PEOPLE: International Journal of Social Sciences
ISSN 2454-5899

Akram & Alam, 2019

Volume 5 Issue 1, pp. 228-241

Date of Publication: 28th March 2019

DOI-https://dx.doi.org/10.20319/pijss.2019.51.228241

This paper can be cited as: Akram, W. & Alam, M. T., (2019). Households' Willingness to Pay for Improved Drinking Water -A Case Study on Khulna City Corporation Using Discrete Choice Model. PEOPLE: International Journal of Social Sciences, 5(1), 228-241.

HOUSEHOLDS' WILLINGNESS TO PAY FOR IMPROVED DRINKING WATER- A CASE STUDY ON KHULNA CITY CORPORATION USING DISCRETE CHOICE MODEL

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Abstract

The purpose of the study is to find out the willingness to pay for improved drinking water services using Discrete Choice Model (DCM). To carry out the study, concept profiling has been done and data have been collected randomly from 120 households from two areas, Basupara and Najirghat of Ward-26 of KCC. Multinomial Logit Model (MLM) has been taken to into consideration to see relative willingness to pay (WTP) for accessing improved drinking water services being in status quo position. The study explores that, people who have the willingness to pay BDT 450 are 9.67 times higher than the willingness to pay BDT 250. On the other hand, people who have the willingness to pay BDT 600 are about 2.38 times more likely to choose Alternative-2 option than those who have the willingness to pay BDT 250.

Keywords

Choice Experiment, Willingness to Pay (WTP), Drinking Water, Multinomial Logit Model (MLM)

1. Introduction

Safe drinking water is a fundamental need for people around the world. The quality of drinking water is closely connected to human health and providing safe drinking water is one of the vital public health priorities. A wide range of water problems are faced by the nations and individuals around the world. The assessment published in 2000 by the World Health Organization (WHO), 1.1 billion people around the world lacking from having access to improved water supply. About 80% of all diseases and over one third of deaths in developing countries are caused by the consumption of contaminated water and even in Bangladesh these types of scenarios is so acute to watch out. As Khulna is located in the southern part of Bangladesh, so there exists acute contaminated drinking water problem in the city. The insufficiency of drinking water has been increasing gradually owing to increasing movement from the surrounding districts for rapid urbanization and industrialization.

Now come to context of Khulna city regarding the affair of pure drinking water. The city is surrounded by lot of industries and it has plenty of importance for its geographical, political, historical and financial reasons. Khulna is one of the densely populated urban areas with 1.5 million people. The people of Khulna City have been suffering from inadequate supply of drinking water. Drinking water supplied by Khulna WASA is not satisfactory in accordance with Bangladesh Drinking Water Quality Standard (BDS) (Fahmida et al., 2013).

2. Literature Review

2.1 Condition of Drinking Water in Khulna City

In Khulna city, scarcity of drinking water is remarkable. To accomplish the crisis of drinkable water, Khulna Water and Sewerage Authority (KWASA) is supplying water to Khulna city dwellers throughout its distribution system.

However, the quality of supplied water is not acceptable. In order to identify such water contamination problems, water samples from different locations of the distribution network were analyzed. Considerable water quality parameters include chloride, arsenic, hardness, BOD_5, pH, color, turbidity, iron, Total Solid (TS), Total Suspended Solid (TSS), Total Dissolved Solid

(TDS), Total Coli form (TC) and Escherichia Coli (EC) were tested. Microbial water quality parameters, TC and EC were found that about 66.67 percent and 100 percent of total sample exceeds allowable limit respectively. Apart from very few cases, other water quality parameters of about all samples satisfy the permissible limits suggested by WHO and BDS guidelines (Fahmida et al., 2013).

ADB (2011) shows one particular classification of groundwater abstraction which reached a total of 98.7 MLD in 2010. It had shown that piped water coverage was 30 percent but excessive increase in city population led to decline in coverage to 20.4 percent (KDA, 2012). ADB's (2013) evaluation was even lower at only 18% (Alam et al., 2009).

Currently there are 17 firms working in Khulna city, all of who claim to be using RO for dealing out underground water. The key researchers interviewed several of the entrepreneurs who come from diverse backgrounds in terms of education and home districts. The operations are usually carried out at normal dwelling or rented premise where water from Deep Tube wells is accessible. Based on the number of firms presently active and city dwellers of 15 lakh people, it is expected that a maximum of 5% households can be covered. However, more than half of production is reported to be delivered to offices and social events (such as, wedding and other parties). Thus, roughly 2% of the city population is likely to be availing jar water (Sajjad et al., 2016).

