Developing Country Studies
ISSN 2224-607X (Paper) ISSN 2225-0565 (Online)
Vol.6, No.6, 2016

Public Perceptions on Location of Filling Stations in the City of Kitwe in Zambia

Thomas Kweku Taylor[1]* Chanda Sichinsambwe[2] Blessings Chansa[1]

1. Department of Urban and Regional Planning, School of The Built Environment, The Copperbelt University, P. O. Box 21692, Kitwe, Zambia
2. Department of Operations and Supply Chain Management, School of Business, The Copperbelt University,, P. O. Box 21692, Kitwe Zambia

Abstract

Location of manufacturing and service activities in urban areas are guided by planning principles and standards, expressed in either structure plans or land use development plans. Though Local authorities are the major overseers on the implementation of approved structure plans based on the advice of Urban Planners and consultants on environmental protection and sustainability, unfortunately, there appears to be sporadic emergence of filling stations within the City of Kitwe in Zambia that raises the questions, "What are the locational determinants for filling stations in urban areas in Zambia?" What is the public's perception on location of filling stations in the City of Kitwe? What are the possible factors that influence filling stations' locations in Kitwe? Are filling stations located according to established planning standards, guidelines and regulations in the City of Kitwe? These are questions that require empirical investigations in view of the possible inflammatory consequences of the service.

The paper is an exploratory study that applied a cross-sectional descriptive research design to find answers to the research questions and to validate the following hypotheses: Environmental Impact Assessment (EIA) Criteria is positively related to the location of filling stations in Kitwe; Entrepreneurs preferential location choices is positively related to location of filling stations; and Planning principles, standards and regulations positively influence locations of filling stations in the City of Kitwe. The t-test statistics was used to validate the hypotheses. The main finding was that, filling stations are located influenced by choices made by service station entrepreneurs.

Keywords: Public Perceptions, filling stations, location, planning standards, Kitwe

1. Introduction

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 mankind's movement patterns around the globe. Light (2004, p.1) stressed that, retail gasoline is one of the most analyzed products in the world, especially in the United States of America because of people's reliance on cars. However, the price dynamics and its effects on economies of both developed and developing worlds have also been documented (Light, 2004; Chan et al., 2004). In the case of price dynamics, it has been documented that there are significant ripple effects on most developing economies due to a rise in a barrel of crude oil. For instance, Sidaway (1998) stated that, petrol stations are very vulnerable to closures resulting from petrol price competition, regulatory pressure and non-strategic locations. The suggestion from Sidaway seems to be supported by Mudambi (1994), when he stated that, location affects many aspects of petrol station operation. The dark side of petroleum (especially, fuel for refueling vehicles) is the environmental effects on the eco-system hence its service location points must be strategically and consciously done to minimize it on both human beings and their immediate environs of their habitation. For instance, in the Scandinavian countries particularly in Finland and Sweden, efforts have been made to remedy the effects of pollutants on air, water and soil within abandoned petrol filling sites (see Nieminen, 2005). Contrary, one significant study that has not been intensively and extensively done is the determination of the pragmatic factors and environmental impact criteria and standards influencing the locational points of sale in urban areas. Though individual countries through their environmental protection institutions and agencies and urban and regional planning establishments have evolved their own planning standards and principles as guidelines, the observed trend in recent times is the risk associated with petrol filling stations, i.e., risks involving the release of petrol vapour into the air during the filling of the storage tanks by tanker delivery personnel and when customers refuel their vehicles; and the potential for releasing polluting agents into soil and water (Nieminen, 2005, p.34). It has been discovered that, petrol filling stations are located close to residential areas and in some cases close to commercial and industrial activities (Mshelia, et al., 2015, p.1).

1.1 Definition of Filling Station

The expression, *filling station* (expression commonly used in Zambia) is synonymously understood differently in different countries of the world. Ayodele (2011), in attempt to define it considered the different expressions as Filling Station, Petrol station, gas station or petroleum outlet as any land, building or equipment used for the sale or dispensing of petrol or oil for motor vehicles or incidental thereto and includes the whole of the land, building or equipment whether or not the use as a petrol station is the predominant use or is only a part thereof (see also Hamid et al., 2009, p.11). Similarly, Nieminen (2005, p.11) defined Petrol station as an area including fuel equipment and piping, storage tanks, forecourt and possible building premises for the sale of fuel (inflammable liquids) to customer's vehicles (see also Hanekom, 2001; Genovese, 2004; and Spencer, 2004). Most filling 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 (Hamid et al., 2009; and American Heritage Dictionary, 2004). Some of the variables considered when selecting location for any utility or some activity are proximity to population centers, distance from neighboring petrol filling stations, the easements of using existing utility, and the magnitudes of environmental pollution parameters. Other factors to take into account when making a decision about the location of business include customers, transport, the neighborhood, finances and the longer term future (Oetomo and Sesulihatien, 2012; see also Mohammed, et al., 2014; Hamid et al., 2009).

The study focused on assessing public's perceptions on the location of filling stations in the City of Kitwe. Several indicators were used in the assessment based on the Zambia Bureau of Standards Guidelines, the Petroleum Industry Code of Practice and The Petroleum Act Cap 435 of the Laws of Zambia. Attempt was made to identify factors affecting locations of petrol filling stations in the City of Kitwe.

1.2 Background to the Study

Zambia has a total of 215 filling stations (Energy Regulation Board, 2014). The filling stations are usually located in major towns and metropolitan areas especially along the line of rail where Oil Marketing Companies (OMC's) including BP, Total, Engen, Chevron and Kobil have established filling stations. Some of the filling stations have been leased out to dealers while others are run by the Oil Marketing Companies (OMC's) themselves (ibid). With the large number of registered cars and filling stations in urban areas, the problems of the distribution, the location and the sitting of filling stations need careful examination with regard to the control that requires to be exercised; the legislation instruments that may be required to enforce such control and the optimum conditions that should be created from the point of view of service to the general public (Gopalaswamy, 1977). This is because, filling stations contribute to air pollution and there has also been incidence of filling station explosions; according to World Health Organization (World Health Organization, 2004), more than 2.3 million lives and properties worth more than US$ 4.5 billion are lost to fire outbreaks associated to petroleum products mishandling. Mshelia et al (2015, p.6), disclosed in their paper, "Environmental Effects of Petrol Stations at Close Proximities to Residential Buildings in Maiduguri and Jere, Borno State, Nigeria" that, "the perceptions of the residents in the order of severity of dangers affecting them, air pollution is the most severe danger variable. Traffic accidents, traffic congestion and fire outbreak are the next severe dangers. Noise has lesser danger than compared to air pollution, traffic accident, traffic congestion and fire outbreak. While soil pollution and felling of trees are the least danger variables as perceived by the respondents in relation to the distance between the petrol stations and the residential houses. Therefore, it is generally important in the planning process for development particularly in the urban centers, to give much consideration to measures that reduce hazards. Planners should at all times assess possible hazards in planning and promote ways of avoiding or mitigating damage that might cause hazards, risk and vulnerability (Mshelia, et al, 2015, p.7).

1.2.1 Statement of the Research Problem

The Zambia Bureau of Standards (ZABS)(2015), states that, location of filling stations shall be approved by the Energy Regulation Board in accordance with the provisions of the Energy Regulation Act, Cap 436 of the Laws of Zambia. In addition, the size of the land to be dedicated to the fueling facility shall be sufficient enough to allow maneuvering of vehicles within its premises and shall not be less than 1600 meter squared with a minimum frontage of 40 meters on the primary street. Mshelia, et al (2015, p.1) stated that, in locating petrol filling stations, it is important to take some precautionary measures like locating them at a required distance from buildings; places of public assembly such as markets, hospitals and schools and areas of high traffic congestions and residential buildings. Unfortunately, this seems not to be the practice and as a result, there have been

proliferations of filling stations that are located close to residential buildings and public places. This might have constituted serious hazards to residents in close proximity to filling stations.

