

## Risk Assessment of Petrol Filling Stations in a Metropolitan City of Kaduna State, Nigeria

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### Abstract

*With both their high-risk and high-profit nature, Petroleum filling stations have become a significant subject in risk estimation and assessment studies. Some of the risks associated with this organization include compliance with laid-down standards by monitoring bodies. This study aims to carry out a risk assessment of petroleum filling stations in Kaduna Metropolis, Nigeria. This involved assessing the level of compliance to laid-down standards on environmental conditions and equipment and assessing the awareness of attendants in these petroleum filling stations to the possible risks in their working environment. The design methodology employed for this study was the use of self-administered questionnaires. The study result showed that the respondents were of the perspective that they are exposed to hazards in the petrol filling station. However, risks such as sleeping disorders, memory loss, cancer, etc., due to long-term exposure to hazardous petroleum substances seem to have lots of uncertainty from the attendants.*

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### Keywords:

Hazards;  
Perspective ;  
Petrol stations;  
Risk Assessment;

### Article History:

Received: July 11, 2022  
Revised: October 17, 2022  
Accepted: October 23, 2022  
Published: June 2, 2023

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## INTRODUCTION

Every year the hazards related to innovation lead to colossal ailment and death, as well as varying ecological and social effects [1][2]. One of the most basic and significant points in risk assessment is the classification of risks. The present-day risks can be grouped by the source, use, potential for harm and numerous other qualities [3, 4, 5]. The choice of group is normally a component of historical or professional decisions and relies upon the individuals or associations that are doing the grouping [6, 7, 8]. A significant accomplishment concerning risk grouping has been a successively structured model, called the causal structure of technological hazard, that portrays the idea of technological risks and helps in grouping them dependently on a few physical, organic and social descriptors, which can be estimated quantitatively as shown in [Figure 1](#).

Petroleum Filling Stations, with both their high-risk and high-profit nature, have become a

significant subject in risk estimation and assessment studies.

For as far back as decades, catastrophes from the Centralia Pennsylvania coal mineshaft fire in 1962, the Exxon and Valdez oil slick in 1989 to the Texaco Refinery fire in 1994 and the most recent Deepwater Horizon oil slick in the Gulf of Mexico in 2012 caused incredible setbacks as well as gigantic misfortunes [9]. Similarly, in Nigeria, there have been several cases of petroleum stations disasters such as the fire incidents at Conoil Abuja in 2013 [10], Forte Oil Petrol Station Lagos in 2018 [11], as well as the Petroleum robbery attack at Nigerian Nation Petroleum Corporation (NNPC) Mega Station Ilorin in 2019 that led to the death of a police sergeant and a security man posted at the petrol station [12].

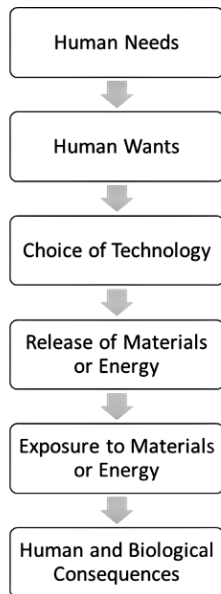


Figure 1. Causal Structure of Technological Hazards

In a typical petroleum filling station in Nigeria, tanker trucks bring the gas to the oil stations and emptied into underground stockpiling tanks. Thus, this leads to exposure concerns, particularly for the attendants [10]. A previous study in another location stated that Gasoline Vapour Recovery Systems (GVRS), which helps to reduce hydrocarbon emission, are usually not found in most Nigerian petroleum filling stations [11][12]. Research works carried out in other countries and settings have recorded health side effects that petroleum station attendants reported as migraines, weakness and throat irritation, which have been linked with exposure to fuel and its components [13, 14, 15, 16]. These revealed health manifestations denote some of the occupational health hazards that attendants in petroleum filling stations are exposed to.

Similarly, Singaraju et al. [17] study in Indore observed that each station attendant pumps an average of 2,000L of fuel, which contains around 5% benzene (a chemical that leads to cancer and leukaemia when above certain limits), during every 8 hours shift. Also, vehicle exhaust transmitted during driving in/out and the restarting of engines at filling stations can be other sources of gasoline components in the territory of filling stations [15][18]. Furthermore, the presence of station rooftops is a common sight in Nigerian petroleum filling stations, yet this results in the building of the concentration of gasoline vapours in both the inhalation zone of the attendants (close to pumps) and also the general zone for up to 3 meters downwind of the pumps [19].