2.2 Stated Preference Techniques and Related Studies of Pure Drinking Water Service

Stated preference technique assesses the value of non-market goods by using individuals' stated performance in a hypothetical setting. The technique includes a number of different approaches such as Conjoint Analysis, Contingent Valuation Method (CVM) and Discrete Choice Models (DCM). CVM has been the most frequently used approach in most of the applications. The concept of CVM was first suggested by Ciriacy Wantrup (1947) and the first study ever done was in 1961 by Davis (1963). Since then, CVM has turned out to be one of the most commonly used methods for valuation of non-market goods although its use has been questioned. At the same time as CVM was developed, other types of stated preference techniques, such as choice experiment, evolved in both marketing and transport economics as well (Louviere et al., 1993).

2.2.1 Choice Experiment

In a choice experiment, individuals are given a hypothetical setting and asked to choose their preferred alternative among several alternatives in a choice set and they are usually asked to perform a sequence of such choices. Each alternative is described by a number of attributes or characteristics. A monetary value is included as one of the attributes, along with other attributes of importance when describing the profile of the alternatives presented. Thus, when individuals make their choice, they implicitly make trade-offs between the levels of the attributes in the different alternatives presented in a choice set (Louviere et al., 1993).

2.2.2 Related Studies

Kentero Yokishida (1997) explored in his study to carry out an assessment of willingness to pay for improved drinking water using both choice experiments and averting expenditure methods. The averting expenditures method can reveal non-market values based on the actual averting actions of citizens. Choice experiments are based on the choices made by the respondent from a hypothetical choice set. Data were collected from a drop-off survey from the people of Tsukuba and a total of 220 samples were collected. Estimated marginal willingness to pay to lessen chlorine was 23.5 yen for the averting expenditures method and 11.5 yen for choice experiments. Marginal WTP for a 1% reduction in trihalomethane was 28.4 yen for the averting expenditures method and 12.5 yen for choice experiments. The result of this study advised that the averting expenditures may not be a minor bound of willingness to pay when compared with choice experiments.

Another study conducted in Hayatabad Town, Peshawar, Northern Pakistan. The study is completely based on a sample size of 150 randomly selected households. The authors have used the Contingent Valuation Method and applied the Multinomial Logit Model to draw the households' willingness to pay for improved drinking water as well their hazard averting behavior. The study has also explored that willingness to pay for improved drinking water service is significantly determined by households' awareness, educational status, income, etc. The findings of the study explored that the households are willing to pay much higher amount than that of current monthly bills charged by City Development and Municipal Department, Peshawar (Khan et al., 2010).

3. Methodology

3.1 Objective of the Study

The aims of the study are-

- To see the consumers' willingness to pay for having improved drinking water.
- To suggest policy options to government regarding the pure drinking water.

3.2 Study Area

As Khulna city is one of the renowned metropolitan cities in Bangladesh and here we can realize the deficiency of acute pure drinking water among the people. As Khulna is located in the southern part of Bangladesh, so there exists so many contaminated attributes in drinking water. The people of Khulna metropolitan area are considered as the population of the research because many families of this area are fighting against having the access of pure drinking water service. For the study purpose, two regions of Khulna City have been taken in to account and these regions are *Basupara* and *Nagirghat* which is placed into Ward no.26. As we can see the availability of the large number of people exists in these regions where people have an access of drinking water supplied by Khulna WASA. So the author has chosen this Ward no. 26 of Khulna City Corporation to implement the study on the household level for having access of improved drinking water service.

3.3 Survey Design

The table below is the profile that has been depicted through the method of choice experiment regarding pure drinking water service for Khulna city. For each attribute, layers of three attribute levels have been assigned. A monetary value is assigned for each level along with the attributes presented in the table below. Status Quo (current level) is representing the existing presence of attribute in drinking water and second level (Alternative-1) is representing the Bangladesh Drinking Water Quality Standard (BDS) level of presence of attribute in drinking water for which consumers would be ready to pay for availing this level (Alternative-1). And Third level (Alternative-2) depicts the situation of above standard level for which people are interested to pay for availing this level of drinking water service from Khulna WASA.

