Estimation of Willingness to Pay for Improvements in Drinking Water Quality in Lahore: A Case Study of WASA, Lahore

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2010

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Abstract

This study examines the existing water quality of Lahore and measures domestic household's willingness to pay for improvement in water quality services. To this end, a Tobit model is estimated by conducting a contingent valuation survey about household perceptions in six towns of Lahore.

The results show that the factors affecting household's willingness to pay are coping costs that a household pay for ensuring quality of water also the education level of head of family is an important factor in determining the willingness to pay for improved water services. It is recommended that by ensuring the supply and quality to the household additional revenue of 4.22 million rupees could be earned by the authority.

Background

Lahore is one of the oldest cities in South Asia and is the provincial capital of Punjab. The Lahore district spreads over and area of 1772 square kilometers with a population density of over 3566 persons per thousand square kilometers (govt. of Punjab, 2005). Population wise, Lahore is the second largest city in Pakistan.

The Lahore development authority is the chief municipal body responsible for preparation and implementation of schemes for environmental improvements, housing slum improvement, solid waste management, transportation and traffic, health and education facilities and water supply and sewerage in the city.

The chief water supplier in urban Lahore is WASA. It extends its services to 350kilometers, supplying water and sewerage services to a population of over five million. Other private water suppliers also exist in Lahore city, but there is no official record of their number and coverage. For administrative purposes, the area covered by WASA is divided into six blocks called 'towns': Allama Iqbal town, Aziz Bhatti town, Ravi town, Shalimar town, Gunjbux town and Nishter town. Each town is further is further divided into operation and management sub-divisions.

Lahore is located along the bank of river Ravi mostly relies on the ground water for its water supply. River Ravi being the most polluted in the country and being dried up is now the source of industrial waste .and pollution and is a constant risk to the population residing on the banks of the river.

Water Quality

. According to world health organization estimates in 2002, 118,400 people in Pakistan die of diarrhea diseases (WHO 2004). With a death rate of 79 people per 100,000 it's and alarming situation for Pakistan.

The question of water quality of Lahore is being under debate for a very long time now. Since the chief water supplier of Lahore is WASA so it comes under heavy criticism for not supplying good quality water. WASA's distribution is one of the oldest in the city which lay its roots back to 1975, the year in which WASA was formed. The distribution system that was laid down initially contained iron pipelines for the supply of water. With the passage of time these lines have depreciated beyond repair, now are the main sources of deterioration of water quality in Lahore. Also the sewerage lines running side by side with the water supply line are one of the biggest sources of contamination in the water supply and distribution system. The mixing of waste water pose serious threats to human life if consumed untreated. Although WASA has demolished most of their water tanks in the city and now they directly pump the water from the ground through tube wells in the distribution system but still the water quality deteriorates as it reaches the user end. This is the reason during the monsoons the number of patients increase's in the hospital due to water borne disease which arise from the contamination of sewage water with the drinking water.

Although WASA claims to provide clean drinking water but these claims do not meet the consumer's perceptions about water quality. A WASA consumer is not only dissatisfied from the services but is also using additional measures to keep the drinking water clean. Measures such as boiling, use of small filters and bottled water are much in common. The absence of a proper drinking water policy and an enforcement agency has created an exploitable bottled water market. The loss of confidence and mismanagement of the water system, non effective pricing strategies and many other factors have led this market to flourish.

The objectives of the study are twin fold. First this study aims to take into account the current water quality of Lahore city which falls under the WASA jurisdiction. The current water quality is of importance in this study as it would reveal the actual and the presumed quality by the consumers and is suitable for policy implications. Secondly this study aims to measure the willingness to pay for household for improvement in water quality. This willingness to pay would give an insight to the fact that by improvement in quality how much revenue WASA can generate by ensuring sustainable water supply and quality to its consumers.

Review of Literature

KyeongAe et.al (1996) used the contingent valuation method and travel cost model to estimate the economic value that people place on improving the quality of water of rivers and seas near their community in Davao, Phillipines. The estimates from both the approaches are very close to each other and are quite low, both in absolute terms and household income which shows that water pollution control is not of high priority to the people of Davao and shows and supports the argument that the household willingness to pay for environmental services such as improved water quality is low.

Rogerson (1996) critically analyze the international research concerning the willingness to pay for water. He states that that major of the existing international studies derive form research work either sponsored by or linked to the World Bank or other development agencies. The paper emphasizes the significance of willingness to pay in terms of planning of new water projects.

Rosada (1998) sets up a nested logit model according to the options available to the household for the tap water treatment. He argues that the problems of potable water in urban centers in developing countries can be solved by public or market intervention. In order for an intervention to occur he determines the public's willingness to pay for safe drinking water services.

Luby et al (2001) pilot tested an in expensive, home based water decontamination and storage system in a low income neighborhood of Karachi where fifty households received a twenty litre plastic water storage vessel with a high quality spout and a regular supply of diluted hypochlorite solution. Also twenty five control households were in the pilot test. The results were collected during unannounced follow up visits. The use of low cost intervention decreased the mean concentration of thermo tolerant coli forms by 99.8%. A specific designed water storage container and an in home water chlorination was acceptable and markedly improved water quality.

Mi-Jung Um et. al (2001) states that a historically polluted water supply has created resistance in the public to use tap water in Korea. The public perceive low water quality levels for tap water whereas the measured data shows that the pollution levels to be lower than the acceptable risk. The perception averting method is introduced in which a perception measure unit is added to the conventional averting method.