In view of the potential challenges and risks associated with filling stations the following research questions evolved; what is the public's perception on location of filling station in the City of Kitwe? What are the possible factors that influence filling station locations in Kitwe? Are filling stations located according to established planning standards, guidelines and regulations in the City of Kitwe?

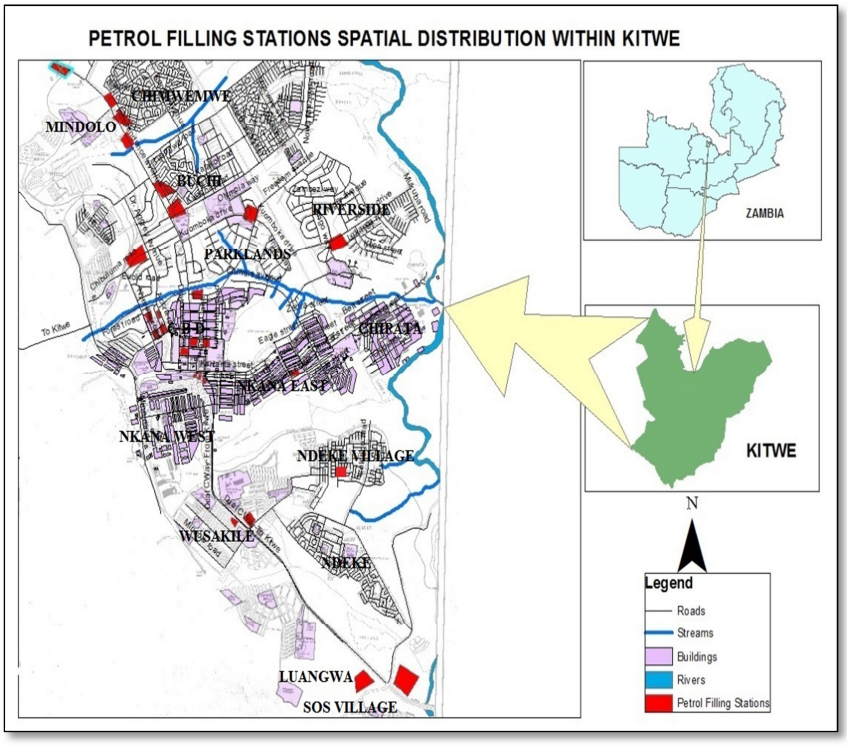
1.3 Study Area

Kitwe was established in 1928 as a mining township to exploit the area's rich copper ore deposits. In 1967, Kitwe was conferred city status. The city covers an area of 777 square kilometers and has an estimated population of 468,682. Kitwe is called the "hub of the Copperbelt" due to its centrality and major economic activities, which include mining, agriculture, trade, commerce, industry, forestry, and fisheries. Kitwe has a well-developed service industry and is a center of education and culture. The city is expanding rapidly; unofficial estimates have pegged Kitwe's residential population at 700,000, while a transient population from the surrounding towns and agricultural hinterland push the daytime population past 1.2 million. It is envisaged that the population of Kitwe will double within the next decade, due to natural growth and the city's growing importance as a center of trade and mining activities (UN-HABITAT, 2009, p. 9).

The City of Kitwe lies between Latitude 12° and 13° south and Longitude 28° and 29° east. The city sits on a fairly flat land with an altitude of 1,295 metres above sea level. The city boasts of the centrality of its location in the Copperbelt Province of Zambia, and is bordered by Kalulushi, Mufulira, Luanshya, and Lufwanyama districts and the City of Ndola (www.kcc.gov.zm). Figure 1 shows the spatial location of Kitwe District in Zambia.

Table 1 (see Notes) shows the statistics of filling stations within Kitwe by different owners. The table shows that a total of 28 petrol filling station stations are in Kitwe. Out of the 28, Kobil and Puma have six (6) each whilst Total has four (4).

Figure 1: Map of Kitwe showing distribution of Filling Stations



Source: Generated by the Authors (2016)

2. Literature Review

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.

This paper made efforts to highlight some of the planning and environmental criteria as well as some case studies as points of reference to guide the research. Public's perception on the location of filling stations can be viewed with regard to the knowledge that the public has on standards and guidelines on filling stations locations. Filling stations were traditionally located in largely uninhabited areas (Isabel, et al., 2010, p.2754). The situation obtaining on the ground proves to be different since many filling stations are being built within urban areas surrounded by residential and public buildings. This trend has been observed regardless of the dangers associated with filling stations. Filling stations come up in newly developed areas only when development reaches a point at which business potential of the areas can be assessed. A delayed demand for Service Site is then created and will culminate in request for permits to use sites which are detrimental to sound development of the area. Preferences for locations on heavily travelled streets so as to obtain the maximum patronage from local area as well as the passing traffic results in serious traffic hazards and traffic congestion (Gopalaswamy, 1977).

Filling stations are a source of volatile organic compound emission which raised concerns and discussions about groundwater contamination in the USA and Europe due to recently detected evidence of fuel spills and leaks that have actually been happening for several decades (EFOA, 2002). Volatile Organic Compounds including benzene and toluene along with toxic gases such as carbon monoxide and traces of soot can have deleterious effect on general health particularly on the respiratory system (Alam, et a., 2014, p.2). According to the Australian Transport Safety Bureau (ATSB) (2005), between 1993 and 2004, there were 243 reported incidents of fires breaking out at petrol stations. The continuous urban growth experienced by Spain in recent years has also resulted in many petrol stations being built within urban areas surrounded by buildings. This situation has led to controversy between the citizens whose houses are close to the petrol stations and the authorities responsible for land management (Isabel, et al., 2010, p.2754).

There are quite a number of case studies that have been carried out on filling stations location around the globe. The studies have been carried out to ascertain the dangers associated with filling stations locations and public's perceptions. One interesting discussion in the literature is the case of City of Singapore. Chan et al (2004, p.1) proposed a structural model to explain both the geographic locations of gasoline retailers in Singapore, as well as the nature of price competition between the retailers and their geographic locations. Interestingly, the premise underlying the development of the model was that, the Singapore government determines where to locate gasoline stations in the city. This was found very unique as compared to most capitalist market driven economies. The authors reiterated that, the government of Singapore is a *social welfare planner* and thus her approach to streamline the distribution of gasoline stations across the city is to minimize aggregate travel cost incurred by consumers in their efforts to buy gasoline in Singapore (2004, p.5).

Another study by Hamid et al (2009) discussed site potentiality for petrol station business based on traffic volume counts using a regression and Geographic Information System (GIS) based spatial system. The authors stressed that, site potentiality is an important factor that influences business success of a petrol station which relies on customer visits (p.10). On this note, Kearny (1998) disclosed that, it was empirically found in the United States of America that, site location was the primary factor for drivers to choose a petrol station (see also Hamid et al, 2009, p.11).

