

An Assessment of the Level of Safety Awareness among the LPG Consumers in Dhaka City, Bangladesh

*Md. Sumon Chowdhury\*, Farjana Junaky, Md. Al Amin, Simanto Kumar Pal, Md. Rokonzaman, Dr Mohammed Mahbubur Rahman*

*Department of Petroleum and Mineral Resources Engineering, Bangladesh University of Engineering and Technology, BUET, Dhaka-1000, Bangladesh*

Received February 24, 2020; Accepted April 30, 2020

---

## Abstract

Liquefied Petroleum Gas (LPG) is coming up as a fuel for domestic and commercial uses. Its popularity is increasing because of low cost and less harmful for environment. The government of Bangladesh has already taken a decision not to give any connection of natural gas in domestic sectors because of supply shortage. Safety awareness, maintenance procedure and risk analyzing capacity of the LPG users help to decrease accidents possibility due to LPG. Leak detection methods, fire hazards, regulator and rubber tube checking and changing, connecting and disconnecting of cylinder and some others are the basic knowledge for LPG using. This research aims to create awareness about LPG hazards, maintenance procedures and investigates the level of safety awareness of the consumers in Dhaka city. Five locations are selected from the city and pre-questionnaire is made for the study. 35 domestic users and 15 hotel/restaurant users are selected for each location and personal interview are taken based on the questionnaire. More than 80% LPG users do not check tube or regulator before connecting and more than 60 % after connecting a full cylinder. Lighting knowledge of gas stove is more than 55% wrong for domestic and more than 65% wrong for restaurant LPG users. Almost 52 % people have incorrect idea about gas leakage detection technique. Several safety trainings and campaigns are recommended to create awareness about LPG using and safe handling.

**Keywords:** *Liquefied petroleum gas, Gas leakage; Fire hazard; Safety awareness; Safety training; LPG safe handling.*

---

## 1. Introduction

Alternative of natural gas, LPG is being used in Bangladesh for domestic purposes. Liquefied Petroleum Gas (LPG) is a hydrocarbon and is an important alternative fuel used in the world today [1-2]. It is produced from natural gas by controlling pressure and temperature. LPG also founds after refinery of natural gas. It consists of mixtures of hydrocarbons such as propane (C<sub>3</sub>H<sub>8</sub>), butane (C<sub>4</sub>H<sub>10</sub>), *n*-butane (C<sub>4</sub>H<sub>10</sub>), iso-butane (methyl-propane), and various proportions of other butanes [3]. But generally, propane and iso-butane are the main elements of LPG in Bangladesh. It comes to the country by refinery and importing. It is preserved by cylinder bottle of several sizes according to its demand. LPG cylinders are made of steel. The capacity of LPG cylinders ranges from under 1kg to 50kg. LPG is flammable and combustible energy source as its explosive range is 1.8% to 9.5% of volume of gas in air which is considerably narrower than other common gaseous fuels [4]. LPG is good energy for cooking as also for engines as it contains propane because propane is the most common type of fuel for internal combustion engine after petrol and diesel [4-6].

LPG has high calorific value and it produces no smoke during burning. Its demand is increasing day by day. Since LPG is kept in the cylinder, several precautions have to be taken to ensure safety. Very harmful and dangerous accident may occur from LPG cylinders. Gas leakage is one of the main dangers which may occur from LPG cylinder. Proper handling is required for using LPG cylinder. The number of death by the explosion of LPG cylinders has

been increased in recent years. Most of them occurred due to gas leakage and ignition problem. The frequency of the blast is almost one at least in a month. From the last June, there were at least 5-6 LPG and 2 CNG cylinders explosion incidents that are reported at various dailies. Those explosions cost at least 7 human lives and left 5 burnt and injured severely while the financial loss was above 30 to 35 million BDT [7]. LPG has to be used with proper safety and maintenance knowledge. Improper handling of LPG can result in incidents such as fires, explosions and loss of lives. Safety knowledge is the improving knowledge, skill, attitude and morale of the consumers. Safety education and safety related training are very much essential for lessening the accidents occurred from LPG cylinder. Safety training is one of the solutions to perform safe work practices and a tool for motivating the employees to change [8-9]. LPG is odorless and colorless. A comprehensive set of rules concerning the safe handling in accordance with government regulations must be strictly adhered to [10]. This study is conducted to determine the safety awareness and risk knowledge of domestic and hotel/restaurant LPG users in Dhaka. This work may help to create awareness of safety issues and safety knowledge among LPG users.

## 2. Study area

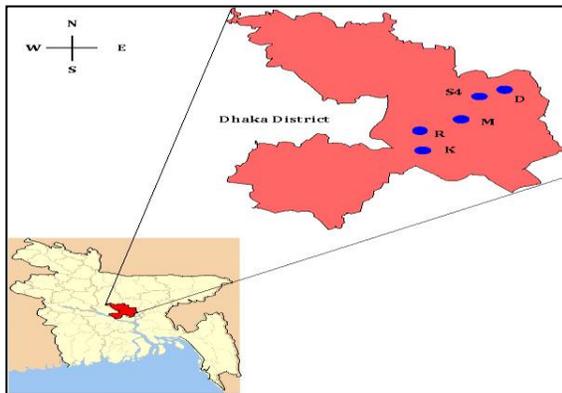


Figure 1. Location map of the study area (modified after Wikipedia)

This study is done in five locations at Dhaka city, Bangladesh (Figure 1). A survey in 5 areas of Dhaka city mentioned below has been conducted.

