did not, implying that an overwhelming majority of the fuel stations were able to comply with this location requirement. It was found out that 85% of the fuel stations have a site plan suggesting that majority of the proprietors were able to meet this regulatory requirement which is important for obtaining license to set-up a fuel station. The findings additionally show that the EPA's location requirement on zoning status letter from the District Assembly had 55% responses

from the fuel stations. This indicates that considerable number of the fuel stations in Sunyani Municipality in applying for licenses at the EPA were not able to provide this document from the Assembly. Principally, the findings show that for the EPA's location requirements, the most complied with is the block plan and the site plan.

For the NPA location requirements, the findings show that 92% of the fuel stations were built with sand-crete concrete, 72% with fire resistance materials, and 98% used galvanized or tiled roof. This shows that an overwhelming majority of the fuel stations used the required materials in constructing their buildings. The findings further show that 88% of the fuel stations have in their buildings store, salesroom, toilet and change room. It was further observed that 96% did comply with the requirement of underground tank with specifications, indicating small percentage (4%) of the fuel stations were non-compliant with that requirement. Generally, the findings show that underground tank with specifications is the NPA's location requirement most observed by the fuel stations which is followed by the materials used for the construction of fuel station buildings and store, salesroom, toilet and change room facilities respectively.

On average, it was revealed that fuel stations mostly complied with NPA's location requirements which is 89.2% than that of EPA (78.5%) and TCPD (66.6%). This suggest that the NPA are stricter on their locational regulations than EPA and TCPD in issuance of fuel station licenses.

Residents' Perceptions on the locations of the Fuel Stations in Terms of Health and Safety

The objective of this section is to find out the residents' perceptions of location of fuel stations in terms of health and safety. This was guided by the fourth research question of the study.

Research Question four: How do the residents perceive the locations of the fuel stations in terms of health and safety? The results were analysed using means and standard deviation presented in Table 18.

Table 18: Analysis of the Respondents Perception on the Activities of Fuel Stations

Code	Statement	Mean	SD
NUS01	Off-loading of fuel products at the station is always a threat	4.57	.85
NUS02	The presence of the fuel station makes me feel insecure	4.43	.96
NUS03	Due to proximity of fuel station to my location I am unable to carry out my normal activities	3.46	1.19
NUS04	Patronage of my business activities have gone down due to siting of the fuel station	2.73	1.61
NUS05	Fuel station is the cause of unnecessary traffic congestions in the area	3.82	1.13
Average Means		3.80	1.15

Source: Field Survey, Bassuah (2018)

The result showed that the statement "off-loading of fuel products at the station is always a threat", and "the presence of the fuel station makes me feel insecure" had the highest mean scores (M = 4.57, 4.43; SD = 0.85, 0.96). These were followed by the following statements "due to proximity of fuel station to my location I am unable to carry out my normal activities" and "patronage of my business activities has gone down due to siting of the fuel station" which had these mean scores (M = 3.46, 2.73; SD = 1.19 and 1.61 respectively) which. The overall result indicates that majority of the residents strongly agreed that off-loading of fuel products at the station is always a threat, and hence make the residents feel insecure.

The threats residents perceive on off-loading of fuel products at fuel station can be attributed to some fuel stations' lack of emergency and preparedness plan to fight fire should there be any fire outbreak. This outcome is consistent with the MITRE Institute (2007) study that opined that individuals will feel safe when there is an emergency plan to guarantee swift responses to danger at facilities where larger quantities of hazardous goods are stockpiled, handled and discharged. The findings also corroborate the findings of Yerevan (2008) that persons close to fuel stations stand a risk of being bathed with petrol, or health problems associated with petrol when fuel products are being offload.

Furthermore, the residents fear of insecurity as a result of the presence of fuel station close to them can also be linked to the slack manner fuel stations attendants handle filling processes and spillage. According to Health and Safety Authority of Dublin (2013), staff of fuel stations must be trained in how to handle

situations such as filling of tanks, loss of spillage, and overflow from the vehicle's fuel tank. So, the inability of the attendants in handling these processes with professionalism could cause apprehension, hence this might be a possible explanation for the residents' insecurity for being close to fuel stations, amid the threats posed by fuel stations on fuel off-loading and handling of fillings, spillages, and overflows that were found in the study. Table 20 further establish how personal safety of lives and properties are perceived by the residents in the metropolis.