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). The standards used in practice for the site selection for petrol filling station were collected from City Planning Department, Ipoh. A set of questionnaire was also designed to get the stakeholders opinion regarding the site selection of the petrol filling stations (ibid). Analytic Hierarchy Process (AHP) was used as a Multi-Criteria Decision Making (MCDM) technique. Expert Choice (EC) was used to analyze the qualitative results. At the end, to achieve the main objective of the research, the spatial data was used to identify the suitable land parcels for installing new petrol filling stations using GIS. The responses from the public were analyzed to generate the land suitability map for petrol filling stations location and to validate the final land suitability map for petrol filling station, the overlay technique was adopted. The

data layer of existing petrol filling stations was generated by using the coordinates. The coordinates were collected from the online available source provided by the Malaysian Geospatial Data Infrastructure. The coordinates were validated by using the hand Global Positioning System (GPS).

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.

From another study carried out in Maiduguri and Jere, Borno State, Nigeria, the workers in the petrol stations and the residents living nearby the petrol stations have in one time or the other suffer various health effects as a result of working in petrol stations or being their close (Mshelia, et al, 2015; Afolabi, et al., 2011). The results from Mshelia et al showed that, respiratory problems (diseases) had the highest percent of 38.05%. This by implication means, it was the most prevalent health problems affecting both the workers and some of the residents as a result of the inhalation of fuel contaminated air. However, skin and sight problems alongside other health complications were also issues of concern. If the situations continue thereafter, such could lead to narcotics effects with symptoms including headache, nausea, dizziness and mental confusion (Mshelia, et al, 2015, p.7). From the result obtained, only 26% were located in conformity with the standards and guidelines. The study also revealed that some of the petrol stations were separated by a wall or narrow path. One significant revelation from the study was that, some of the petrol stations were located much earlier before environmental guidelines and regulations were formulated. Similarly, some of the residential houses were developed close to petrol filling stations. In other words, urban planners also fail to implement physical development control measures to restrain potential landlords to build in close juxtaposition to petrol filling stations (ibid).

The issue of location preferences of entrepreneurs also features within the literature (Njoku and Alabge, 2015; Mohammed et al 2014; Afolabi et al., 2011). Njoku and Alagbe stated that, in as much as petrol filling stations should be located where they can be easily accessible, the concern had been that there has been over-provision within one geographical area as well as indiscriminate locations within Oyo town and Nigeria at large (see also Afolabi et al., 2011). The observed trend within the literature is that, some owners prefer to select the optimum location to locate their petrol filling station on the profit maximization principle. Nkoju and Alagbe (2015, p.11), disclosed 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 filling stations"*.

The review of the literature brought to light the efforts governments throughout the world are making to ensure that the risks associated with petrol filling stations locations are either avoided or minimized. One of the risks experienced in recent times in connection with filling stations is fire explosions. This brings to the fore the importance of all stakeholders adhering and ensuring that planning guidelines and environmental standards are complied with in the sitting of filling stations. However, in view of some lapses in the application of the planning guidelines and standards in some of the countries in the developing world there has been serious fire explosions related to filling stations in Accra, Ghana and Lagos, Abuja, Kano in Nigeria and Umvoti and Cato Ridge in KwaZulu Natal in South Africa (enca.com South Africa). In Accra Ghana, one of the worst fire explosions engulfed the Goil Filling Station on 3rd June 2015 at the Kwame Nkrumah Circle which killed nearly 200 people during a rainstorm. In Nigeria, fire explosions at filling stations have been a common feature which has destroyed properties within the vicinities of the filling stations (see AllAfrica com; dailytimes.ng and dailypost.ng). The filling stations that were engulfed by fire explosions include ASCON on the Admiralty Way Likki Phase 1 Lagos (see dailytimes.ng), MRS Filling Station in Surulere in Lagos (dailypost.ng) and Canoil Filling Station Opposite the Nigerian National Petroleum Corporation (NNPC) in Abuja (AllAfrica.com, 2013; see also dailytrust.com, 2013). One of the standout models to avoid or minimize risks associated with filling stations is the case of Singapore, where the government is the main social welfare planner who ensures that petrol filling stations are sited based on national planning standards. Similarly, in Malaysia, planning standards and principles generated have identified factors that influence potential petrol filling station locations. They identified three types of sites of petrol station (Planning Standards MPJBT, 1998; see also Hamid et al., 2009, p.12). The first, *left*, whereby the petrol filling station is situated off a street and it is accessible from that street

only. The second is *Corner*, whereby the petrol station is situated at a corner where two streets meet. It is accessible from both streets. The third is a *T-Junction,* whereby the petrol station might have a three-way position. It may be accessible from one or two streets (ibid). Besides, it must be reiterated that, there has been significant research that has been done on technological, price differential issues and competition amongst petrol filling stations as well as efforts to model their locations in the light of optimization and minimization of traffic congestions.

Contrary, there appears to be virtually no serious interest in conducting research on the public's perception on the location of petrol filling stations. Reflecting on the explosions of filling stations in Accra, Ghana, Nigeria and South Africa, the major concerns the general public may reflect upon will be, *"How should petrol filling stations be located to avoid such disasters in future?"* The study of the public's perceptions on locations of filling stations is worth researching on. The next section attempted to envision the authors' perspectives on how the public's perception could be conceptualize on the subject matter.

3. Theoretical Expositions

Based on the literature review and considering the fact that filling stations are service activities that are privately owned by entrepreneurs, they could be regarded as firms whose location could also be influenced by the preferential choices of the owners (entrepreneurs). In this respect, the study identified four main determinants that could be embedded in the conceptual postulations, i.e., location choices made by the owner of the filling station; the locational criteria specified by Environmental Protection Agency of Zambia; Guidelines for sitting of filling stations by Energy Regulation Board of Zambia (2015), and the Planning Principles and Standard of the Town and Country Planning Act (now Urban and Regional Planning Act 2015); some theoretical formulation regarding obnoxious and inflammatory facilities locations, and the theory of Central Place.

The discussion on the theoretical expositions begins with the obnoxious facility location model; Obnoxious facilities location model categorized facilities into two, i.e., desired facilities and undesired facilities. Desired facilities are those which are desired by inhabitants to be placed in closer areas. Undesired facilities are those which are never desired to be placed in nearby areas by the inhabitants and they are termed under what is known as obnoxious facilities (Rana and Garg, 2014). In the literature review, it was discovered that petrol filling stations pose a risk to the environment and are a source of concern in case of fire explosion (Muzenda, 2015). Hence, they can be categorized under obnoxious facilities. The location of petrol filling 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 and Garg, 2014).

Obnoxious facility location problem deals with the proper placement of such materials which are preferred to be placed far from the populated area to prevent the inhabitants from health related issues as caused by such facilities (ibid). If petrol filling stations are located closer to populated areas, it may be dangerous to the lives of mankind and keeping in view all adverse effects of the petrol filling stations over the environment and population, it is crucial to locate obnoxious facilities away from the populated area (Rana and Garg, 2014). The exposition by Rana and Garg was affirmed by the studies by Mshelia et al 2015 and Afolabi et al., 2011) who highlighted on respiratory and other health problems affecting both workers and residents living within close proximity of the filling stations.

As discussed above, the location of a filling station is supposed to be in consonance with the Energy Regulation Board planning principles, standards and guidelines for sitting of petrol filling stations. Unfortunately, petrol filling station operators always assume that quality of site location is 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 (Iman, et al., 2009). This means that filling station operators always have a location preference with the hope of maximizing sales and profits. Hence, they will choose to locate their business at a central place where they feel it will attract a lot of motorists for refueling and as a result, maximize on their income.

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 and 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 filling station operators to locate their businesses at a central place where they can attract motorists. The primary concern of filling 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).