1. Sector-4, Uttara
2. Dakshinkhan, Uttara
3. Mirpur
4. Rampura
5. Kamrangir Char

Dhaka is the capital city of Bangladesh where 18.237 million peoples live according to the year 2016 and its density is 23,234 people per sq kilometer [11]. The latitude and longitude of the city is 23°42'37.44"N, 90°24'26.78"E [12].

## 3. Objectives of the study

The main objective of the study is to determine safety awareness of the LPG users of both domestic and hotel/restaurant. Besides some other objectives are-

- 1) Creating a general awareness of health and safety issue on LPG among users of domestic and restaurant in the study area.
- 2) Investigate the phenomena of consciousness about risk of LPG using.
- 3) Finding out the risk of LPG using.
- 4) Finding out the interest on Training on LPG using.

## 4. Methodology

This section describes the methods used for this research work and analysis technique to make an acceptable output. Physical survey in the study area is conducted and collected related information based on some pre-made questions and some random inquiry. The working process is shown in Figure 2

### 4.1. Necessary data and data types

Basic safety knowledge about using LPG cylinder and risk assessment in both domestic and restaurant are the major concern of the study. We collect both primary and secondary data for this research work. Primary data is found from the response of the consumers of LPG cylinder based on our pre-made questionnaire. Secondary data is taken from several research

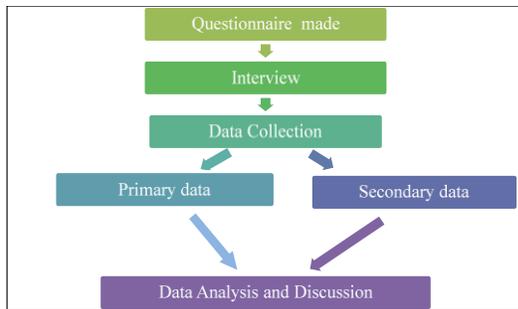


Figure 2. Working procedure of the study

papers, books, government documents and our group discussion. No single source of data has a complete advantage over the others but rather they are all highly complementary [1, 13].

The questionnaire concerning about safety, hazards and consumers consciousness about LPG cylinder using for this research is provided in Appendix-1.

## 4.2. Data collection techniques

The authors made a discussion about the causes of fire accidents occurred in Bangladesh in recent time before starting the research work. Finally, decision was taken to make a field survey upon the consumers of LPG in Dhaka city about the knowledge of proper use, maintenance and consciousness. A questionnaire enriched of various questions is made. This questionnaire was designed for the domestic and hotel-restaurant users of LPG. Questionnaire is one of the best techniques for data collection if it can be properly and accurately designed [14]. Interview of total 250 users, among them 50 users for each location were conducted. Among 50 users, 35 are domestic consumers and 15 are hotel-restaurant users for each location. According to the questionnaire several questions were asked to them. Sometimes random questions which are not in the questionnaire were asked to them. Their simple answer of YES or No helped to complete this study.

## 4.3. Risk of the survey

The authors faced several problems during the survey work. Some consumers of the area like Kamrangir Char, Dakshinkhan and Mirpur were disturbed due to the interview. They could not take the questions normally as they thought it could make problems to them. Some consumers did not agree to give any interview. When picture was going to be captured of some scenery, they forbid to do that. Beside natural problem like rain was very problematic for this survey work.

## 5. Results and discussions

The result of the study is made by calculation of positive and negative responses of the consumers and also based on some standards of LPG using. This section presents the safety knowledge of the consumers about LPG using.

### 5.1. Leakage Check before connection and disconnection of LPG cylinder

LPG cylinder connection and disconnection properly is very much important as several accidents can occur from the lack of this knowledge. Now a day, gas cylinder accident is increasing in Dhaka city due to proper knowledge. In Dakshinkhan and Sector-4, Uttara, most of the domestic users (60% and 90%) connect and disconnect their cylinder by their Caretaker where as in Kamrangir Char, this proportion is very low (Figure 3). People connect and disconnect gas cylinder by themselves in restaurant.

The level of awareness about leakage check before connections/disconnections of regulator/tube is remarkably low in Kamrangir Char (6%) (Figure 4). More than 80% domestic consumers are not conscious about leakage check before connecting/disconnecting of regulator. Restaurant consumers of Mirpur are mostly unaware (93%) of leakage check before connection/disconnection of LPG among the study area.

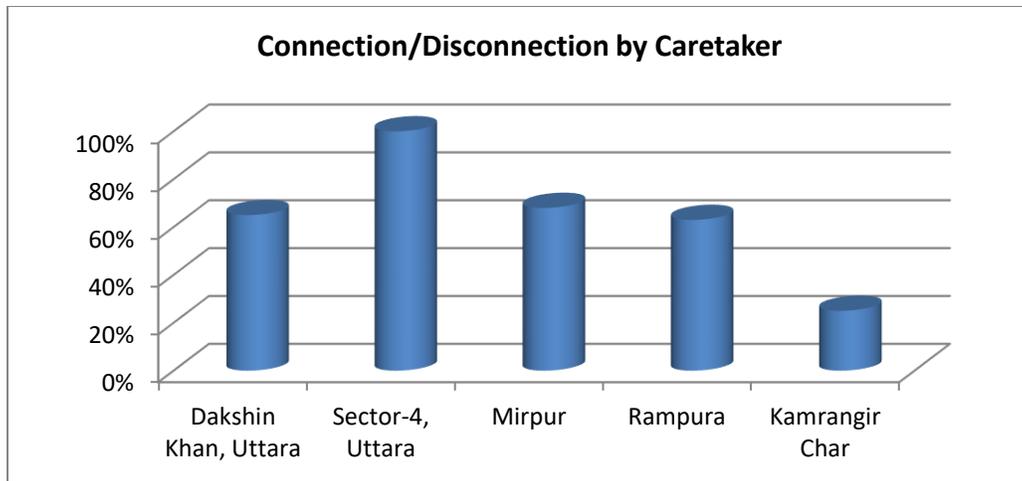


Figure 3. People who connects/disconnects LPG cylinder



Figure 4. Regulator/Tube leakage checking before connecting LPG cylinder

### 5.2. Safety knowledge during connecting full cylinder of LPG

LPG cylinder has bad impact if it cannot maintain properly. Several problems may occur during connection a full cylinder. This study found a lake of knowledge about LPG cylinder in domestic and Hotel/Restaurant uses. Table 1 shows the summary of safety knowledge about LPG using before connecting and disconnecting cylinder for the study areas.