Table 19: Analysis of Personal Safety of Lives and Properties (PLP)

Code	Statement	Mean	SD
PLP01	Personally, lives are not safe under this environment due to the location of the fuel station.	4.18	.88
PLP02	The siting of fuel stations in this area has some health consequences for residents living over here.	3.84	.93
PLP03	Due to human activities surrounding the fuel stations I feel insecure for lives and properties within the area.	4.34	.79
PLP04	I perceive looming danger to lives and properties should there be any little fire outbreak at the station.	4.64	.67
PLP05	Business activities of the fuel station closer to me suggest that they do not have value for personal lives and properties.	3.88	.97
Average Means		4.18	.85

Source: Field Survey, Bassuah (2018)

The result showed that the statements 'I perceive looming danger to lives and properties should there be any little fire outbreak at the station', 'due to human activities surrounding the fuel stations I feel insecure for lives and properties within the area', and 'personally, lives are not safe under this environment due to the location of the fuel station' had the highest mean scores respectively (M = 4.64, 4.34 and 4.18; SD = 0.67, 0.79, 0.88). These were followed by other statements such as 'business activities of the fuel station closer to me suggest that they do not have value for personal lives and properties' and 'the siting of fuel stations in this area has some health consequences for residents living over here' which have the following mean scores respectively (M = 3.88 and 3.84; SD = 0.97 and 0.93). The overall result indicates that majority of the resident strongly perceive looming danger to lives and properties should there be any little fire outbreak at the fuel stations, due to human activities surrounding the fuel stations.

It is therefore as result of the above perceive insecurity of staying close to fuel stations and closeness of human activities around such facilities that is why in Ghana a minimum distance of 15 metres is maintained whiles Nigeria and India keep a distance of 200 metres as a regulation to prevent human activities been located close to fuel station to protect human lives and properties.

Chapter Summary

This chapter has provided information on socio-demographic characteristics of respondents and map out the distribution of fuel stations in the Sunyani Municipality. The subsequent sections highlighted on the factors influencing the location of fuel stations in the study area, analysis on the level of

compliance of fuel stations to the locational requirements of setting up their facilities in Ghana, as well as residents' perception of the location of the fuel station in terms of health and safety. Most of the residents felt insecure about the fuel stations location in the municipality and in occasions when the fuel stationsare off-loading their fuel products. The next chapter focuses on the summary, conclusions and recommendations of the study.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Introduction

In the previous chapter, results and discussion of the study were presented. This chapter sums up the entire study on the locational analysis of fuel stations in the Sunyani Municipality. A summary of the objectives of the study, and the key findings are presented under the chapter. Conclusion from the findings, as well as the recommendations to improve siting of fuel stations in accordance with Ghana National Spatial Development Framework in Sunyani Municipality and elsewhere are also presented. The chapter ends with areas suggested for further research, and then the contribution of the study to knowledge.

Summary

The study set out to assess location of fuel stations in the Sunyani Municipality. Specifically, the study was undertaken to:

- map out the locations of the fuel stations in the Sunyani Municipality;
- analyse the factors that influence the location of the fuel stations;
- evaluate the compliance of the fuel filling stations to the location standards of siting a fuel station in Ghana; and
- assess residents' perceptions of the locations of the fuel filling stations in terms of health and safety.

The data collection instruments used were self-administered questionnaire, interview guide, and observation checklist/guides. The entire data for the study were collected from 10th August to 23rd November 2017.

In all, 185 respondents were covered. This number comprised 136 residents, 46 fuel station proprietors/managers, and one representative each from the regulatory bodies (NPA, EPA, TCPD). Data collected were analysed and presented using frequencies, percentages, averages, proportions and diagrams. Factor analysis was used to analyse the factors influencing the siting of fuel stations in the municipality.

The key findings were as follows:

- The finding revealed that distribution pattern of the fuel stations in the Sunyani Metropolis are perfectly clustered as the nearest neighbor index (Rn) value is less than 1 and *Z*-value is -13.56, less than -1.96.
- Moreover, overwhelming majority of the fuel stations are located along the road from Sunyani to Bomso and the stretch from Sunyani to Dormaa. All these fuel stations are mostly set-up in and around the Central Business District (CBD) where brisk commercial activities take place.
- Ten (10) notable factors influence the siting of the fuel stations in their present locations. These factors were:

i. the accessibility of the fuel station location to the customers,

ii. location's market attractiveness in terms of sales,

iii. location of the fuel station that enables customers to have access to other services,

iv. location of the fuel stations was sited closer to other important facilities such as fire hydrant, lorry station, accessed road, electricity and market centre.

v. sales revenue a major consideration for the setup,

vi. strengths,

vii. opportunities

viii. threats

ix. consideration of labour costs, transportation costs and benefits of cluster of enterprises,

x. minimum operation costs,

- The study revealed that the regulators (TCPD, EPA and NPA) acknowledged fuel stations bearing brands of major Oil Marketing Companies (OMCs) to a very large extent follow the laid down procedures based on Ghana National Spatial Development Framework (GNSDF) requirement to legally acquire plot of land meant for such purposes.
- The lesser known oil companies usually do not obtain permits from TCPD for such fuel station setup rather they convert sites meant for other purposes for the setting-up of fuel stations.
- The 'pump stations', the artisanal fuel stations operators who carry out their businesses from the table tops and containers do not acquire land permit for such purpose but rather are located at awkward places without regards to GNSDF requirement.
- The finding further shows that residents perceive looming danger over lives and properties should there be any little fire outbreak at the stations because off-loading of fuel products which they see it as a threat.
- The locations of fuel stations cause unnecessary traffic congestions.