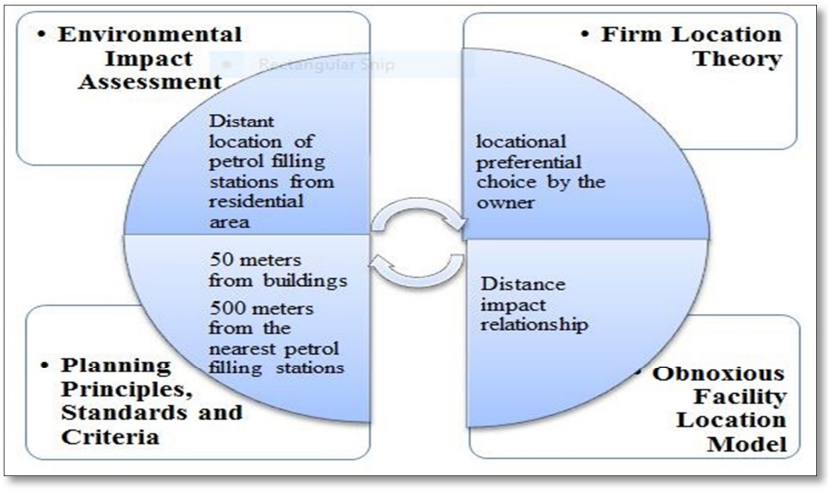
Even though filling stations' operators have locational preferences, it should be understood that, the location of filling stations generally despite its importance to the economy, is expected to be guided by a defined standards (Mshelia, et al, 2015). Bolen (1988) stated that, every location on the earth has its analyzable advantages and disadvantages and according to Mshelia et al (2015), before the planning permission is granted to construct a petrol filling station, it is a requirement to conduct an Environmental Impact Assessment (EIA). Lawrence (1997) 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, et al (2009) stated that, location of petrol filling 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 filling stations owners which is based on profit maximization (O'Sullivan, 2005).

Figure 2: Determinants for the Location of Petrol Filling Stations



Source: developed by Authors (2016)

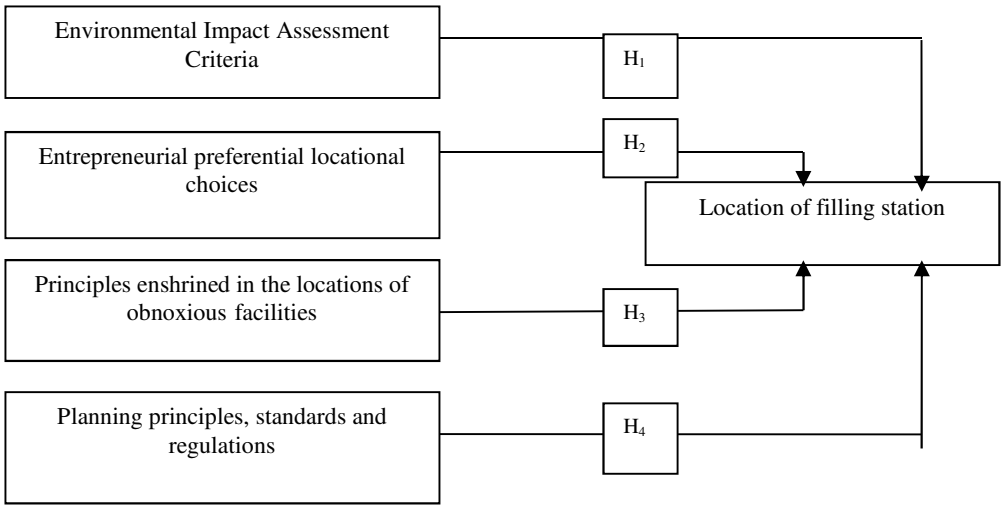
The Environmental Protection and Pollution Control (Environmental Impact Assessment) Regulations (SI No. 28 of 1997) provide a guideline for conducting an Environmental Impact Assessment. In carrying out an environmental site assessment on petrol filling stations, Mulroy (2012) in his presentation at an Environmental Petroleum Seminar in Mitchelstown County Cork disclosed that, petrol filling stations are an environmental liability as they are a potential hazards to the environment hence, site investigation and generic risk assessment need to be undertaken in order to institute a remedial plan for mitigating the significant negative impact that petrol filling station pose on the environment. Hence, due considerations will be made in relation to petrol filling stations location standards and principles as established by the ERB. Figure 2 shows what is considered to be the main determinants that influence the location of filling stations in Kitwe.

The theoretical frameworks reviewed provide the guidelines and criteria in dealing with the location of filling stations which are associated with negative impacts. The integration of the reviewed theories is significant in the assessment of public's perception on location of filling stations.

3.1 Conceptual Framework

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, Obnoxious Facility Location Model and The Planning Principles, Standards and Criteria in order to carry out effectively the assessment of public's perception on location of filling stations. 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 3 shows the conceptual framework for the research, outlining the relationship between the main locational determinants and the location of filling stations. The determinants are conceptualized to play a significant part in the location of petrol filling stations.

Figure 3: Conceptual Framework



Source: Developed by the Authors (2016)

3.1.1 Hypotheses

The hypotheses that emerged from the conceptual framework were:

H_1: Environmental Impact Assessment Criteria positively influence the location of filling stations in the City of Kitwe

H_2: Entrepreneurial preferential locational choices positively influences the location of filling stations in the City of Kitwe

H_3: The principles and standards enshrined in the locations of obnoxious facilities are positively related to location of filling stations in the City of Kitwe

H_4: Planning principles, standards and regulations positively influence locations of filling stations in the City of Kitwe.

Environmental Impact Assessment Criteria seeks to ensure sustainable development through the evaluation of impacts arising from a major activity that is likely to significantly affect the natural and man-made environment (Scot and Ngoran, 2003). The EIA criteria are assumed to determine the location of filling stations in the City of Kitwe. Isabel et al (2010) disclosed that, petrol filling stations could contaminate the environment as far as 100 meters away. Hence, from the literature reviewed, the criterion that is used to determine the location of petrol filling stations in accordance with the environmental impact of the facility (soil, water and air contamination as well as fire explosion) is 100 meters away from public and residential buildings. Moschini, et al (2005) disclosed that, underground storage tanks corroded and leak for an average period of 20 years after installed, in many cases, in 15 years, if they did not have a cathodic protection contaminate the soil, underground and surface water.

Entrepreneurial preferential location choices are based on profit maximization (O'Sullivan, 2005). The preferential location choices of an entrepreneur which are profit oriented determine the location of filling stations in Kitwe. According to Iman, et al (2009), entrepreneurial preferential location choices are determined by volume of traffic flows passing the site, proximity to a major travel route, visibility from the road, and distance of catchment area from residential neighbourhood areas, and within a residential or commercial area.

Obnoxious facility location criteria are concerned with location of obnoxious facilities far from public and residential areas (Rana and Garg, 2014). The criteria enshrined in the model determine the parameters for obnoxious facilities location, i.e., filling stations as obnoxious facilities in Kitwe. The criteria are in consonance with planning principles, standards and guidelines and state that, a petrol filling station should:

- Be sited 50 meters away from residential and private building
- Have 40 meters buffer zone of open space or 40 meter frontage for the road.
- Be located 500 meters away from the nearest petrol filling station.
- Be located 100 meters away from water bodies.

Planning Principles, Standards and Regulations have been formulated by the Energy Regulation Board (ERB)(2015), to guide the location of filling stations; The Board recommends that, a filling station should have:

- 50 meters minimum distance from residential or public buildings.
- 500 meters minimum distance from a nearest petrol filling station.
- 40 meters buffer zone of open space from the road.

The operationalization of the concepts in the hypotheses guided the development of the questionnaire.