Before connecting a full LPG cylinder, regulator checking is very essential. Several accidents may occur only from this unconsciousness. This study found that maximum correspondents like to check the regulator on/off before connecting cylinder for all study areas. Checking the stove switch on/off is very crucial for LPG using. If the stove is on position, the gas will emit form the stove and danger may occur during lighting.

The users agreed that sometimes they faced problems during connecting/disconnecting a cylinder (Figure 5, Figure 6.) Gas leakage happened to them when they tried to connect cylinder. The regulator sometimes causes the leakage as they told. They can realize the gas coming out by sound.

Table 1. Safety knowledge on connecting/disconnecting LPG cylinder

Questions to the consumers	Location	Domestic (35 persons)		Hotel/Restaurant (15 persons)	
		Yes	No	Yes	No
Do you check leakage of Regulator/Tube/Tube Joint after connecting full cylinder?	Dakshinkhan, Uttara	11 (31%)	24(69%)	6 (40%)	9 (60%)
	Sector-4,Uttara	17 (49%)	18 (51%)	7 (47%)	8 (53%)
	Mirpur	13 (37%)	22 (63%)	6 (40%)	9 (60%)
	Rampura	10 (29%)	25 (71%)	5 (33%)	10 (67%)
	Kamrangir Char	9 (26%)	26 (76%)	3 (20%)	12 (80%)
Do you check the regulator is on/off before connecting a cylinder?	Dakshinkhan, Uttara	21 (60%)	14 (40%)	7 (47%)	8 (53%)
	Sector-4,Uttara	25 (71%)	8 (29%)	11 (73%)	4 (27%)
	Mirpur	22 (63%)	13 (37%)	8 (53%)	7 (47%)
	Rampura	23 (66%)	12 (36%)	9 (60%)	6 (40%)
	Kamrangir Char	19 (54%)	16 (46%)	8 (53%)	7 (47%)
Do you check the regulator is on/off before disconnecting a cylinder?	Dakshinkhan, Uttara	12 (34%)	23 (66%)	7 (47%)	8 (53%)
	Sector-4,Uttara	14 (40%)	21 (60%)	6 (40%)	9 (60%)
	Mirpur	11 (31%)	24 (69%)	5 (33%)	10 (67%)
	Rampura	13 (37%)	22 (63%)	6 (40%)	9 (60%)
	Kamrangir Char	9 (26%)	26 (74%)	5 (33%)	10 (67%)
Do you check the valve of stove is off/on before connecting a cylinder?	Dakshinkhan, Uttara	19 (54%)	16 (46%)	9 (60%)	6 (40%)
	Sector-4,Uttara	23 (66%)	12 (36%)	11 (73%)	4 (27%)
	Mirpur	20 (57%)	15 (43%)	8 (53%)	7 (47%)
	Rampura	21 (60%)	14 (40%)	11 (73%)	4 (27%)
	Kamrangir Char	18 (51%)	17 (49%)	9 (60%)	6 (40%)

Problems during connecting/disconnecting LPG cylinder (Domestic)

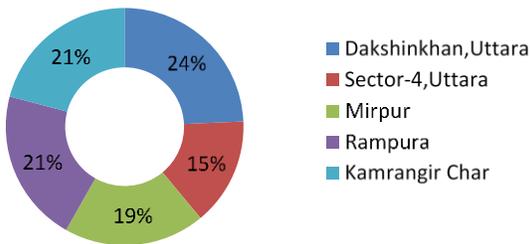


Figure 5. Problems faced during connecting/disconnecting LPG Cylinder (Domestic)

Problems during connecting/disconnecting LPG cylinder (Hotel/Restaurant)

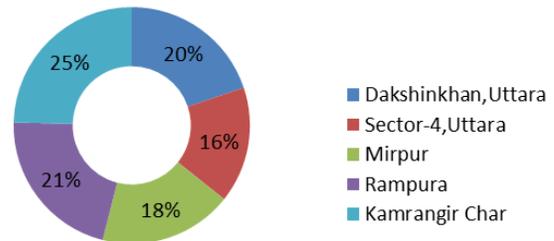


Figure 6. Problems faced during connecting/disconnecting LPG Cylinder (Hotel/Restaurant)

### 5.3. Safety knowledge about lighting gas stove

Lighting is a big risk when needs to cook or any necessity in gas stove. In this survey, it is found that most of the domestic consumers (29) use automatic gas stove in Sector-4, Uttara. Maximum domestic LPG users in Kamrangir Char area feel comfort to use manual gas stove in the kitchen. The total number of manual and automatic stoves user are shown in Table 2.