Table 1: *Profile based on Selected Attributes, Description and Levels*

Attributes	Description	Levels
Color	Improvement in color	i. 166 pt.Co (Current Status) ii. BDS 30 pt. Co (Alternative-1) iii. Above Standard (15 pt.co) (Alternative-2)
Chloride	Reduction rate of chloride (per liter) from supplied water	i. 550 mg/L (Current Status) ii. BDS 250-500 mg/L (Alternative-1) iii. Above Standard 250-300 mg/L (Alternative-2)
Iron	Reduction rate of Iron (per liter) from supplied water	i. 0.31 mg/L (Current Status) ii. BDS .30 mg/L (Alternative-1) iii. Above Standard 0.25 mg/L (Alternative-2)
Pipes	Condition of pipes will be used for water supply	i. Current pipes (Current Status) ii. Current pipes (Alternative-1) iii. Improved pipes (Alternative-2)
Hardness	To lessen hardness	i. 1222.32 mg/L (Current Status) ii. BDS 200-500 mg/L (Alternative-1) iii. Above Standard 250-450 mg/L (Alternative-2)
BOD_5	To lessen BOD_5 level	i. 2.97 mg/L (Current Status) ii. BDS 0.20 mg/L (Alternative-1) iii. Above Standard 0.15 mg/L (Alternative-2)
Total Coli (TC)	To lessen TC level	i. 335 Nos /100 ml (Current Status) ii. BDS 0 nos/100 ml (Alternative-1) iii. Above Standard 0 Nos / 100 ml (Alternative-2)
Escherichia coli (EC)	To lessen EC level	i. 120 Nos /100 ml (Current Status) ii. (BDS 0 nos/100 ml (Alternative -1) iii. Above Standard 0 Nos / 100 ml (Alternative-2)
Cost to you (BDT)	Monthly payment for having improved drinking water with proper treatment	i. 250 (Current Status) ii. 450 (Alternative-1) iii. 600 (Alternative-2)

Source: Authors Own Compilation, 2016

3.4 Model Specification

Mutinomial Logit Model (MLM) model has been used to estimate the mean willingness to pay. To estimate the Multinomial Logit Model (MLM) the author has used maximum likelihood method. Households' willingness to pay for an improved drinking water is expected to be influenced by many factors such as respondents' socio-economic background, their

demographic characteristics, existing conditions of pure drinking water the respondents receive, environmental and health awareness. (Bennet et al., 2001)

3.5 Result and Discussion

Likert scale has been taken into account to investigate the perception of respondents on how improved water quality can alleviate the presence of TC and EC, reduce the presence of Hardness as well, improve the living standard of the people, reduce medical bills and reduce households' cost of water treatment. 35 percent and 60 percent represent the percentage of those who agree strongly and those who agree that betterment of water quality can reduce the presence of TC and EC. And 5 percent of the respondents remain neutral regarding the issue of this betterment of water quality for avoiding the presence of TC and EC. Moreover 0% percent respondents remain disagrees and strongly disagree.

Another issue regarding the betterment of water quality which can reduce the presence of hardness has been positively supported by the respondents. 38 percent and 52 percent represents the percentage of those who agree strongly and those who agree that betterment of water quality can reduce the presence of Hardness. And 7 percent of the total respondents remain neutral in the issue of reducing hardness through the betterment of quality drinking water. Moreover 0 percent of the respondents disagrees and strongly disagrees. Improvement of living standard has been strongly linked to consumption of safe drinking water, respondents indicated that improved drinking water raise the standard of living for the people of *Basupara* region's of Ward No.26, those who agree strongly are 42 percent and those who agree are 53 percent while 5 percent of the total respondents remain neutral and 0 percent of the respondents disagree and strongly disagree.

When any of the households' members fall sick as a result of waterborne diseases such households' income would be used to offset his or her medical bills and this puts a negative effect on the gross household disposable income. 38 percent of the respondents agree strongly and 59 percent agree with the statement, besides this 3 percent of the respondents are remaining at neutral point. 0 percent of the respondents is at the side of disagree and strongly disagree.