4. Research Methodology

The research design was a case study which employed a descriptive cross sectional survey. The sampling frame consisted of all residents above the age of 18 years living within 100 meters from petrol filling stations within Kitwe. The sample size was 385**.** The study used purposive sampling technique to identify the respondents. In view of the 28 filling stations in the city, a sample of 10 was used as reference points to identify the residents to represent the public's perception. Table 2 shows the stratification of the sample by filling stations and their locations. Out of the total of 385 questionnaires distributed to the residents 379 was received. This was 98.44% which was considered very high in terms of the response rate. It must be stressed that one (1) respondent was selected from each house. This was very important to eliminate bias in the responses. It was also to spread out the sample and to generate a more representative opinion from the respondents. It is also pertinent to disclose that, the main primary data for the study was divided into two, i.e., physical survey of the location of petrol filling stations with respect to standards by Energy Regulation Board of Zambia and the Planning Authority of the City of Kitwe. The second primary data relates to questionnaire generated information from the respondents on issues reflected in the theoretical and conceptual framework derived from the literature reviewed. The data was collected through the administration of structured questionnaires for residents within 100 meters radius of the location of filling stations. The questions reflecting on the variables were structured using the Likert scale anchored between strongly disagree equals 1 and strongly agree equals 7. The questionnaires were pretested to determine whether questions and instructions were clear on the subjects and whether respondents understood the information required from them.. The pretesting of the questionnaire was carried out on 20 residents in the residential area that was not scheduled in the survey. Finally, the Google Earth Map 2015 was used to capture all the filling stations after the actual site survey. This was aimed at saving spots images for spatial analysis in Geographic Information System Arc Map 10.1.

Table 2: Filling Stations around which Residents were sampled

No.	Name of Filling Station	Location	Type of Residential Area	Number of Residents Sampled	Number of Questionnaires Received
1	Puma	Central Business District	Medium/High Residential Area	**40**	**40**
2	Puma	Kabala Shopping Centre Nkana East	Medium / High Income Residential Area	**40**	**39**
3	Puma	Wusakile	Low Income Residential Area	**40**	**39**
4	Total	Parklands Shopping Centre	Medium / High Income Residential Area	**40**	**40**
5	Kobil	Chemwemwe	Low Income Residential Area	**40**	**40**
6	Kobil	Central Business District	Medium / High Income Residential Areas	**35**	**33**
7	Engen	Parklands	Medium / High Income Residential Areas	**35**	**34**
8	SGS	Riverside Shopping Area	Medium / High Income Residential Areas	**40**	**40**
9	Petroda	SOS Village	Medium Income Residential Area	**35**	**34**
10	Eco-Petroleum	Buchi	Low Income Residential Area	**40**	**40**
	Total			**385**	**379**

Source: Generated by the Authors (2016)

4.1 Reliability and Validity Test

In view of the likert scale type of the questionnaire used for the data collection, the data was subjected to reliability and validity test to determine the internal consistency of the questions. The Cronbach's Alpha was computed at the summative level for all the ten (10) qualitative statements under the four main themes defined within the conceptual framework that also defined the hypotheses. The Cronbach's Alpha for the ten items was found to be very good and acceptable at .901 (see Table 3). The Cronbach's Alpha for all the four hypothetical themes was also computed (see Table 4). Table 4 shows that the internal consistency of the questions was very good with the Cronbach's Alpha ranging between .846 and .946.

Table 3: Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Item	Number of Items
.901	.913	10

Table 4: Reliability Statistics (Main Themes)

Thematic concepts of the Conceptual framework	Number of Items	Cronbach's Alpha
Environmental Impact Assessment Criteria	3	.846
Entrepreneurial preferential locational choices	2	.851
Principles enshrined in the locations of obnoxious facilities	2	.881
Planning principles, standards and regulations	3	.946

Source: Generated from Statistical Analysis (2016)

Besides the Cronbach's Alpha, factor analysis was also computed for all the ten items. All the items had extraction coefficients greater than .500. With that information from the computations, it was concluded that the questionnaire had a very high level of reliability and validity. It must be stressed herein that, the initial number of statements was 16. The factor analysis reduced the number to 10 which was used for the analysis.

5. Results and Discussions

Table 5 shows the demographic characteristics of residents living within the 100 meter radius of the filling stations within Kitwe. The table presents the age, education level, employment status, gender, and marital status. The demographic characteristics are presented to show the frequency and percentage of respondents according to the outlined categories. In terms of age, most residents fell in the age group of 31- 40 represented by 34 percent, while the smaller proportion fell in the age group of 61 and above representing 6.9 percent. In terms of educational level, a bigger proportion of residents have had Grade Twelve (12) Certificate representing 36.7 percent while the least percentage was those who have attained Second Degree representing 6 percent. It can also be seen from Table 2 that, under employment status, the majority of the residents was in formal employment representing 55.4 percent while a smaller proportion was not in employment representing 20.8 percent.

Table 5: Demographic Characteristics of Residents

		Residents	
A	**Age**	**Frequency**	**Percent**
1	19-30	83	21.9
2	31-40	129	34.0
3	41-50	89	23.5
4	51-60	52	13.7
5	61 and Above	26	6.9
	Total	**379**	**100.0**
B	**Education Level**	**Frequency**	**Percent**
1	Grade 12 Certificate	139	36.7
2	Certificate	91	24.0
3	Diploma	72	19.0
4	First Degree	35	9.2
5	Second Degree	6	1.6
6	Other	36	9.5
	Total	**379**	**100.0**
C	**Employment Status**	**Frequency**	**Percent**
1	Formal	210	55.4
2	Informal	90	23.7
3	No Employment	79	20.8
	Total	**379**	**100.0**
D	**Gender**	**Frequency**	**Percent**
1	Male	324	85.5
2	Female	55	14.5
	Total	**379**	**100.0**
E	**Marital Status**	**Frequency**	**Percent**
1	Single	33	8.7
2	Married	322	85.0
3	Divorced	11	2.9
4	Widowed	13	3.4
	Total	**379**	**100.0**

Source: Generated from Statistical Analysis (2016)

The results also showed that most sampled residents were males representing 85.5 percent with female accounting for the 14.5 percent. In terms of marital status the sample indicated that singles were represented by 8.7 percent, married were represented by 85 percent, divorced by 2.9 percent and widowed were represented by 3.4 percent.

The demographic characteristics highlighted that most of the respondents were educated and responsible; this was very important because it indicated that the respondents were able to understand, reflect, articulate and provide objective responses. The statistics depicted by Table 6 show that the distributions from the sampled residents were normally distributed (see the Figures 3, 4, 5 and in the notes). Apart from the means for the elements, *filling stations in Kitwe are located based on the EIA criteria and filling stations are located in Kitwe based on Guidance from the Planning Experts at the Local Authority,* which were 2.6482 and 3.7480 respectively, which were below the hypothesized mean of 4.5, the remaining two were above the hypothesized mean of 4.5.