Table 2. Gas Stove types in the study area

Area	Domestic		Hotel/Restaurant	
	Automatic Stove	Manual Stove	Automatic Stove	Manual Stove
Dokshin Khan, Uttara	14	21	6	9
Kamrangir Char	13	22	5	10
Mirpur	18	17	8	7
Sector 4, Uttara,	29	6	11	4
Rampura	13	22	7	8

The consumers faced of safety related question about lighting their stove. They were asked to give simple yes or no answer based on the question "Do you strike the match first and switch on the stove? Do you switch on the stove first and then strike match?" The answer is collected from the manual gas stove users for both domestic and hotel users. The responses of the consumers are shown in Figure 7 and Figure 8. The best practice is to strike the match first and then knob the gas appliance [15]. If male practice like knob the stove first and then strike match, accidents may occur. Anyhow if the gas leakage happens and the consumers cannot understand, fire accident might be occurred.

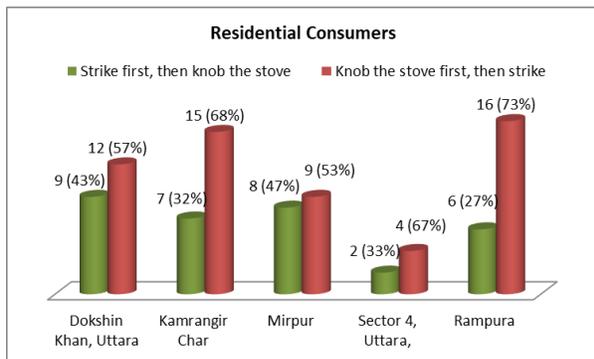


Figure 7. Safety knowledge on lighting gas stove (residential consumers)

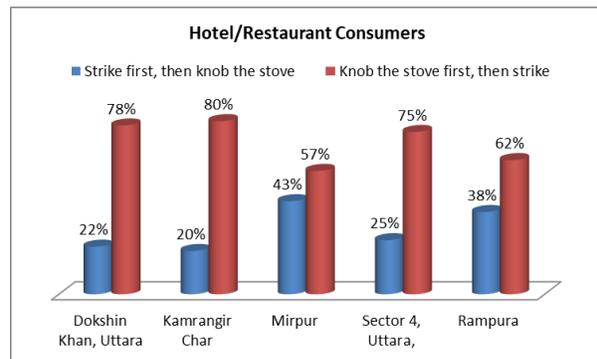


Figure 8. Safety knowledge on lighting gas stove (hotel/restaurant consumers)

When the consumers knob first and strike match, they faced several problems. The main problem is sudden fire with sound. Other problems are match stick broken and thus gas loss, fire heat on hand and such others (Table 3).

Table 3. Problems due to stove first than strike match/lighter

Event	Problems
Knob the stove first and then strike the match/lighter	High rise sudden fire with sound
	Gas loss
	Fire heat on hand
	Lighter blast

LPG cylinder users of 26% from Dakshinkhan, 20% from Kamrangir Char, 23% from Mirpur and 24% from Rampura agreed that they faced several problems when they strike the match/Lighter after the stove switch on.

### 5.4. Knowledge about exhaust fan/ventilation

Ventilation is the process of air control. In kitchen, ventilator is very much essential as air in the kitchen becomes warmer when cooking. It needs to replace the warmer air to normal air. Besides it is mandatory for passing toxic gas like LPG cylinder gas from the kitchen or living room. Exhaust fan is one type of booster fan that passes the inside air into outside. Using exhaust fan in the kitchen is the easiest thing anyone can do to improve their indoor air quality [16].

It is essential to open the window of the kitchen before lighting the gas appliances as leakage gas may store in the kitchen or adjacent room which may cause severe accident. So stored leakage gas can exits from the kitchen when the exhaust fan is switched on or ventilation door is open before lighting the stoves. This study reports that only 29% residential consumers switch on the exhaust fan or open window before lighting gas appliance in Kamrangir Char (Figure 9).

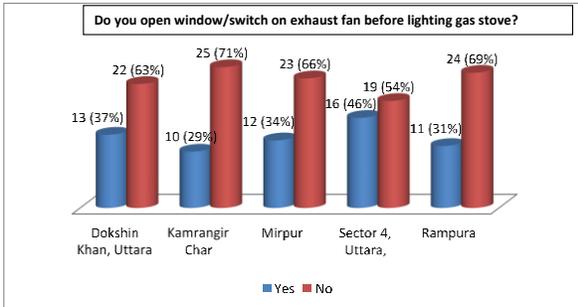


Figure 9. Safety knowledge on exhaust fan/ventilation window (Domestic users)

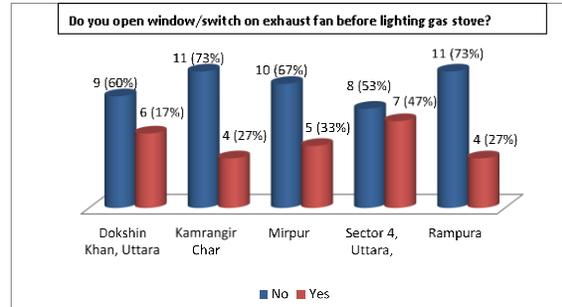
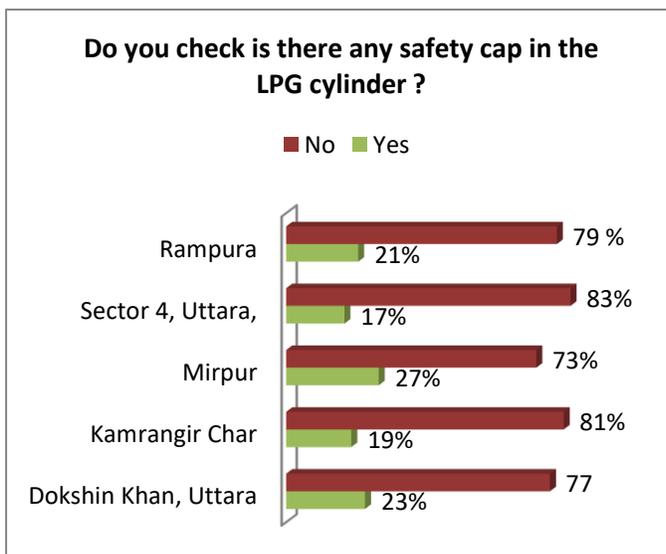