- It was found that operators of the fuel stations do not undertake simulation exercise to test their readiness against fire outbreaks, and also Ghana National Fire Service not undertaking any routine checks on fuel stations' facilities.
- The residents perceive that operators of the fuel station do not comply with the standards of the regulators, and as such lives and properties are not safe within the environment due to the locations of the fuel stations.

Conclusions

Based on the findings of the study, four broad conclusions could be drawn:

1. The fuel stations in the municipality are mostly located along the road from Sunyani to Bomso in the south-east and Sunyani to Dormaa in the north-east. Most of the fuel stations were found in and around the Central Business District (CBD) where brisk commercial activities take place. This was found to be due to the fact that some fuel station operators look up for locations with place brand to serve the classed customers and in so doing the Ghana National Spatial Development Framework for planning is disregarded.
2. Ten (10) main factors influence the siting of the fuel stations in the Sunyani Municipality. These factors include accessibility to customers, location's market attractiveness in terms of sales, customers easy access to the fuel station, fuel station closeness other facilities such as fire hydrant, lorry station, accessed road, electricity and market. Other influencing factors are

potential sales revenue, location's strengths and opportunities, threats and operational costs.

3. Fuel stations bearing brands of major Oil Marketing Companies (OMCs) to a very large extent follow the laid down procedures based on Ghana National Spatial Development Framework (GNSDF) to legally acquire plot of land specifically meant for such purposes. However, other fuel stations particularly lesser known and artisanal ones do not comply with TCPD regulations by not using GNSDF planning requirements for siting fuel stations.
4. The residents perceive looming danger of their lives and properties should there be any little fire outbreak at the fuel stations. Besides, the locations of fuel stations cause unnecessary traffic congestions. Off-loading of fuel product is always a threat to residents due to closeness of the fuel stations' locations in the municipality.

Recommendations

Based on the findings and conclusions of the study the following recommendations are made:

1. To control the sitting of fuel stations at unauthorized places, TCPD, EPA, and NPA should ensure that permits and authorization for the siting of fuel stations are only issued to applicants having proof of location based on the planning standards and land use regulations of Ghana and the land-use plan of Sunyani Municipality.

2. The regulators particularly TCPD and EPA should further ensure that all applications for fuel station permits rigidly follow the Ghana National Spatial Development Framework (GNSDF) planning requirement. This will help curb the indiscriminate siting of fuel stations anyhow in the municipality. Furthermore, requirements for the applicants of fuel stations permits should include entrepreneurs having franchise arrangement with OMCs with brand to protect since the result showed that most compliant of the GNSDF planning document are those traced to such group.
3. As the residents feel unsafe of their lives and properties particularly during the off-loading of fuel products, EPA and NPA whose remits allows them to relocate or close- down fuel station should ensure that in times of off-loading all the necessary safety measures required by the fuel stations are put in place. Furthermore, to make the residents feel safe about their lives and properties fuel station should be compelled by the EPA and NPA to have regular simulation exercise to test their firefighting readiness. For public safety, the Ghana National Fire Service should also endeavour to carry out their mandate to ensure routine checks are done on facilities of fuel stations.

Areas for Future Research

This study focused on the assessment of the locational of fuel stations in the Sunyani Municipality. Further research can look at the situation in biggest cities of Ghana such as Kumasi and Accra in order to have a broad understanding

and picture of the location of fuel stations in the physical landscape of these major cities.

Contribution to Knowledge

This study makes significant contribution to knowledge by adding to knowledge a framework of assessing the factors that influence the proprietors of fuel stations to site their facilities in the context of Ghana.

REFERENCES

Adjei-Mensah, C. (2010). *Causes and consequences of informal settlement planning in Ghana: A case study of Aboabo, a suburb of Kumasi Metropolis.* Unpublished master's thesis, Department of Geography and Regional Planning, University of Cape Coast.

Afolabi, O.T., Olajide, F.O., & Omotayo, S. K. (2011). Assessment of safety practices in fuel stations in Ile-Ife, South Western Nigeria, *Journal of Community Medicine and Primary Health Care, 23(1&2*), 9-15.

Alesheikh, A. A., & Golestani H. A. (2011). GIS applications in optimum site selection for Gas Stations. *Journal of Environmental Management and Safety*, *3*(5), 106-123.

Alvi, M. H. (2016). A manual for selecting sampling techniques in research.

American Heritage Dictionary (2011). The American heritage dictionary of the English language, Fifth edition. Available at http://www.hmhco. com/shop/books/theameriacan-dictionary-of-the-english-language-fifth-edition.

Ayeni, B. (1991). Public facility location, using maximal service distance, *Research for Development, 7*, 1-2.

Bolen, H. W. (1988). *Contemporary retailing*. New Jersey: Prentice-Hall International, Inc.

Chan, T. Y., Padmanabhan, V., & Seetharaman, P. B. (2004). A structural model of locational competition among gasoline retailers: *An Empirical Analysis (bschool.nus.edu. retrieved on 8th March 2016).*

Chinambu, C. (2011). *A study on market structure and competition: The petroleum industry in Zambia*. Department of Petroleum Resource (DPR) (2007) Procedure Guide for Grant of and Approval to Construct and Operate Petroleum Products Retail Outlets. Issued by Department of Petroleum Resources, - Ministry of Petroleum Resources Nigeria.