Table 6: Descriptive Statistics of Main Conditions of the Hypotheses

	Variables	Residents			
		Mean	**Standard Deviation**	**Skewness**	**Kurtosis**
1	Filling stations in Kitwe are located based on the EIA Criteria	2.6482	.69385	.108	-.434
2	Filling stations are located in Kitwe based on Guidance from the Planning Experts at the Local Planning Authority.	3.7480	.86325	-.124	.122
3	Filling stations in Kitwe are located based on owner's preferential locational choice	4.9354	.71855	-.406	.239
4	Filling stations in Kitwe are located based on Obnoxious Facility Principles and Standards	5.7291	.65817	-.474	.175

Source: Generated from Statistical Analysis (2016)

Figures 3, 4, 5 and 6 (See Notes) show the normality of distribution of the responses for all the four conditions underlying the research. The first condition is skewed to the left which implies that, most of the respondents were not in agreement that most of the *filling stations are located based on the Environmental Impact Assessment (EIA) Criteria.* The second graph for the condition that, *Filling stations are located based on guidance from the planning experts at the Local Authority* depicted that most respondents were not sure if the condition was being met. The mean figure of 3.7480 was approximately close to 4 which is the same as not sure or being neutral. The last two conditions were all above the hypothesized mean of 4.5 (see Table 6) on the one sample t-test of hypotheses. Both conditional variables were skewed to the right implying that, the respondents were in agreement with statements. The EIA Criteria was not positively related to the location of filling stations in Kitwe due to the result (t= -51.97, p= 1.000, which is greater than 0.05). The result implies that the null hypothesis was accepted. On the Entrepreneurial preferential locational choice, it was realized that, it was positively related to location of filling stations in Kitwe with the result being (t=11.80, p = 0.000 which is less than 0.05). The hypothesis was supported hence the null hypothesis was rejected. Similarly, the third hypothesis was also supported with a t-value of 36.35 and p-value being 0.000 which is less than the 0.05. The last conditional variable was not supported hence the null hypothesis was accepted.

The hypotheses testing results were very significant. In the first place, it was realized that, most of the residents are well aware of the compliance to the Environmental Impact Assessment Criteria that are to be used to guide the location of filling stations in Kitwe. This perception might have been conceived from the location of recent filling stations in Riverside shopping centre and the construction of a new filling station in Ndeke Residential Area (in the southern part of Kitwe) which is yet to start operation.

Other filling stations that are perceived to have been poorly located are those in the Wusakile Residential area (a low income residential area). In the Central Business District of Kitwe, it is also observed that, the filling stations are located very close to each other. Though there might be advantages in their location within the CBD, there are also environmental risks that are associated with such close juxtapositions in locations. The cases in Accra, Ghana, Lagos and Abuja in Nigeria and Umvoti Cato Ridge in KwaZulu Natal in South Africa are recent examples of how risky such close locations to other human activities could be. However, it is important to reflect on the educational level of the residents from the demographic characteristics. The statistics indicated that, most of the residents are well educated hence it could be assumed that most of the residents are well informed on issues on the environment. Besides, the residents are also able to perceive *"the wrongs"* that take place

especially with land use planning and implementation of projects within the urban environs.

Table 7: Hypotheses Testing Using One Sample t-test

Hypotheses	Residents		
	t-value	p-value	Comment
H_1: Environmental Impact Assessment Criteria positively influences the location of petrol filling station in the City of Kitwe	-51.97	1.0000	Not Supported
H_2: Entrepreneurial preferential locational choices is positively related to location of petrol filling stations in the city of Kitwe	11.80	0.0000	Supported
H_3: The principles enshrined in the locations of obnoxious facilities are positively related to petrol filling stations in the City of Kitwe	36.35	0.0000	Supported
H_4: Planning principles, standards and regulations positively influences locations of petrol filling stations in the City of Kitwe.	-16.96	1.0000	Not Supported

Source: Generated from Statistical Analysis (2016)

Besides the hypotheses testing, the research examined the overall perceptions of the respondents with respect to the questionnaire. The summary of the perceptions based on the means are depicted under Table 8. A critical review of the results indicated that on the issues of meeting quantitative standards, it appears the publics' perceptions are all in disagreement of the conditional statements. For instance, the first statements (i.e., numbers 1 to 5) were all disagreed by the public. However, on conditional statements highlighted under numbers 8, 9 and 10, the public affirmed their agreement. The three statements are perceived by the public to be very important to reduce the environmental risks.

Aside the main observations highlighted, two significant outcomes of the research were that most respondents perceive that filling stations were located with the influence of the entrepreneurs deciding on their locational preferences; the assumption by most residents is that, entrepreneurs of fuel distribution products influence personnel involved in spatial planning to approve their preferential locations for suiting their filling stations.

Table 8: Public's Perception on Conditional Qualitative Statements Used in the Likert Scale Questionnaire

No.	Conditional Statements Variables	Mean	t value	P value	Residents Perception
1	Filling stations are located at a minimum distance of 100 meters away from water bodies	2.80	-27.55	1.000	Disagree
2	Filling stations are located at a minimum distance of 500 meters away from the nearest Filling station.	2.72	-27.11	1.000	Disagree
3	Filling stations are located at a minimum distance of 40 meters away from the road	2.38	-37.58	1.000	Disagree
4	Filling stations are located according to approved land use propositions in accordance with Local Authority Structure Plan Planning Standards	3.47	-14.03	1.000	Disagree
5	Filling stations are located after Environmental Impact Assessment reports have been approved by Zambia Environmental Management Agency and Local Planning Authority	4.02	-9.17	1.000	Disagree
6	Owners decide the location of Filling stations based on locational preference	5.23	14.82	0.000	Agree
7	Owners locate their petrol their Filling stations on locational profit maximization principle	4.84	2.72	0.000	Agree
8	Filling stations must not be located at a minimum distance of 50 meters away from the nearest residential or public building	6.27	39.95	0.000	Agree
9	A Filling station must be located on a minimum of 1600 meter squared area having a minimum buffer zone of 40 meters of open space	5.44	18.62	0.000	Agree
10	A Filling station must be located at a minimum distance of 500 meters away from a closest filling station	5.48	16.77	0.000	Agree

Source: Generated from Statistical Analysis (2016)

Conclusions

From the research problem three questions emerged namely, *what is the public's perception on location of petrol filling stations in the City of Kitwe? What are the possible perceived factors that influence filling station locations in Kitwe? Are filling stations located according to established planning standards, guidelines and regulations in the City of Kitwe?*

On the first question, the research revealed that, 77.38% of filling stations in the City of Kitwe were not located according to the established planning standards, guidelines and regulations. The justification to this statement was that, planning standards were not in place until 2014; however, most of the filling stations were established more than 30 years ago. Thus, it was concluded that, before 2014 attention was not focused on how filling stations were to be located in relation to the negative effects that the facility poses on the environment, people and property as discussed under literature review. However, Table 6 provides a summary of the public's perceptions of the issues based on all the conditional qualitative statements used in the Likert scale questionnaire. It could be realized that the first five statements were all disagreed by the public. The outcomes are in support of the results obtained for the hypotheses testing.

On the second question, it was observed from the analysis that, two main factors influence the location of filling stations in the City of Kitwe. The first factor is the preferential locational choice exercised by the investor or entrepreneur willing to establish a filling station. An entrepreneurial locational choice determines points of maximization of sales and profits. From the literature, it was disclosed that in most developed economies, locational choices are influenced by the price differentials and competitiveness between the filing stations. Documentations by Light (2004), Chan et al., (2004), and Sidaway (1998) are some of the cases as evidence of price differentials and competitiveness that affect filling stations locations

On the third question, it was ascertained that, filling stations in Kitwe were not located according to the established planning standards, guidelines and regulations. This is reflected by 75% representing twenty one (21) out of twenty eight (28) filling stations located in violation to the planning standards. However, since locational standards and guidelines were formulated and implemented after 2014, it was realized that different stakeholders have different perceptions regarding the location of filling stations even if institutions such as Zambia Environmental Management Agency, Energy Regulation Board, and Local Authorities subscribe to the idea that planning standards, guidelines and regulations should be complied with.