In order to consume improved drinking water and avoid the problems of waterborne diseases, households in *Basupara and Nagirghat* regions of Ward No. 26 often resort to some averting behaviors like boiling of water, filtration and purchase of bottled water etc. This often brings some additional costs to the households. So if Khulna WASA supply improved drinking`

water to the households then it will be able to reduce the cost of water treatment. Respondents' perception on this statement indicated that 36 percent of the respondents agree strongly and 64 percent agree. Similarly 0 percent of the respondents remain neutral in this matter. 0 percent and 0 percent of the respondents remain disagree and strongly disagree.

Table 2 below shows that respondents have understood and supported all the statements. Their perception is that the improvement in water quality and service attributes would have a positive effect of improving their overall standard of living.

Table 2: *Respondent's Perception about Improved Drinking Water by Percentage (%)*

Characteristics	**Strongly Agree (%)**	**Agree (%)**	**Neutral (%)**	**Disagree (%)**	**Strongly Disagree (%)**
Reduce the presence of TC and EC	42 (35%)	72 (60%)	5 (5%)	0 (0%)	0 (0%)
Reduce the presence of hardness	46(38%)	66 (55%)	8 (7%)	0 (0%)	0 (0%)
Improve the living standard of the people	50 (42%)	63 (53%)	6 (5%)	0 (0%)	0 (0%)
Reduce the medical bills	46 (38%)	71 (59%)	3 (3%)	0 (0%)	0(0%)
Reduces household's cost of water treatment	44(36%)	74(64%)	0 (0%)	0 (0%)	0 (0%)

Source: Calculation Based on Field Survey, 2016

3.6 Choice Sets (Valuation Tasks)

With the decision problem and potential solution defined and the appropriate frame established, respondents are prepared to be introduced to the choice scenarios. For each choice set, participants were asked to consider the two management options present and select the one they preferred keeping mind the status quo option too (Blamey et al., 2000).

As the study is based on the method of choice experiment and the objective is to see the consumers' maximum willingness to pay for getting improved drinking water service from Khulna WASA. The study reveals (Table 3) that 61 percent of the total respondents have preferred to choose Alternative-1 and also willing to pay BDT 450 to get this service. Similarly 29 percent of the total respondents have preferred to choose Alternative-2 and also willing to pay BDT 600 for availing this service. And 10 percent of the total respondents wanted to be at status quo position and hence they don't want to avail either of the alternatives. So at last it can be denoted that the most preferred option chosen by respondents is Alternative-1.

Table 3: *Choice Set*

Alternative Attributes	**Alternative-1 (BDS Standard)**	**Alternative-2 (Above Standard)**	**Status Quo (Current Situation)**
Color	Color (BDS 30 pt. Co)	Color (15 pt.co)	Color (166 pt.co)
Chloride	Chloride (BDS 250-500 mg/L)	Chloride (250-300 mg/L)	Chloride (550 mg/L)
Iron	Iron (BDS .30 mg/L)	Iron (.25 mg/L)	Iron (.31 mg/L)
Pipes	Current Pipes	Improved Pipes	Current pipes
Hardness	Hardness BDS (200-500 mg/L)	Hardness (250-450 mg/L)	Hardness (1222.32 mg/L
BOD_5	BOD_5 (BDS .20 mg/L)	BOD_5 (.15 mg/L)	BOD_5 (2.97 mg/L)
Total Coli form (TC)	No TC (BDS 0 nos/100 ml)	No TC (0 nos/100 ml)	High TC (335 nos/100 ml)
Escherichia Coli (EC)	No EC (BDS 0 nos/100 ml)	No EC (0 nos/ 100 ml)	High EC (120 nos/100 ml)
Cost to you (Monthly/BDT)	450	600	250