Creswell, J. W. (2013). *Steps in conducting a scholarly mixed methods study*. London: Edward Arnold.

Creswell, J. W., & Clark, V. L. P. (2017). *Designing and conducting mixed methods research*. Sage publications.

Daskin, M. (2013). What you should know about location modeling. *Naval Research Logistics, 55*, 283-294.

Department of Petroleum Resource (DPR) (2007). Procedure guide for grant of and approval to construct and operate petroleum products retail outlets. Issued by Department of Petroleum Resources - Ministry of Petroleum Resources Nigeria.

Department of Petroleum Resource, DPR (2007). *Procedure guide for grant of and approval to construct and operate petroleum products retail outlets*. Issued by DPR, Ministry of Petroleum Resources.

Eiselt, H. A., & Marianov, V. (2012). Pioneering developments in location analysis in foundations of location analysis. *International Series in Operations Research & Management Science, 155*, 23-45.

Energy Regulation Commission, ERC (2012). *Environmental and impact assessment and audit guidelines for Downstream Petroleum Sector*.

Energy Regulation Commission, ERC (2012). General Guide to Pollution Prevention Guidelines.

Esmail, S. (2017). *Assessing the Effects of Disruptive Issues on the CSR of Canadian Multinational Gold Companies* (Master's thesis, University of Waterloo).

Fisher, A. A., Laing, J. E., Stoeckel, J. E., & Townsend, J. W. (1998). *Handbook for family planning operations research design*. New York: Population Council.

Gbakeji, O. J. (2014). *Location theory and public facilities, civil and environmental research, 6*(6), 92-97.

Ghosh, A., & Rushton, G. (1987). *Spatial analysis and location-allocation Models*. New York: Van Nostrand Reinhold Company Inc.

Habtamu, A. B. (2012). *Factors affecting the sustainability of rural water supply systems*. The case of Mecha Woreda, Amhara Region, Ethiopia. A project paper presented to the Faculty of the Graduate School of Comell University in Partial Fulfilment of the Requirement for the Degree of Master of Professional Studies.

Hamid, A. B., Iman. M. H., Suriatini, B. I., Martin, R. B. (2009). Site potentiality of petrol stations based on traffic counts. *Malaysia Journal of Real Estate, 4*(1), 45-58.

Hamid, A. B., Iman. M. H., Suriatini, B. I., & Martin, R. B.T. (2009). Site potentiality of petrol stations based on traffic counts. *Malaysia Journal of Real Estate, vol. 4*, No.1.

Health and Safety Authority of Dublin (2013). Retrieved on 28th March 2017,

Health and Safety Executive (2014). Petroleum (Consolidation) Regulations.

Hockey, J., Robinson, V., & Meah, A. (2008). What's sex got to do with it? A family-based investigation of growing up heterosexual during the twentieth century. *The Sociological review, 56*(3): 454-473.

Iman, M. H., Suriatini, B. I., & Martin, R. (2009). Site potentiality of petrol fuel stations based on traffic counts. *Malaysian Journal of Real Estate, 4*(1), 10-33.

Inyang, S. I., & Ogbonna, D. O. (2001). Optimum location for petroleum storage depot in Northern Nigeria, *International Journal of Transportation Studies, 1*(1), 55 – 71.

Ioj, C.I., & Tudor, C. A. (2011). *Temporal analysis of incompatible land-use and landcover: the proximity between residential areas and gas stations in Bucharest suburban area*. Proceedings of Urban Sustainability, Cultural Sustainability, Green Development, Green Structures and Clean Cars, 15 20.

Iqbal, S., Zakar, R., Zakar, M. Z., & Fischer, F. (2017). Perceptions of adolescents' sexual and reproductive health and rights: a cross-sectional study in Lahore District, Pakistan. *BMC international health and human rights*, *17*(1), 5.

Keane, J., & Ward, T. (2002). A computational framework for location analysis. Institute of Electrical and Electronics Engineers *32*(5), 574-581.

Kearny, A. T. (1998). *India petrol retailing expectations and opportunities*. Qualitative Research Findings for Delhi, 1734.

Khahro, S. H., Abd Nassir Matorib, A. N., Imtiaz Ahmed Chandiob, I, A., & Talpurb. M. A. H. T. (2013). Land suitability analysis for installing new petrol fuel stations using GIS. Fourth international symposium on infrastructure engineering in developing countries, *International Economic Development Council, 77*, 28-36.

Khan A. (2008). Modern operational risk management. Retrieved on Feb16 2017, http://www.stamfordrisk.com/management.html

Kothari, C. R. (2004). *Research methodology: Methods and techniques*. New Age International.

Kumekpor, B. (2002). *Research methods and techniques of social research*. Accra: Son Life Press and Services.