Based on the conclusions derived from the study, the following suggestions are being made to ensure that planning standards and environmental impact assessment reports should be adhered to. There is need for coordination between Local Authority, Energy Regulation Board, and the Zambia Environmental Management Agency in the planning of how filling stations should be located in urban areas. It is not just enough to approve the EIA reports. It is important to ensure that, there is serious monitoring and evaluation of the project implementation. Besides, the institutions should strategically develop and embark on serious public educational campaign to educate the general public especially all the potential entrepreneurs contemplating of entering into petroleum distribution in the country.

There is need to ensure that, adherence is made to planning standards and guidelines in real time on the location of filling stations. It is also important that, critical analysis is made to the established planning standards so that, all serious issues are incorporated within the planning standards, including the minimum distance from water bodies.

Filling stations that do not meet the established planning standards must be relocated or the residents within the parameter should be relocated according to the parameters set. Location of filling stations should be done by observing obnoxious facility principles and standards so that negative impacts are mitigated.

References

Afolabi Olusegun, T. Olajide Folakemi, O and Omotayo, Sunday, K. (2011), Assessment of Safety Practices in Filling Stations in Ile-Ife, South Western Nigeria, Journal of Community Medicine and Primary Health Care, vol. 23. Nos. 1&2, Mar/Sept, pp. 9-15.

Alam, R., Zafar, A., Ghafoor, A., Naseem, A., Ali, Q., and Imtiaz, F. (2014), Lung Function Abnormalities Among Fuel Filling Workers In Karachi, Pakistan. Pinnacle Environmental and Earth Sciences, vol. 1, No. 1, pp. 183-187

Australian Transport Safety Bureau (2005), An examination of the myths and facts about fire cause by electricity and exploding mobile phones. Static fire at retail petrol filling stations, Australia

Ayeni, B. (1991), Public Facility Location, using Maximal Service Distance, Research for Development, 7:1-2.

Ayodele S. J (2011). Spatial Distribution of Petroleum Filling Station in Kaduna North Retrieved on 5th March, 2013 from www.srib.com/samuel ayodele1.

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

Chan, T. Y., Padmanabhan, V. and 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.

European Fuel Oxygenates Association (EFOA) (2002), Methyl Tertiary Butyl Ether Resource Guide. Brussels. Belgium.

Energy Regulation Act (Cap 436), Laws of Zambia

Environmental Council of Zambia (2010), Environmental Impact Assessment Process in Zambia.

Environmental Protection and Pollution Control Act (Cap 204), Laws of Zambia

Energy Regulation Board (ERB), (2015), Guidelines for Sitting Filling Stations. (First Revision) June (2015)

Energy Regulation Board (ERB), (2014), Guidelines for Setting up of Rural Filling Stations.

Gbakeji, O. J. (2014), Location Theory and Public Facilities, Civil and Environmental Research, Vol.6, No.6, pp. 92-97.

Genovese, P. (2004). "Full-Service Gas Stations:"In Lurie Maxine N; Mappen Marc. Encyclopedia of New Jersey, Rutgers University Press: Piscataway. New Jersey.

Gopalaswamy, R. (1977). Guide to the Location of Gasoline (Motor Fuel) Filling Stations and Filling-Cum-Serv1ce Stations in Urban Areas. Town and Country Planning Organisation, New Delhi

Hamid, A. b., Iman. M. H., Suriatini, b. I. and Martin, R. bt., (2009), site Potentiality of petrol Stations Based on Traffic Counts, Malaysia Journal of Real Estate, vol. 4, No.1

Hanekom, P. (2001), Guidelines for the Construction and Upgrade of Filling Stations and Associated Tank Installations. Agricultural, Conservation, Environmental and Land Affairs, Diamond Corner Building, 68 Eloff and Market Street, Johannesburg, South Africa, pp. 1 – 17.

Iman, M. H., Suriatini, b. I. and Martin, R. (2009), Site Potentiality of Petrol Filling Stations Based on Traffic Counts, Malaysian Journal of Real Estate, Vol. 4, No.1, pp. 10-33.

Inyang, S. I and Ogbonna, D. O. (2001), Optimum Location for Petroleum Storage Depot in Northern Nigeria, International Journal of Transportation Studies, Vol. 1, No. 1, pp. 55 – 71.

Isabel, M., Minarro, M., Ferradas, E., Caracena, A, and Rico, J. (2010), Assessing the impact of petrol stations on their immediate surroundings: Journal of Environmental Management.

Khahro, S. H., Abd Nassir Matorib, A. N., Imtiaz Ahmed Chandiob, I, A., and Talpurb. M. A. H. T. (2013), Land suitability analysis for installing new petrol filling stations using GIS. Fourth International Symposium on Infrastructure Engineering in Developing Countries, IEDC 2013, Vol. 77, pp. 28-36

Kearny, A. T. (1998), India Petrol Retailing Expectations and Opportunities, Qualitatitive Research Findings for Delhi, 17-34.

Lawrence, P. D. (2000), Planning Theories and Environmental Impact Assessment, Environmental Impact Assessment Review

Light, J. J. (2004), An empirical Investigation of Product Differentiation in Retail Gasoline Industry. United States Naval Academy- Trident Scholar Project Report, Annapolis Mal.,

Losch, A. (1954), The Economics of Location. Yale University Press: Yale.

Mohammed, M. U., Musa, I. J., and Jeb, D.N., (2014), GIS-Based Analysis of the Location of Filling Stations in Metropolitan Kano against the Physical Planning Standards. American Journal of Engineering Research, vol. 3, No.9, pp. 147-158

Morrill, R. L. (1970), The Spatial Organization of Society. Duxbury Press, Belmont, California, p. 241.

Moschini, L. E, Santos, J. E and Pires, J. S. (2005), Environmental Diagnosis of Risk Areas Related to Gas Stations. Vol. 48, No. 4, pp. 657-666.

Mshelia, M., Abdullahi, J. and 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.

Mudambi, S. M. (1994), A Topology of Strategic Choice in Retailing, International Journal of Retail & Distribution Management, 22 (4): 32-40.

Mulroy, P. (2012), Environmental Site Investigation and Due Diligence in current Market: Paper Presented at the Environmental APEA Petroleum Seminar: Firgrove Hotel Mitchelstown County Cork: 15th November 2012.

Muzenda A. (2015). Petrol Filling Stations: The Time Bomb of African Cities https://www.archimedes.me/petrol-stations-the-time-bomb-of-african-cities\ Retrieved 15th October 2015.

Nieminen, P. M. (2005), Environmental Protection Standards at Petrol Stations: A Comparative Study of Technology

Between Finland and Selected European Countries. Thesis for the Degree of Doctor of Technology, Tampere University, Finland

Njoku, C. G. and Alagbe, A. O. (2015), Site Suitability Assessment of Petrol Filling Stations (PFS) in Oyo Town, Oyo State, Nigeria: A Geographic Information System (GIS) Approach. ISOR Journal of Environmental Science, Technology and food Technology (IOSR-JESTFT) e-ISSN: 2319-2402, p-ISSN:2319-2399 volume 9, issues 12 Ver III

O'Sullivan, A. (2005), Where do Firm Locate. Urban Economics (5th Edition), Boston: McGraw Hill

Oetomo W. H and Sesulihatien W. T. (2012), The Application of Index Model for Valuation a New Gas Station, Vol. 50, No. 1.

Petroleum Act (Cap 432:2), Laws of Zambia

Planning Policy Guidance 8 (2012), Location and Sitting of Filling Stations. Mauritius.