In this manner, a profound and intensive assessment of the dangers in petroleum filling stations, to keep mishaps from occurring and control risk, is vital to researchers, government, and regulatory bodies. Therefore, the aim of this study is to carry out a risk assessment of petroleum filling stations in the Kaduna Metropolis. This involved assessing the level of compliance to laid-down standards on environmental conditions and equipment and assessing the awareness of attendants in these petroleum filling stations to the possible risks in their working environment.

**METHOD**

The current study adopted the survey research method, and the flowchart is shown in Figure 2. It is defined as collecting data by sending a questionnaire to relevant persons [20]. In this case, the relevant persons are the petroleum filling station attendants in Kaduna Metropolis, Nigeria. Kaduna State is one of Nigeria's original seven Hausa city-states and is about 270 km from Abuja, the Capital of Nigeria. The state is home to Nigeria's biggest university and the second biggest on the African landmass, Ahmadu Bello University. It is also the origin of numerous noticeable Nigerians, such as Former President Olusegun Obasanjo, Former Vice President Architect Namadi Sambo just to refer to a couple.

The sample size (SS) used for this research, with a total petroleum filling station of 53 in Kaduna Metropolis, was 20. A blend of primary and secondary data collection was adopted for this study due to its nature. Precedence was given to primary data sourced through hard copies questionnaire designed for that purpose.

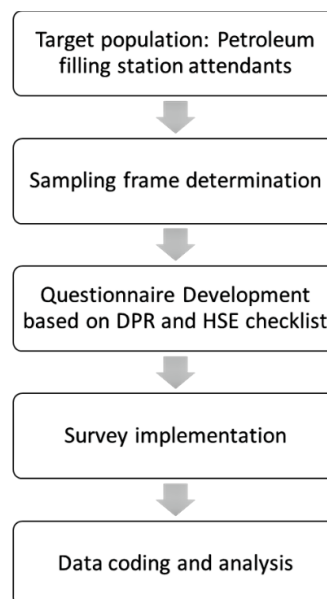


Figure 2. Flowchart of the research methodology

The perceptions of the petroleum filling station attendants were obtained in form of a structured questionnaire which was developed using the Department of Petroleum Resources (DPR) checklist for the operation of petroleum filling stations in Nigeria, as well as the Health, Safety, and Environment (HSE) issue of the United Kingdom.

The primary data sources were obtained between December 2021 and January 2022 and this process was supervised by two of the authors and consisted of copies of the questionnaire distributed and administered to the 20 petroleum filling stations. The focus was placed on the attendants that were on break during the time of the visit. Care was taken in making sure that all the questionnaires were filled and the attendants were guided on the process. The questionnaire was designed and formulated based on the stated hypothesis. The questionnaire was divided into two sections;

- Section A: contains demographic information such as gender, age group, academic qualification, and years of experience (4 questions).
- Section B: contains the attendants' perception of compliance with laid-down standards, possible hazards, and awareness of the employees to the risks in their working environment through the use of direct questions containing options on a scale of 5 (Likert Scale), ranging from Strongly Agree to Strongly Disagree.

Inferential statistics were employed in the analysis of the data collected through the use of frequency counts and percentages using Microsoft Excel (Version 2019) Software. In answering the research questions, the mean respondent and standard deviation of the respondents were used. However, in the analysis of the research hypothesis, using the SPSS (Version 26) Software, the chi-square statistics test was used in analysing the authenticity of the null hypothesis made earlier using a significance level of 5%.

## RESULTS AND DISCUSSION

### Demographic Information of the Respondents

Information about the gender, age group, academic qualification and occupation of the populace of the district based on the sample size is shown in Table 1. The result showed that the gender distribution of the attendants in the study area stands at majority as male (60%) while 40% were female. Furthermore, it was observed that the age group distribution of the respondents had

a maximum percentage of 30-34 years (40%), while the age group of 35-39 years and 40-49 years had 20% each, while 25-29 years and 45 years and above had 10% each.

Table 1 also shows the respondents' academic qualifications distribution in which the academic qualification with the highest record was NCE (45%). OND/HND and B.Sc/B.Ed had 35% and 20%, respectively. Also, the result shows that the majority of the attendants (65%) had above five years of work experience, while 15%, 10% and 10% of the attendants in the study area had 3-4 years, 4-5 years, and 2-3 years of experience respectively.