Latifatu, I. S. (2017). *Effects of Artisanal and small-scale mining on food security in Dakurupe And Kui Communities of Bole District* (Doctoral dissertation).

Lawrence, P. D. (2000). *Planning theories and environmental impact assessment*, Environmental Impact Assessment Review. Procedia Environmental

Losch, A. (1954). *The economics of location*. Yale University Press: Yale.

Mertens, D. M. (2003). Mixed methods and the politics of human research: The transformative-emancipatory perspective. In A. Tashakkori & C. Teddlie (Eds.), *Handbook of mixed methods in social and behavioral research* (pp. 135–164). Thousand Oaks, CA: Sage.

Ministry of Environment Science and Technology Town and Country Planning Department in Ghana (2011). Zoning Guidelines and Planning Standards.

MITRE Institute (2007). *MITRE systems engineering (SE) competency Model, Version 1, pp. 10,* 40-41.

Mohammed, M. U., Musa, I. J., & Jeb, D.N. (2014). GIS-Based analysis of the location of fuel stations in metropolitan Kano against the physical planning standards. *American Journal of Engineering Research, 3*(9), 147-158.

Morrill, R. L. (1970). *The spatial organisation of society*. Belmont, California, Duxbury Press.

Mshelia, M., Abdullahi, J., & Dawha, E. (2015). Environmental effects of petrol stations at close proximities to residential buildings in Maiduguri and Jere, *Borno State, Nigeria, Vol. 20, No. 4*, pp. 1-8.

Murray, A., & Tong, D. (2009). GIS and spatial analysis in the media. *Applied Geography, 29*, 250-259.

Mwenda, S., & Oloko, D. (2017). Determinants of motorists choice of a petrol station in Kenya a survey of Thika Sub County.

Netz, J. S., & Taylor, B. A. (2002). Maximum or minimum differentiation? Location patterns of retail outlets. *Review of Economics and Statistics, 84*(1), 162-175.

Neuman, W. L. (2003). *Social research method* (5th ed). Boston: Pearson Education.

Newton-Levinson, A., Leichliter, J. S., & Chandra-Mouli, V. (2016). Sexually transmitted infection services for adolescents and youth in low-and middle-income countries: perceived and experienced barriers to accessing care. *Journal of Adolescent Health*, *59*(1), 7-16

Njoku, C. G., & Alagbe, A. O. (2015). Site suitability assessment of petrol filling stations (PFS) in Oyo Town, Oyo State, Nigeria: A Geographic Information System (GIS) Approach. *Journal of Environmental Science, Technology and food Technology*, *9*(12), 2319-2399.

O'Sullivan, A. (2005). *Where do firm locate: Urban Economics* (5th ed.). Boston: McGraw Hill.

Oetomo, W. H., & Sesulihatien, W. T. (2012). The application of index model for valuation a New Gas Station. Journal of Petroleum and Gas Engineering, 1(5), 89-94,

Pallant, J. (2005). *SPSS survival manual* (2nd ed.). Berkshire: Open University Press.

Punch, K. F. (1998). *Introduction to social research: Quantitative and qualitative approaches*. Thousand Oaks, CA: Sage.

Rana, R., & Garg, D. (2014). Algorithm for obnoxious facility location problem, *International Journal of Advancements in Technology, 5*(4), 96-106.

Saini, Y. K., & Matinise, S. V. (2013). An exploratory study on factors influencing customer decision making: a case of fuel retailing industry. *University of Witwatersrand, Johannesburg, South Africa*.

Sarantakos, S. (2012). *Social research* (2nd ed.). London: Macmillan Press Limited.

Sarantakos, S. (2012). *Social research* (3rd ed.). Basingstoke: Palgrave Macmillan.

Sarantakos, S. (2012). *Social research*. Macmillan International Higher Education. Sciences 14(2001) 49-58.

Survey and Mapping Division of Ghana. (2018). *Country shapefiles*. Survey and Mapping Division of Ghana.

Tashakkori, A., & Teddlie, C. (Eds.). (2003). *Handbook of mixed methods in social and behavioral research*. Thousand Oaks, CA: Sage.

Taylor, T. K., Sichinsambwe, C., & Chansa, B. (2016). Public perceptions on location of filling stations in the City of Kitwe in Zambia. *International Journal of Advanced Engineering Sciences and Technologies*, *7*(1), 110 – 121.

Ujjwal, S., & Sokhi, B. S. (2006). GIS city hazard petrol station vicinity vulnerability assessment. *Goa Institute of Management International, 20*(8), 56-67.

Wough, D. (2007). *Geography. An integrated approach*. Thomas Nelson and Sons, New York, USA.