Figure 10. Safety knowledge on exhaust fan/ventilation window (Hotel/Restaurant users)

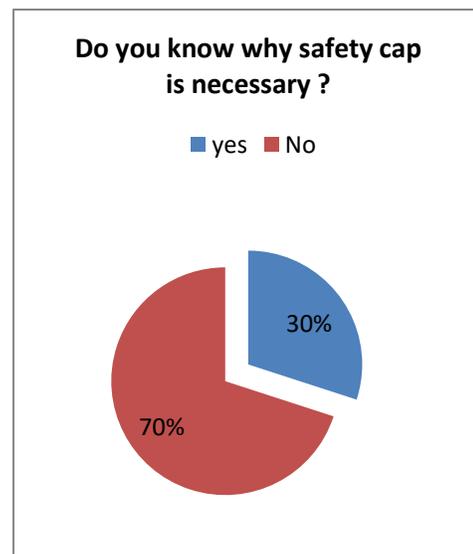
The consciousness of the LPG users in hotel is not so satisfactory. Most of the users do not maintain the safety rules during lighting the gas appliances. They are not properly careful of ventilation system of kitchen (Figure 10). More than 60% of the restaurant users do not check whether the window is open or closed, or the exhaust fan is on/off before lightening.

### 5.5. Knowledge about safety cap

Safety cap is an important component of LPG cylinder. Generally, it is made of high grade plastic. It is used for confining gas in the cylinder. It is helpful for gas firing hazard protection. If gas leakage occurs from the valve, putting safety cap right way will prevent leakage [17]. Most of the users do not use safety cap in their LPG cylinder. The surprising matter is that they have very poor idea about the necessity of safety cap. Larger portion of both residential and hotel consumers do not check whether any safety cap prevails in the cylinder or not (Figure 11). More than 70% hotel and restaurant users of the study area do not check safety cap. Besides those who check the safety cap, 85% do not use the cap when it is necessary. Why safety cap necessity is not clear to the maximum of the consumers (Figure 11).



(a)



(b)

Figure 11. Knowledge on use of Safety cap (a) Domestic (b) in total

### 5.6. Leak detection and leak hazards

Leak detection systems finding out of the LPG users was one of the major reasons of the study. Most of the accidents in Bangladesh from LPG cylinder occur due to unable of leak detection. The people of the study area believe that gas leakage is dangerous for life but they have no clear idea of gas leak detection method. Some people have absolutely wrong idea about gas detection system. Almost 93% (162 of 175) LPG cylinder gas users of residential area agreed that gas leakage is dangerous and fire hazard may occur from the leakage. 85% hotel and restaurant consumers also know that gas leakage is harmful and accident may occur from this leakage. But this study found that very low percentage (14%) of the users check the leakage in domestic kitchen and only 15% in the hotel/restaurant kitchen. Table 4 represents the gas leakage knowledge of the LPG users.

Table 4. Safety knowledge on gas leakage of LPG users

Question	Location	Domestic (35 users/location)		Hotel/restaurant (15 users/ location)	
		Yes	No	Yes	No
Do you think gas leakage is dangerous?	Dokshin Khan, Uttara	31 (89%)	4 (11%)	12 (80%)	3 (10%)
	Kamrangir Char	34 (97%)	1 (3%)	13 (81%)	2 (9%)
	Mirpur	32 (91%)	3 (9%)	14 (93%)	1 (7%)
	Sector 4, Uttara, Rampura	33 (94%)	2 (7%)	12 (80%)	3 (10%)
	<b>Total =</b>	<b>93%</b>	<b>7%</b>	<b>85%</b>	<b>15%</b>
Have you ever checked for gas leak?	Dokshin Khan, Uttara	5 (14%)	30 (86%)	3 (20%)	12 (80%)
	Kamrangir Char	2 (6%)	33 (94%)	2 (13%)	13 (87%)
	Mirpur	6 (17%)	29 (83%)	1 (7%)	14 (86%)
	Sector 4, Uttara, Rampura	7 (20%)	28 (80%)	3 (20%)	12 (88%)
	<b>Total =</b>	<b>14%</b>	<b>86%</b>	<b>15%</b>	<b>85%</b>

The regulator and rubber tube should be checked before lighting a gas appliance. If any leak remains in the rubber tube, fire hazard may occur during lighting. They have very little idea about the gas leakage detection technique. Most of them applied matchstick ignition to check the leakage which is absolutely wrong. Out of the 250 consumers, only 17% apply soap solution to find out gas leak. Figure 12 shows how the LPG users test gas leak in regulator, tube and tube joint.

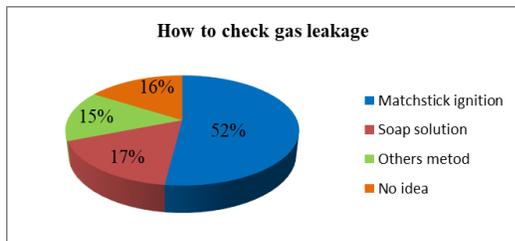


Figure 12. Gas leak detection method LPG users in regulator, tube and tube joint

The best practice for gas leak detection is applying Soap solution as it has no risk to check and if leakage occurs, bubble of soap creates from the leak place [18].