### Level of Compliance of Petroleum Filling Stations to Laid-down Standards

The level of compliance of the petroleum filling stations in the study with the laid-down standards is shown in Figure 3. The result showed that the majority (61%) of the attendant believed that standards such as setback regulations and the distance between filling stations and other properties. This result denotes that most of the filling stations were 15m from the roads, 100m from residential areas, and 500m apart from a filling station. The result also showed that the majority of the filling stations in the study area do not have poor environmental conditions such as overhead electric cable, drainage systems channelled into a stream, and open-pit storage vessels. Furthermore, the result showed that the majority of the filling stations have safety equipment such as muster points and emergency shut-down systems.

Table 1. The demographic information of the respondents

Variable	Number	Percentage
<b>Gender</b>		
Male	12	60.00
Female	8	40.00
<b>Age Group</b>		
25-29 Years	2	10.00
30-34 Years	8	40.00
35-39 Years	4	20.00
40-44 Years	4	20.00
45 Years and above	2	10.00
<b>Academic Qualification</b>		
NCE	9	45.00
OND/HND	7	35.00
B.Sc/B.Ed	4	20.00
<b>Occupation</b>		
2-3 Years	2	10.00
3-4 Years	3	15.00
4-5 Years	2	10.00
Above 5 Years	13	65.00

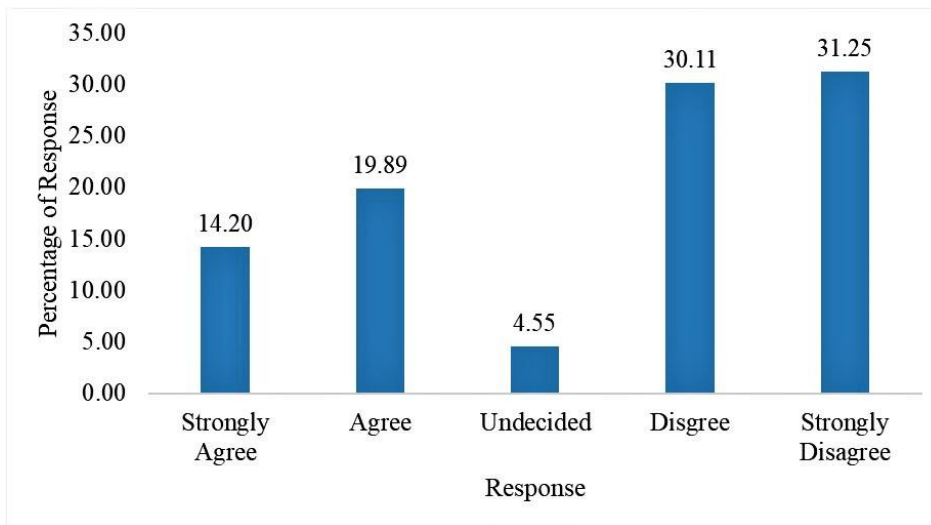


Figure 3. Level of Compliance of Petroleum Filling Stations to Laid-down Standards

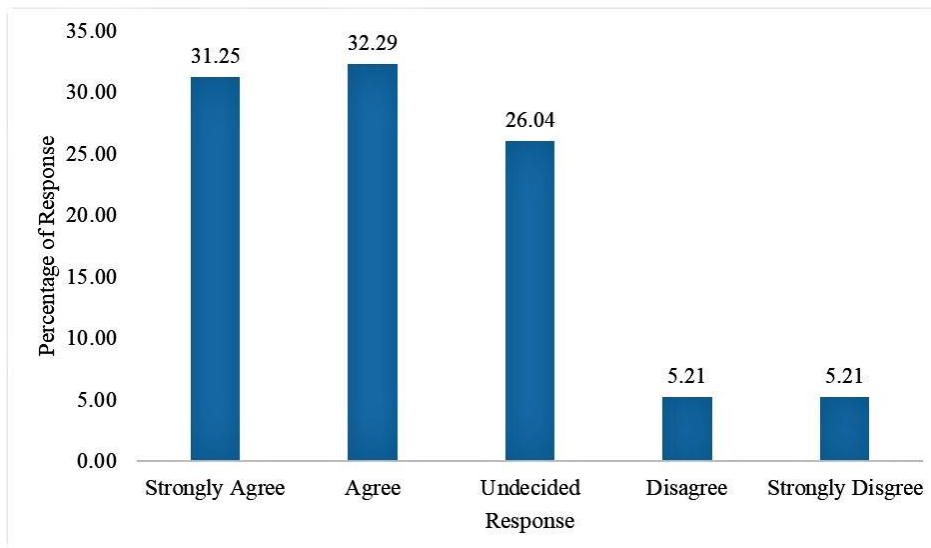


Figure 4. Awareness of the Attendants to Possible Risks in their Working Environment

However, the combined percentage of disagreeing and undecided of 39% showed that some filling stations still do not comply with the laid-down standards, which is a source of concern for the safety of the attendants and the general public. The result of the hypothesis analysis on the level of compliance of petroleum filling stations to laid-down standards is given in Table 2.