Yerevan, A. (2008). Risk management outline to petrol operations. USAID Armenia, Social Protection Systems Strengthening Project, http://pdf.usaid.gov/pdf_docs/Pnads651.pdf viewed March28th2017

APPENDIX A

INTERVIEW GUIDE FOR TOWN AND COUNTRY PLANNING DEPARTMENT (TCPD)

Date of interview:

Place of interview:

Interviewer name:

Interviewee Position:

Introduction

The key objective of this study is to carry out locational analysis of fuel stations in Sunyani Municipality. This interview guide is planned to obtain information on the requirements for fuel stations operating license and sanctions for non-compliance of laid down standards. Information provided will be used exclusively for the purpose of this research. You are assured of full confidentiality and privacy of all the information you will provide. You should therefore feel free to offer the right information to ensure the success of this work. Thanks for your cooperation.

(a) Role of Your Institutions

1. What are the roles of your organisation concerning the operation of fuel stations in Sunyani Municipality?
2. What process does your organisation goes through to issue permit to prospective fuel station for their operation?
3. Are the roles too much for your organisation to carry out?
4. Do you have any problem regarding your role in carrying out issuance of fuel station licenses?
5. If any, what are they?

(b) Requirements for Setting-up of Fuel Stations in the Sunyani Municipality

6. Do you have specifications for the fuel station location in the municipality?
7. If 'yes', what are the specific requirements an entrepreneur need in setting-up fuel station in the municipality?
8. Are there special locations in the municipality specifically designed for fuel stations siting?
9. If 'yes', what are provisions put in place for the siting of the fuel stations?
10. Does your organisation have a mandate to revoke fuel station license with respect to wrongful siting of location in the municipality?
11. If 'yes', under which circumstances the fuel station license can be withdrawn?
12. Please kindly provide some examples of punishment that your outfit can take against fuel station that is not complying with your standards?

(c) Challenges Facing Your Organisation

13. What challenges does your organisation face in sanctioning fuel stations that are not well located?
14. In your supervisory challenges, do you ensure that fuel stations locational standards setting are strictly adhere to?
15. If 'yes', how do you ensure their compliance?
16. What are the major health and safety problems fuel stations normally posed to the lands in the municipality?
17. To what extent do these problems affect lives and properties?

18. What concrete remedies does your organisation have in place to forestall these health and safety problems in the municipality?

APPENDIX B
INTERVIEW GUIDE FOR ENVIRONMENTAL PROTECTION AGENCY (EPA)

Date of interview:

Place of interview:

Interviewer name:

Interviewee Position:

Introduction

The key objective of this study is to carry out locational analysis of fuel stations in Sunyani Municipality. This interview guide is planned to obtain information on the requirements for fuel stations operating license and sanctions for non-compliance of laid down standards. Information provided will be used exclusively for the purpose of this research. You are assured of full confidentiality and privacy of all the information you will provide. You should therefore feel free to offer the right information to ensure the success of this work. Thanks for your cooperation.

(d) Role of Your Institutions

1. What are the roles of your organisation concerning the operation of fuel stations in Ghana?
2. What process does your organisation goes through to issue license to prospective fuel station for their operation?
3. Are the roles too much for your organisation to carry out?
4. Do you have any problem regarding your role on operations of fuel stations?

Requirements for Setting-up of Fuel Stations

5. Do you have specifications for siting fuel stations?
6. If 'yes', what are the specific environmental requirements an entrepreneur need to meet to set-up fuel station in Ghana?
7. What kind of education do you give to prospective entrepreneur who show interest in setting up fuel station in any location?
8. Does your organisation have a mandate to revoke fuel station license with respect to wrongful siting of location?
9. If 'yes', under what circumstances can a fuel station's license be withdrawn?
10. Please kindly provide some examples of punishment that your outfit can take against fuel station that is not complying with your set standards?

Challenges Facing Your Organisation

11. What challenges does your organisation face in controlling the location of fuel stations that in this area?
12. Notwithstanding all the challenges facing your institution, how best do you ensure that fuel stations still maintain good operational standards?
13. What environmental problems do the activities of the activities of fuel stations create to make the work of outfit difficult in Sunyani Municipality?
14. What concrete remedies does your organisation have in place to preserve natural environment from poor siting of fuel stations in Sunyani Municipality?

15. What is the way forward for good location of fuel stations in Sunyani Municipality and Ghana as a whole?

APPENDIX C

INTERVIEW GUIDE FOR NATIONAL PETROLEUM AUTHORITY (NPA)

Date of interview:

Place of interview:

Interviewer name:

Interviewee Position:

Introduction

The key objective of this study is to carry out locational analysis of fuel stations in Sunyani Municipality. This interview guide is planned to obtain information on the standards for setting up fuel stations and sanctions for non-compliance of laid down standards. Information provided will be used exclusively for the purpose of this research. You are assured of full confidentiality and privacy of all the information you will provide. You should therefore feel free to offer the right information to ensure the success of this work. Thanks for your cooperation.

Role of your institutions

1. What are the roles of your organisation concerning the operation of fuel stations in Ghana?
2. What process does your organisation goes through to issue license to prospective fuel stations for their operations?
3. Are the roles too much for your organisation to carry out?
4. Do you have any problem regarding your role in issuing licenses to fuel stations?
5. If any what are they?