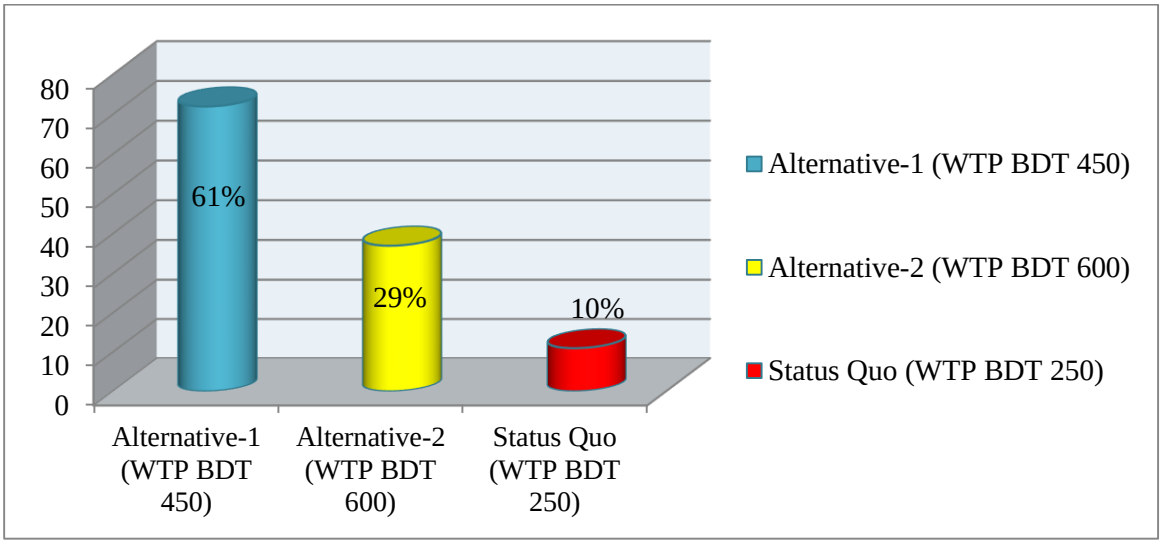
Source: Authors Own Compilation, 2016
Note: 'Pt.co' stands for Platinum Cobalt and 'nos' for Nitric Oxide Sulfuric.

3.7 Preferred Option to the Respondents by Percentage (%) with the Cost (BDT) Associated

As the study is based on the method of choice experiment and the objective is to see the consumers' maximum willingness to pay for getting improved drinking water service from Khulna WASA. Having surveyed to the households in Ward no. 26, it is satisfactory to see that most of the consumers are ready to pay (BDT) more than what they pay right now to consume the water. As we have profiled consumers' willingness to pay for getting improved drinking water in three different categories. First one is about the current amount they pay for the drinking water service that is Status Quo (Current situation) which costs BDT 250 per month, second one is the choice of Alternative-1 which costs BDT 450 to the respondents in every month with the attributes setting through Bangladesh Drinking Water Quality Standard (BDS) standard and another choosing option is Alternative-2 which costs BDT 600 to the respondents in every month whose attributes are related to above standard of BDS. The noticeable thing is that almost every respondent responded positively to give more amount of money to have the access of better

drinking water facilities through choosing Alternative-1 (BDT 450) and Alternative-2 (BDT 600). The figure below depicts the scenario more clearly.

The figure below depicts that 61 percent of the total respondents have preferred to choose Alternative-1 and also willing to pay BDT 450 to get this service. Similarly 29 percent of the total respondents have preferred to choose Alternative 2 and also willing to pay BDT 600 for availing this service. And 10 percent of the total respondents wanted to be at status quo position and hence they don't want to avail either of the alternatives. So at last it can be denoted that the most preferred option chosen by respondents is Alternative-1.



Source: Calculation Based on Field Survey, 2016

Figure 1: *Preferred Options from the Respondent by Percentage (%)*

3.8 Explanatory Variables and their Relevant Significance

Estimated results from bi-variate analysis have been presented in Table below. It is observed that all variables except Gender and Family type are associated with dependent variable (Status quo, Alternative-1 and Alternative-2). As per screening criterion, a variable is a candidate for the multivariate model when its *p*-value <0.30. A relatively high significance level is chosen not to miss any possible variable associated with dependent variable (Status Quo, Alternative-1 and Alternative-2).