### 5.7. Knowledge about gas detector equipment

LPG is odorless and ethyl mercaptan is added for odor, so that LPG leakage can be easily detected [19]. Gas detector detects the gas when it exceeds a certain limit and makes sound of alarm to aware the consumers about gas leakage.

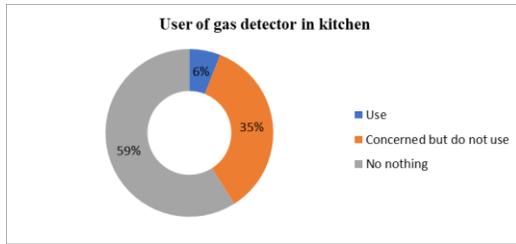


Figure 13. Knowledge about gas detector

Several types of gas detector are used in both industry and resident for safety purposes. But this study shows a negligible percentage (6%) of both domestic and restaurant use gas detector in their kitchen. The people even have very poor idea about the leak gas detector. They even do not know this type of detector is available in the market.

**5.8. Knowledge about fire protection equipment**

Fire extinguisher is a fire protection device. Now a day it is popular in several offices, hospitals, markets, shopping malls, electric substation and such others. This research finds out that most of the LPG consumers are not concerned about the fire extinguisher though in Sector-4, the maximum users use fire extinguisher (Table 5).

Table 5. Fire protection equipment knowledge of the LPG cylinder users in Dhaka city

Equipment	Location	Domestic (35)		Hotel/Restaurant (15)		Total users (kitchen)
		Yes	No	Yes	No	
Fire extinguisher	Dokshin Khan, Uttara	9	4	22	6	20%
	Kamrangir Char	3	3	29	4	14%
	Mirpur	6	5	24	5	20%
	Sector 4, Uttara	20	9	06	9	<b>36%</b>
	Rampura	7	4	24	7	22%

**5.9. Knowledge about rubber tube and regulator change**

The rubber tube and regulator should be checked regularly as their leakage and fracture may cause vital accidents. The regulator should be changed after 5 years normally [20] and rubber tube should be changed after 2 years [21].

65% respondents of all the area agreed that they change the rubber tube and regulator when any defect is detected. Only 20% of the respondents have proper safety knowledge about changing rubber tube and regulator. They change the tube and regulator between 1.5- 2 years.

**5.10. Knowledge about expiry date of LPG cylinder**

LPG cylinder manufacturing date is important. It should be checked before purchasing a gas cylinder. Most of the respondents, more than 80% do not check expire date of LPG gas. Besides more than 70% (among who do not check) do not understand the meaning of expiration date or may not find expire date (Figure 14). Table 6 describes expire date knowledge of the LPG users.

Table 6. Knowledge about LPG cylinder gas expire date

Question	Area	Domestic		Hotel/Restaurant	
		Yes	No	Yes	No
Do you check the date expire of cylinder?	Dokshin Khan, Uttara	5 (14%)	30 (86%)	2 (13%)	13 (87%)
	Kamrangir Char	4 (11%)	31 (89%)	3 (20%)	12 (88%)
	Mirpur	8 (23%)	27 (77%)	4 (26%)	11 (89%)
	Sector 4, Uttara	5 (14%)	30 (86%)	4 (26%)	11 (89%)
	Rampura	4 (11%)	31 (89%)	3 (20%)	12 (88%)

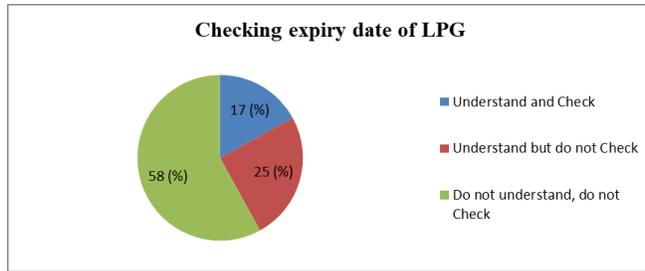


Figure 14. Safety knowledge on LPG expiry date

### 5.11. Other safety related issues

This research also investigates some other safety related issues. Almost 95% respondents agreed that they check company seal or company name of the LPG. Very few (5%) responded that they cannot check the company seal or company name because sometimes they contact with the LPG sell center over the phone and they connect the cylinder in the basement. The distance between the LPG cylinder and gas stove should be at least 1-1.5 meter. Most of the LPG users (more than 95%) keep that distance for their safety. Maximum respondents of Uttara area do not keep the cylinder inside the kitchen.

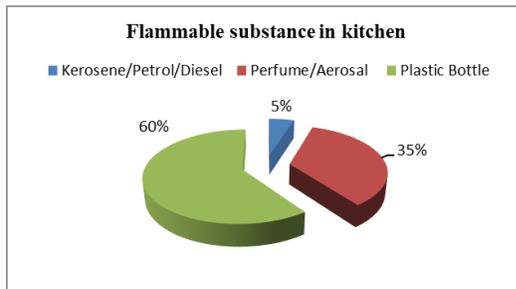


Figure 15. Safety knowledge on flammable substances in kitchen

Rather than kitchen, they keep it into basement. Keeping flammable substance like petrol, kerosene, diesel and such as is very harmful. It may cause dangerous accident. This study found that maximum correspondents do not keep diesel, petrol or kerosene. But almost every users of the five study area agreed that there are a lot of plastic bottles in their kitchen. Plastic bottle near the gas stove may causes accident. Figure 15 shows the safety knowledge on flammable substance in kitchen.