Requirements for Setting-up of Fuel Stations in Ghana

6. In what ways should fuel stations store petroleum products in their premises?
7. What are the specific locational requirements for the establishment of fuel stations in Ghana?
8. Which section(s) of a city does your organisation approves for the siting of fuel stations?
9. In terms of land size, what requirements do fuel stations have to meet in order to get approval from your outfit?
10. Taking into consideration the various requirements or standard governing the setting up of fuel stations in Ghana, how do you see the fuel stations in Sunyani Municipality.
11. What are the indications that suggest that fuel stations in Sunyani are operating within the set standards of NPA?
12. Do the fuel stations in Sunyani have minimum standards for discharging their fuels?
13. What mandate(s) does your organisation have in revoking fuel station license with respects to wrongful siting of fuel stations?
14. Under what circumstances can a fuel station's license be withdrawn by your outfit?
15. Please kindly provide some examples of punishment that your outfit can take against a fuel station that is not complying with your set standards?

Challenges Facing Your Organisation

16. What challenges does your organisation face in sanctioning fuel stations that are not well located?
17. In all your supervisory challenges, how best do you ensure that fuel stations still maintain minimum operation standards?
18. What health and safety challenges do fuel stations face in the Sunyani Municipality?
19. Among the health and safety challenges which one(s) is very common in this locality?
20. What is the way forward for good location of fuel stations in Sunyani Municipality and Ghana as a whole?

APPENDIX D

INTERVIEW GUIDE FOR FUEL STATION MANAGERS

Date of interview:

Place of interview:

Interviewer name:

Interviewee Position:

Introduction

The key objective of this study is to carry out locational analysis of fuel stations in Sunyani Municipality. This interview guide is planned to obtain information on the factors influencing the entrepreneurs/managers to site fuel stations in particular locations within the municipality. Information provided will be used exclusively for the purpose of this research. You are assured of full confidentiality and privacy of all the information you will provide. You should therefore feel free to offer right information to ensure the success of this work. Thanks for your cooperation.

Section A: Respondent Information

1. Manager's status:

   a) Proprietor [ ] b) Employee [ ] c) Partner [ ]

   d) Other……

2. Number of years fuel station has been in the location:

   a) Less than 1 year [ ] b) 1 – 5 yrs. [ ] c) 6 – 10 yrs. [ ]

   d) 11 – 15 yrs. [ ] e) 16 – 20 yrs. [ ] f) Over 20 years [ ]

3. Oil Marketing Companies (OMCs) the company franchised:

   (a) Shell [ ] (b) Goal [ ] c) Total [ ] d) Allied Oil [ ]

   e) Other……

Section B: Place Brand Factor (PBF)

4. Did customers' accessibility to the location influence the consideration for siting of the fuel station?
5. If 'yes', how accessible is the fuel station location to the customers?
6. How do you describe location's market attractiveness in terms of sales?
7. Does the location of your fuel station have a special place brand?
8. If 'yes' what is the place brand of the location?
9. Give specific attraction of the location that influenced you to site the fuel station at the place?

Section C: Central Place Factor (CPF)

10. Does the location of your fuel station enable customers to have access to other services?
11. If 'yes' what other key services customers can have access to besides the purchase of fuel?
12. In your siting of the fuel station, which of the following facilities did you considered most appropriate to be closed to your location?

    i. fire hydrant,

    ii. police station,

    iii. lorry station,

    iv. accessed road,

v. electricity

vi. market centre

13. For the choice of the location's consideration, which of the demand factor(s) appears relevant to your business:

i. location of competitors,

ii. importance of proximity to customers,

iii. elasticity of product demand,

iv. extent of market area,

v. relative competitiveness of the industry

Section D: Market Area Factor (MAF)

14. In view of market area factor of business set up, what major consideration was given to sales revenue?
15. Did brisk economic activities of the location form the main basis for siting your fuel station?
16. If 'yes', how does the brisk economic activities of a location help fuel station to maximize sale revenue?
17. Have you carried out SWOT analysis of your fuel station's location?
18. If 'yes', what are the strengths, weaknesses, opportunities and threats of the location?

Section E: Least Cost Factor (LCF)

19. For the siting of fuel station at particular location, labour costs, transportation costs, and benefits of cluster of enterprises are given

consideration. Which of these cost factors was your prime consideration in siting of your fuel station?

20. Give reason(s) for the choice of your least cost factor(s) of the location?

APPENDIX E

UNIVERSITY OF CAPE COAST
DEPARTMENT OF GEOGRAPHY AND REGIONAL PLANNING

I am a postgraduate student from the University of Cape Coast and as part of my programme, I am conducting a research on "**Locational Analysis of Fuel Stations in Sunyani Municipality**". I would be very grateful if you could kindly spend some time to share your thoughts and experiences earnestly to contribute to the success of the study. Be assured that all information given will be treated with utmost confidentiality.

DIRECTIONS: Please fill in the needed information by ticking like this (√) in the appropriate box [ ] or write down your answer appropriately to each item as the question or statement may require.