Table 4: *Distribution of Explanatory Variables and their Relevant Significance*

Explanatory Variables	Choice sets			P-Value	Comment
	Status Quo	Alt-1	Alt-2		
Sex of HHH^{cat}					Should not be included
Male	10 (9.8%)	62 (60.8%)	30 (29.4%)	0.665	in the model
Female	1(9.5.6%)	10 (55.6%)	7(33.9)		
Family Type^{cat}					Should not be included
Nuclear	10 (9.3%)	64 (59.8%)	33 (30.8%)	0.988	in the model
Joint	1(7.7%)	8 (61.5%)	4 (30.8%)		
Buying water from Store^{cat}					Should be included in the model
No	10 (90.9%)	0 (0%)	1 (9.1%)		
Yes	41 (56.9%)	3 (4.2%)	28 (38.9%)	.048	
Sometimes	26 (70.3%)	4 (10.8%)	7 (18.9%)		
Disease^{cat}					
No	7(9.7%)	33 (45.8%)	32 (44.4%)	.000	Should be included in
Yes	4 (8.3%)	39 (81.2%)	5 (10.4%)		the model
Iron^{cat}				.000	
No	1 (3.7%)	14 (51.9%)	12 (44.4%)		Should be included in
Yes	10 (10.8%)	58 (62.4%)	25 (26.9%)		the model
WTP^{cat}					Should be included in
BDT 250	5 (22.7%)	11 (50%)	6 (27.3%)	.000	the model
BDT 450	5 (6.6%)	57 (75.2%)	14 (18.4%)		
BDT 600	1 (4.5%)	4 (18.2%)	22 (77.3%)		
Educational Status^{cat}					Should be included in
Primary	1 (25.1%)	3 (75%)	0 (0%)		the model
Secondary	3 (7.9%)	19 (50%)	16 (42.1%)	.287	
Higher	3 (10.3%0	21 (72.4%)	5 (17.2%)		
Secondary	4 (8.2%)	29 (59.2%)	16 (32.7%)		
Tertiary					
Income^{con}				0.14	Should be included in the model

Source: Calculation Based on Field Survey, 2016

Note: 'cat' stands for categorical variables 'con' stands for continuous variable

3.6 Multinomial Logit Model Results:

3.6.1 Interpreting Alternative-1 in Respect to Status Quo in Regard to WTP

The odds ratio indicates that households are one time more likely to be in Alternative-1 than that of Status quo for a one unit increase in income. The odds ratio for a one-unit increase in the variable 'Store' who says 'yes' is 24.76 for being in Alternative-1 vs. Status quo. The odds ratio for a one-unit increase in the variable 'who store water sometimes' is 9.07 ($e\beta$= 0.05) for being in Alternative-1 vs. Status quo. This statement is statistically significant at 5% level. The

odds ratio for a one-unit increase in the variable 'WTP' is 9.67 for being in Alternative-1 vs. Status quo. And this is statistically significant at 1% level.

3.6.2 Interpreting Alternative-2 in Respect to Status Quo in Regard to WTP

Odds ratio indicates that households are one time more likely to be in Alternative-2 than that of Status quo for a one unit increase in income. The odds ratio for a one-unit increase in the variable 'WTP' is 2.38 for being in Alternative-2 vs. Status quo. And this is statistically significant at 10% level.

Table 5: *Results from Multinomial Logistic Regression Model for the Effect of Explanatory Variables on Choosing Options (Status Quo, Alternative-1, and Alternative-2)*

Dep Var	**β**	**Odds Ratio**
Status Quo	**Base category**	
Alternative-1	**Choosing Option**	
Income_con	0.00003	1.00
Store		
No	-	-
Yes	12.4192.206**	24.76
Sometimes		9.07
Disease		
No	-	-
Yes	.8122	2.25
Iron		
No	-	-
Yes	-.7867	.455
WTP		
BDT 250	-	-
BDT 450	2.26***	9.67
_cons	1.1327	3.10
Alternative-2	**Choosing Option**	
Income_con	0.00018	1.00
Store		
Yes	12.94	41.88
Sometimes	.6851	1.98
Disease		
No	-	-
Yes	-1.158	.314
Iron		
No	-	-
Yes	-.8521	.426
WTP		
BDT 250	-	-

BDT 600	1.34* 1.324	2.38 5.25
_cons		

Source: Calculation Based on Field survey, 2016

*p<0.1, **p<0.05, *** p<0.01

4. Conclusion

People of Khulna city are under the serious threat due to the scarcity of improved drinking water service. Qualities of water parameters vary from regions to regions within the city areas. Adult people are more sufferers than children and over aged people. Household with handsome earning capacity wants to pay more for getting improved drinking water service. Almost half of the respondents want to pay additional BDT 200 to get the service of Alternative-1 (BDS) in terms of what they pay right now (Status quo). But the distribution of drinking water of Khulna WASA through piped line services contains several problems than they delivery water through containers. So, if Khulna WASA makes a proper treatment of water quality according to Bangladesh Drinking Water Quality Standard (BDS) then it will be helpful for the people to reduce medical cost, reduce the water cost treatment and hence can increase their standard of living. So, the authority should conduct regular monitoring program to prevent possible contamination of water along its distribution.

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