The decision on the test of the hypothesis on the level of compliance is such that since the calculated chi-square value ( $X_c^2 = 135$ ) is greater than the critical chi-square value ( $X_t^2 = 55.759$ ) at df of 40 and a significance level of 5%, then the null hypothesis which state that “petroleum filling stations in Kaduna Metropolis are not complying to laid-down standards in terms of environmental conditions and equipment” is rejected while the alternate hypothesis is accepted.

Table 2. Hypothesis Analysis on the Level of Compliance of Petroleum Filling Stations to Laid-Down Standards

	Calculated Chi-square	Tabulated Chi-square
Hypothesis	135	55.759

Hence, the result showed that the petroleum filling stations in the Kaduna metropolis comply with the laid-down standards in terms of environmental conditions and equipment. This result is in agreement with the functionality of the Petroleum Product Pricing Regulatory Agency (PPPRA) and the Department of Petroleum Resources (DPR).

### Awareness of the Attendants in Petroleum Filling Stations to Possible Risks in their Working Environment

From Figure 4, it is seen that the majority of the attendants (63.54%) agreed that they are exposed to risks due to their working environment, 10.42% believed that these risks do not have an impact on them, while 26.04% were undecided. A detailed analysis of the result showed that the attendants were familiar with workplace risks such as vehicles colliding with each other and structures, the risk of an employee getting hit by vehicles, the risk of arm robbery attacks and harassment and the risk of fatigue and injury.

However, due to long-term exposure to petroleum hazardous substances, the risk of sleeping disorders, memory loss, cancer, etc. seems to have lots of uncertainty from the attendants. These results are in agreement with the findings of Khisroon et al. [21], who studied the DNA of fuel filling stations and automobile workshop workers from Khyber Pakhtunkhwa province in Pakistan as well as the result of Oe & Qm [22].

The findings of Barros et al. [23] and Johnson et al. [24] also proved that petroleum attendants in Europe (specifically Portugal) and America, respectively, are exposed to certain health hazards as a result of the volatile organic compounds that they are exposed to.

The result of the hypothesis analysis on the awareness of attendants in petroleum filling stations to risks associated with the workplace is given in Table 3. The decision on the test of the hypothesis on the awareness of attendants is such that since the calculated chi-square value ( $X_c^2 = 71$ ) is greater than the critical chi-square value ( $X_c^2 = 31.410$ ) at df of 20 and significance level, then the null hypothesis which state that "The employees in petroleum filling stations in Kaduna Metropolis do not have adequate awareness of the possible risk in their working environment" is rejected while the alternate hypothesis is accepted.

Hence, the result showed that the employees in petroleum filling stations in Kaduna Metropolis have adequate awareness of the possible risk in their working environment. Notwithstanding this result, more effort should be made to educate the workers in petrol filling stations on the risks they are exposed to and how to prevent or limit exposure to those risks.

The limitations of this study are the geographical limitation of the study to petroleum filling stations in Kaduna Metropolis alone, although the findings can be extended to similar geographical settings.

Table 3. Hypothesis Analysis on the Awareness of Attendants in Petroleum Filling Stations to Workplace Risks

	Calculated Chi-square	Tabulated Chi-square
Hypothesis	71	31.410

Furthermore, this study is limited to the use of the checklist risk assessment method in analysing the risks in these petroleum filling stations.

### CONCLUSION

This study evaluated the risks associated with petroleum filling stations in Kaduna State, Nigeria, a major metropolis. The self-administered questionnaire used for this study's design technique was distributed to the sample unit, which consisted of the attendants of the petroleum filling stations in Nigeria's Kaduna Metropolis.

The study's findings indicated that while the majority of respondents believed that the petrol filling stations generally complied with established standards, environmental violations and equipment availability issues, such as filling stations' proximity to homes and the lack of designated areas for muster points, were frequent in these stations. The results also indicated that while the majority of respondents believed that they were exposed to physical, psychological, and health risks while working in a gas station, the attendants appeared to be very unsure about risks like cancer, memory loss, and sleeping disorders that could result from prolonged exposure to petroleum-related hazardous substances.

### ACKNOWLEDGMENT

The authors thank the staff and students of the Department of Mechanical Engineering, Ahmadu Bello University Zaria, Nigeria

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