Section A: Respondents Information

1. Type of resident:

   b) House [ ] b) Church [ ] c) Mosque [ ]

   d) School [ ] e) Business [ ] f) Health facility [ ]

   g) Other……

2. Age:

   a) 18 – 22yrs [ ] b) 23 – 27yrs [ ] c) 28 – 32yrs [ ] d) 33 – 37yrs [ ]

   e) 38 – 42yrs [ ] f) 43 – 47yrs [ ] g) 48 – 52yrs [ ] i) 53 and above [ ]

3. Sex

   a) Male [ ] b) Female [ ]

4. Religion:

   a) Christian [ ] b) Muslim [ ] c) Traditional [ ] d) Other……

5. Number of years you have lived close to the fuel station:

   b) Less than 1 year [ ] b) 1 – 5 yrs [ ] c) 6 – 10 yrs [ ]

   e) 11 – 15 yrs [ ] e) 16 – 20 yrs [ ] f) 21 years and above [ ]

6. Was the fuel station closed to your setup in the location before you settled?

   (a) Yes [ ] (b) No [ ] c) Not sure [ ]

Section B: Nuisance of Fuel Stations' Operations to Others

1 Strongly Disagree	**2 Disagree**	**3 Neither Agree nor Disagree**	**4 Agree**	**5 Strongly Agree**

NUS01	Off-loading of fuel products at the station is always a threats	1	2	3	4	5
NUS02	Threat is such that I feel insecure in this place	1	2	3	4	5
NUS03	Due to proximity of fuel station to my location I am unable to carry out my normal activities	1	2	3	4	5
NUS04	Patronage of my business activities have gone down due to siting of the fuel station	1	2	3	4	5
NUS05	Fuel station is the cause of unnecessary traffic congestions in the area	1	2	3	4	5

Section C: Personal Safety of Lives and Properties (PLP)

1 Strongly Disagree	**2 Disagree**	**3 Neither Agree nor Disagree**	**4 Agree**	**5 Strongly Agree**

PLP01	Personally, lives are not safe under this environment due to the location of the fuel station.	1	2	3	4	5
PLP02	The siting of fuel stations in this area has some health consequences for the residents living over here.	1	2	3	4	5
PLP03	Due to human activities surrounding the fuel stations I feel insecure for lives and properties within the area	1	2	3	4	5
PLP04	I perceive looming danger to lives and properties should there be any little fire outbreak at the station.	1	2	3	4	5
PLP05	Business activities of the fuel station closer to me suggests that they do not have value for personal lives and properties	1	2	3	4	5

Section D: Residents' Perspectives on Standards

7. The operators of the fuel station closer to me in my personal view do not comply with the standards of the regulators.

   a) Strongly agree [ ] b) Agree [ ] c) Neither agree nor disagree [ ]

   d) Disagree [ ] e) Strongly disagree [ ]

8. Fuel station operators appear to follow standards when off-loading fuel from the tankers?

a) Strongly agree [ ] b) Agree [ ] c) Neither agree nor disagree [ ]

d) Disagree [ ] e) Strongly disagree [ ]

9. Due to lack of proper supervision of fuel stations by the regulators spillage of fuel frequently pose threats to residents here.

a) Strongly agree [ ] b) Agree [ ] c) Neither agree nor disagree [ ]

d) Disagree [ ] e) Strongly disagree [ ]

10. I hardly see the fuel stations undertaking simulation exercise to test their preparedness in case of fire outbreaks.

a) Strongly agree [ ] b) Agree [ ] c) Neither agree nor disagree [ ]

d) Disagree [ ] e) Strongly disagree [ ]

11. Ghana National Fire Service do not undertake any routine checks on the facilities of fuel stations in this area.

a) Strongly agree [ ] b) Agree [ ] c) Neither agree nor disagree [ ]

d) Disagree [ ] e) Strongly disagree [ ]

Thank you for participation

APPENDIX F

ROTATED FACTOR LOADINGS AND TOTAL VARIANCE EXPLAINED

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	9.585	39.936	39.936	9.585	39.936	39.936	7.762	32.340	32.340
2	5.045	21.021	60.956	5.045	21.021	60.956	4.329	18.036	50.376
3	2.543	10.594	71.551	2.543	10.594	71.551	4.293	17.888	68.264
4	1.935	8.063	79.614	1.935	8.063	79.614	2.077	8.654	76.918
5	1.138	4.743	84.357	1.138	4.743	84.357	1.785	7.439	84.357
6	.862	3.592	87.949						
7	.666	2.775	90.724						
8	.556	2.318	93.042						
9	.384	1.600	94.642						
10	.258	1.076	95.718						
11	.210	.873	96.592						
12	.153	.639	97.231						
13	.129	.539	97.771						
14	.109	.455	98.225						
15	.087	.364	98.590						
16	.076	.319	98.908						
17	.064	.265	99.174						
18	.057	.237	99.410						
19	.039	.164	99.574						
20	.030	.125	99.699						
21	.026	.108	99.807						
22	.019	.080	99.887						
23	.016	.067	99.954						
24	.011	.046	100.000						

Extraction Method: Principal Component Analysis.