All most all the people keep their cylinder in vertical position. Horizontal position of gas cylinder is very risky. Other safety related issues are described in Table 7.

Table 7. Others safety related issues

Question	Location	Domestic		Hotel/Restaurant	
		Yes	No	Yes	No
Have your cylinder get sun shine/rain/heat?	Dokshin Khan, Uttara	11 (31%)	24 (69%)	9 (60%)	6 (40%)
	Kamrangir Char	13 (37%)	22 (63%)	9 (60%)	6 (40%)
	Mirpur	9 (26%)	26 (74%)	5 (33%)	10 (67%)
	Sector 4, Uttara	6 (17%)	29 (71%)	4 (27%)	11 (73%)
	Rampura	14 (40%)	21 (79%)	6 (40%)	9 (60%)
Do you ever shake your cylinder for residue gas after you understand gas is finished?	Dokshin Khan, Uttara	0	100%	0	100%
	Kamrangir Char	0	100%	0	100%
	Mirpur	0	100%	0	100%
	Sector 4, Uttara	0	100%	0	100%
	Rampura	0	100%	0	100%
Dokshin Khan, Uttara	0	100%	0	100%	

Question	Location	Domestic	Hotel/Restaurant
Do you use any box for put the cylinder into it?	Kamrangir Char	0	100%
	Mirpur	0	100%
	Sector 4, Uttara	0	100%
	Rampura	0	100%

### 5.12. Training of the LPG users

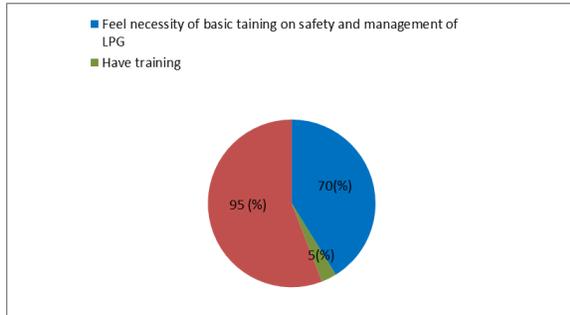


Figure 16. Training of the LPG users

The LPG cylinder users should take some fundamental training on safety of using LPG and management systems. If the users know the basic safety knowledge, accident will reduce. This research investigated that almost 70% correspondents want basic training on LPG safety where as more than 95% do not have any training.

## 6. Conclusions and recommendations

Safety and precautions are very much essential before and during any job which has risk of injury. The number of LPG consumers in Dhaka city is rising day by day. Accidental events are noticed to be increased due to lack of safety knowledge and proper maintenance of LPG cylinder and its appliances. This study found that most of the residential and hotel/restaurant consumers of Dhaka city are not aware of safety management and risk analysis. They have not received any basic training on LPG risk assessment and safety knowledge. The users are not properly aware of gas cylinder leakage and safety cap. Very small portion of the respondents for this study replied positively about gas regulator checking, changing, expire date checking and right procedure for gas stove lighting and gas leakage checking. If the users are not taken under proper training very soon, accidents due to LPG using will be one of the main headaches in Dhaka city. Some recommendations based on this research work are listed as follows:

- i. Large scale survey should to be carried out for more information.
- ii. Basic training should be provided to the LPG users by Government and Non-Government organizations.
- iii. The care taker of the house should be also taken under training on safety management of LPG cylinder using.
- iv. Fire extinguishers have to be kept in the kitchen or near to kitchen.
- v. Finally, Awareness has to be created among the LPG consumers.

### Appendix-1

No.	Questions	Yes	No
1.	Who Connects/Disconnects LPG Cylinder		
2.	Do you Check leak of regulator/Tube/Tube joint before connecting full cylinder?		
3.	Do you Check leak of regulator/Tube/Tube joint after connecting full cylinder?		
4.	Do you know how to check leak?		
5.	Do you check the regulator is on/off before connecting a cylinder?		
6.	Do you check the regulator is on/off before disconnecting a cylinder?		
7.	Do you check the valve of stove is off/on before connecting a cylinder?		
8.	Have you any problem during connecting/ disconnecting a cylinder?		
9.	Do you open the window/ switch on exhaust fan before lighting the stoves?		

No.	Questions	Yes	No
10.	Do you strike match/light first and then knob the stove?		
11.	Do you knob the stove first and then strike match/light?		
12.	Have you any problem during lighting stove?		
13.	Do you check is there any safety cap in the cylinder?		
14.	Do you use the safety cap?		
15.	Do you know why safety cap is necessary?		
16.	Do you think gas leakage is dangerous?		
17.	Have you checked your rubber tube before this interview?		
18.	Have you ever checked for gas leak?		
19.	Do you check ruber tube/regulator before lighting?		
20.	Do you know how to check leak after connecting a cylinder?		
21.	Which method you applied for checking leak after connection?		
22.	Have you any problem during check?		
23.	What do you do if you get smell of gas?/understand the gas leakage?		
24.	Do you have any gas detector equipment in your kitchen?		
25.	Do you have any fire protection equipment in the kitchen?		
26.	Do you feel any necessity to change the rubber tube and regulator?		
27.	How often you change the tube and regulator?		
28.	Why you need to change the rubber tube and regulator?		
29.	Do you check the date expire of cylinder?		
30.	Do you check the cylinder has a company seal?		
31.	Is your stove is higher positioned than your cylinder?		
32.	Do you know the minimum distance between cylinder and stoves?		
33.	How distance you keep between the cylinder and stoves?		
34.	Du you have petrol/kerosene/flammable equipment in the kitchen?		
35.	Ventilation is top level than stove/cylinder?		
36.	Do you check your valve when cylinder is not used?		
37.	Do you know where cylinder should be kept?		
38.	Where do you place your cylinder? Inside of kitchen? Outside of kitchen?		
39.	Have your cylinder get sun shine/rain/ heat?		
40.	Cylinder position is vertical/horizontal?		
41.	Do you think cylinder give more pressure if you put it horizontally?		
42.	Do you ever shake your cylinder for residue gas after you understand gas is finished?		
43.	Do you use any box for put the cylinder into it?		
44.	Do you open window/switch on exhaust fan before cooking?		
45.	Is your window of kitchen kept closed / open during cooking?		
46.	Do you feel any training needs on safety about LPG uses?		
47.	Do you have any training on safety related or risk management on LPG?		