Planning Standards MPJBT (1998), Guidelines and Geometric Standards on Road Network System. Malaysia: Jabatan Perancangan Bander dan Desa, Kementerian Perumhundan Kerajan Tempatran 18 pp.

Rana, R. and Garg, D. (2014), Algorithm for Obnoxious Facility Location Problem, International Journal of Advancements in Technology, Vol.5, No. 4, Pp. 96-106.

Scot, J. and Ngoran, J. M (2003) Public Participation in Environmental Impact Assessment, International Masters Degree in Environmental Policy and Global Challenge Roskilole University, Roskilole, Denmark

Spencer, K. (2004)."Mobile Phone as Fire Risks".(BBC News Online) http://newsbbc.co.uk/1/hi/programmes/clickonline/3986509.stm. [Retrieved 2015-10-14].

Sidaway, R. (1998), Study of Petrol Stations in Rural Scotland. General Agricultural Policy and Rural Development (16), 455-98

The American Heritage Dictionary of English Language (2004), Houghton: Mifflin Company.

UN-Habitat (2009), Zambia: Kitwe Urban Profile

World Health organization (2004), Safe Piped Water: Managing Microbial Water Quality in Piped Distribution Systems by Richard Ainsworth.

Zambia Bureau of Standards (ZABS, 2015), The Petroleum Industry–Code of Practice. Zambian Standard

http://www.kcc.gov.zm

AllAfrica.com (2013) (Retrieved on the 20th of June 2016)

dailypost.ng (Retrieved on the 20th of June 2016

dailytimes.ng (Retrieved on the 20th of June 2016)

www.enca.com south Africa (Retrieved on the 20th of June 2016

Acknowledgement

The Authors would like to thank all the respondents who made it possible to secure the data during the data collection period. Particular gratitude goes to the Owners of the Filling Stations who willingly provided the information during the interviewing section for additional information as a form of triangulation. Finally, we wish to thank all the respondents who expressed their opinion freely knowing very well that the subject of investigation was very sensitive. We also wish to Thank the Zambia Energy Regulation Board for the documentation guidelines for sitting filling stations in Zambia.

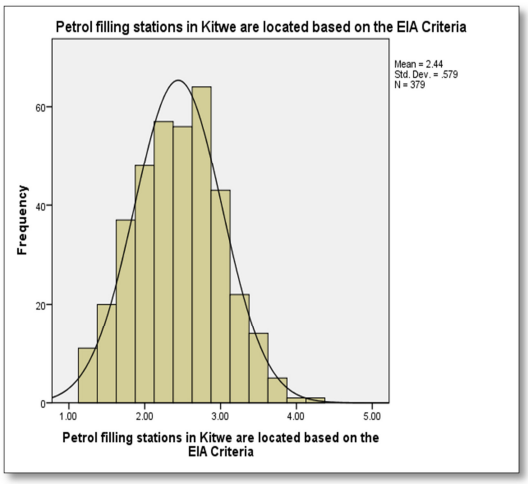
Notes

Table 1: Filling Stations Statistics

	Frequency	Percent
Kobil	6	21.4
Engen	1	3.6
Total	4	14.3
Lake Petroleum	1	3.6
Samfuel	1	3.6
Petroda	2	7.1
SGC	1	3.6
Mount Meru	2	7.1
Puma	6	21.4
Eco Petroleum	1	3.6
Oryx Energies	1	3.6
Suban	1	3.6
Atlas	1	3.6
Total	**28**	**100.0**

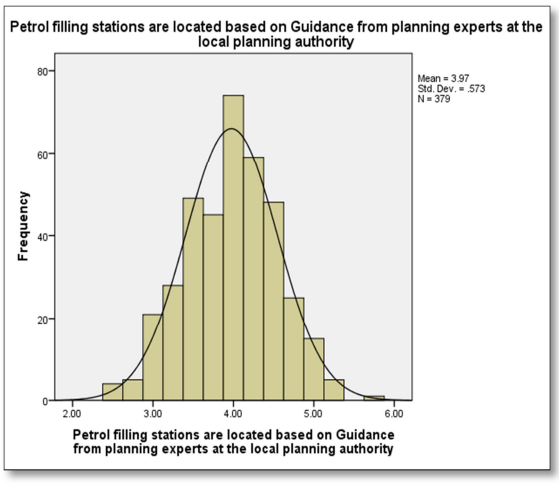
Source: Generated from the statistical analysis (2016)

Figure 3: Petrol filling stations are located Based on EIA Criteria



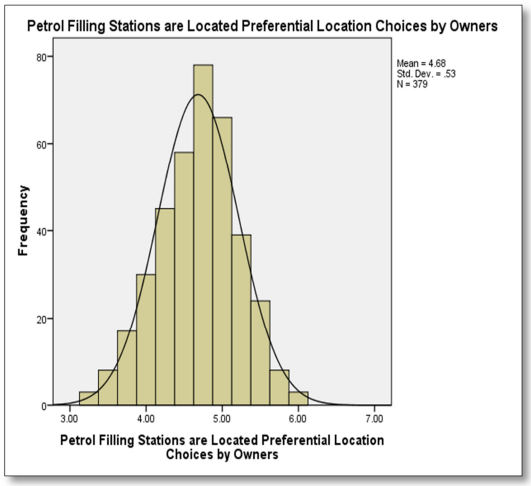
Source: Generated from Statistical Analysis (2016)

Figure 4: Petrol Filling Stations are located based on Guidance from Planning Experts from at the Local Planning Authority



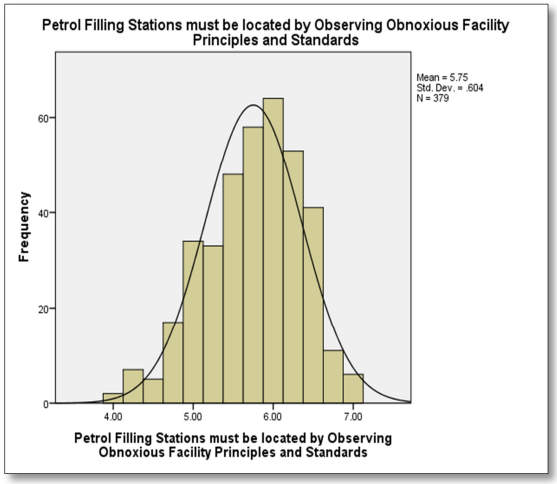
Source: Generated from Statistical Analysis (2016)

Figure 5: Petrol filling stations are located based on Preferential Locational Choices by Owners of Petrol Filling Stations



Source: Generated from Statistical Analysis (2016)

Figure 6: Petrol Filling Stations must be by observing Obnoxious Facility Principles and Standards



Source: Generated from Statistical Analysis (2016)

Plate 1: Total Filling Station located at Parkland Shopping Centre

Source: Author (2016)

Plate 1: This is a Total Filling station located at a corner near a roundabout in a commercial centre at Parklands Residential area. There is no space between the filling station site and the shopping activities.

Plate 2: SGC Filling Station located at Riverside located close to the Bakery at the Shopping Area

Source: Author (2016)

Plate 2: This is the SGC Filling station located close to a bakery in a at the Riverside shopping centre. The only dividing line is the entry or access road to the bakery. Behind the filling station, the dividing line is fence wall. Similarly, there is dividing fence wall on the left side of the filling station overlooking the main road. In effect, the filling station is sandwiched between different land use activities that are incompatible.

Plate 3: A New Filling Station located in a Ndeke Village Residential Area

Source: Author (2016)

Plate 3: This is a new filling station built in Ndeke Residential Area. Though it is located at a T-Junction, there is no buffer or space between the station and the adjacent residential building.