## References

- [1]. Bediako BE, Amarin R, Aworte S K. Safety Knowledge of Domestic Liquefied Petroleum Gas (LPG) Users in GHANA – A CASE STUDY. *Petroleum and Coal*, 2017. *Pet Coal* (2017); 59(1): 54-61
- [2]. Broni-Bediako E and Dankwa KO. Assessment of Liquefied Petroleum Gas (LPG) Utilisation in Ghana, A Study at Tarkwa, *International Journal Scientific of and Technology Research*, 2013; 2(9): 6-10
- [3]. Mustafa KF and Gitano-Briggs HW. Effect of Variation in Liquefied Petroleum Gas (LPG) Proportions in Spark Ignition Engine Emissions. *International Conference on Environment, Penang*, (2008), Malaysia, pp. 1-7
- [4]. Amarin R, Bediako EB, Worlanyo D, Konadu SA. The Use of Liquefied Petroleum Gas (LPG) as a Fuel for Commercial Vehicles in Ghana: A Case Study at Tema Community 1. *Current Journal of Applied Science and Technology*, 2018; 29(2): 1-8.
- [5]. Dorosz P, Wojcieszak P, Malecha Z. Exergetic analysis, optimization and comparison of LNG cold exergy recovery systems for transportation. *Entropy*, 2018; 20(59):1-18.
- [6]. Liu E, Yue SY, Lee JA. Study on LPG as a fuel for vehicles. *Research and Library Services Division, Hong Kong*, 1997; 30.

- [7]. EB Report, 2017. Gas Cylinders Blast: Deaths Continues, Energy Bangla, 16 February 2017. Available at <http://energybangla.com/gas-cylinders-blust-deaths-continues/> (Accessed 17 August 2019).
- [8]. Bhattacharjee G, Neogi S, Das SK. Safety Knowledge of LPG Auto Drivers and LPG Tank Drivers, Open Journal of Safety Science and Technology, 2011; 1: 101-107.
- [9]. Ray PS and Bishop PA. Can Training Alone Ensure a Safe Workplace? Professional Safety, 1995: 56-59.
- [10]. Tyler D. Guidelines for good safety practices in the LPG industry, world LPG Association (WLPGA), United Nations Environment Programme (UNEP). 2015; 64
- [11]. Dhaka Population, 2019. World Population Review, 12 July 2019. Available at <http://worldpopulationreview.com/world-cities/dhaka-population/> (Accessed 17 August 2019).
- [12]. Dhaka, Bangladesh latitude longitude, 2015. Latitude Longitude, 2015. Available at <https://latitudelongitude.org/bd/dhaka/> (Accessed 17 August 2019).
- [13] Yin RK. Case Study Research: Design and Methods. Sage Publications, Thousand Oaks, California, (2008), 240 pp.
- [14]. Best JW, and Kahn JV. Research in Education. Allyn and Bacon Publishers, Boston, (1993), pp. 112 - 117.
- [15]. Mithalagas 2017. LPG Safety Tips. MITHALA GAS AGENCY, 2017. Available at <http://mithalagas.com/l-p-g-safety-tips/> (Accessed 6 August, 2019).
- [16]. Bailes A. 2018. The 2 Main Problems With Kitchen Ventilation. energy vanguard, 4 September 2018. Available at <https://www.energyvanguard.com/blog/2-main-problems-kitchen-ventilation> (accessed 6 August, 2019).
- [17]. User Manual, 2017. Bashundhara LP GAS Limited. Available at <http://www.bashundharalp-gas.com/user-manual> (Accessed 6 August 2019).
- [18] Sayed DAAHE. 2014. Gas Leak Detection. hsmemagazine, 18 December, 2014. Available at <https://www.hsmemagazine.com/article/gas-leak-detection-1115> (Accessed 8 August, 2019).
- [19]. Supergas, 2019. LPG Leak Detector for Home, 2019. Available at: <https://www.supergas.com/lpg-for-Home/lpg-leak-detector> (Accessed 8 August 2019).
- [20]. Mymesra, 2010. Safety Tips. Gas Petronas, 2010. Available at: [https://www.mymesra.com.my/Gas\\_PETRONAS-@-Safety\\_Tips.aspx](https://www.mymesra.com.my/Gas_PETRONAS-@-Safety_Tips.aspx) (accessed 8 August 2019).
- [21]. HPCL, 2014. Safety Tips for Consumer. Hindustan Petroleum Corporation Limited, 2014. Available at: <https://www.hindustanpetroleum.com/LPGSafetyTips> (Accessed 8 August 2019).

---

*To whom correspondence should be addressed: Md. Sumon Chowdhury, Department of Petroleum and Mineral Resources Engineering, Bangladesh University of Engineering and Technology, BUET, Dhaka-1000, Bangladesh, E-mail: [sumonpme12@gmail.com](mailto:sumonpme12@gmail.com)*