Raje et .al (2002) study aims at determining the consumer's wtp for improvements in water supply system and identifying the factors affecting wtp. They hypothesized that the satisfaction of consumers about water services, their belief about water management system and the affordability might influence wtp more for water. Logistic regression analysis is used to describe the impact of various factors on wtp.

Brox et. Al (2003) deals with the problem of item non response in contingent valuation surveys by applying a grouped data sample selection estimation technique that is capable of imputing the missing values which are conditional upon a respondent's decision to answer a wtp question. The advantage of using this technique is its ability to utilize all of the information in the sample permitting a more efficient estimation in the presence of item non response bias. The authors also look at the key determinants off wtp which appear to b household income, number of children, education, perceptions about water quality and environmental issues.

Whitehead (2003) argues that the contingent valuation studies include measures of quality perceptions as covariates in the willingness to pay model to avoid omitted variable bias. He argues that the quality perceptions vary across respondents are endogenous variables. Endogeneity bias is addressed by using instrumental variable approach in which quality perceptions are included as a determinant of willingness to pay and is simultaneously determined by exogenous factors.

Hensher (2004) states that customers in many countries face changing water levels such as shortage of water supply linked to possible climate change and limited catchments capacity. The need to assess the value and benefits to society of varying service levels and prices is an effort to secure the provision of and disposal of water has risen on public agendas. A series of stated choice experiments and mixed logit models are used to establish the wtp to avoid interruptions in water service and overflows of wastewater, differentiated by frequency timing and duration of these events.

Markandiya (2004) addresses different issues of water quality in developing countries like the targets to be achieved in the millennium development goals, household without access to safe water, environmental health risks and valuing the disability adjusted life years in developing countries. Also states that unsafe water is responsible for thirteen times more DALY as compare to urban air pollution. Also focuses on different case studies in his paper which led to the improvement of water quality. The most noticeable is the clean up of Ganges in India. This is the single largest attempt to improve the water quality of the river.

Atezaz and Sattar (2007) states in their paper that the demand for environmental goods is often low in developing countries. The factors which contribute to this low demand are awareness regarding the contamination of water and poverty. A household survey from Hyderabad city was used to estimate the contribution of awareness and income of households' water purification behavior. The study finds that the different level of schooling of decision makers and household heads and their exposure to media have significant effects in home purification methods for drinking water.

Khan and Yasir (2007) discuss the current situation of water and sanitation sector in Pakistan. They state that most of the households in Pakistan do not have access to safe drinking water and lack adequate sanitation systems. Approximately 38.5 million people lacked access to safe drinking water and approximately 50.7 million people lacked access to improved sanitation in Pakistan. If the same trend continues by year 2015 almost 52.8million people will be deprived of safe drinking water and 43.2 million people will have no access to adequate sanitation facilities in Pakistan. The study investigates that even if we reach the national or regional targets how many people would still be deprived of these basic necessities.

Methodology

The study aims to check the existing quality of the water being provided to the household and to find the households perceptions and willingness to pay about improvement in drinking water quality. Drinking water, as referred to in the Policy[1], means that the water used for domestic purposes including drinking, cooking, hygiene and other domestic uses.

The term "safe water" refers to the water complying with National Drinking Water Quality Standards.

"Access" means that at least 45 and 120 liter per capita per day water is available for rural and urban areas, respectively, and that the total time required for reaching the public water source (where applicable), collecting water and returning to home is not more than 30 minutes.

Water Quality

To find willingness to pay for the household for improvement in quality the existing quality of water being supplied by the WASA is checked to verify the perceptions about quality. Whether the quality is really deteriorating or is it just the loss of confidence on the part of organization that they are inefficient to provide the water of a good quality. For this purpose the respondents household quality iis checked in the laboratory and the water would be considered fit if it falls under the

[1] National Drinking Water Policy 2007

guidelines of world health organization. WASA claims to provide quality assured water in its official jurisdiction.

There are two basic components of water quality. Chemical and bacterial. Both of these components were tested in laboratories in order to give a water sample fit or unfit for consumption.

The water samples are collected in sterilized bottles that were autoclaved at 120 degree Celsius. In order to minimize the bacterial contamination from air contact. These samples were then tested for bacterial contamination. According to W.H.O. the basic cause of child mortality is the presence of bacterial coli forms in water. According to W.H.O's guidelines the bacterial coli forms should not be present in any amount in drinking water.

The methodology adopted to test bacterial content was to check the growth of bacteria in a special medium. Lactose broth was used in order to check the growth of bacteria. Five test tubes of Double strength broth containing 10ml of sample and one tube of 1ml and one test tube of 0.1ml were used. These tubes were incubated for 35degreee Celsius for 24hours to check the presence of coli forms in the sample. The presence of gas would confirm the presence of coliforms. If the tubes turned out to be positive then they were incubated for 48hours in order to check the presence of feceal coli forms. The bacterial count was then calculated on the basis of positive tubes. Most probable number or MPN/100ml was used to calculate the bacterial count. Higher the value of mpn higher is the chance probability of presence of bacterial presence. Fecal coli forms are present in water due to contamination of waste water in the drinking water which is a cause of water borne disease like diarrhea, dysentery, typhoid. If the fecal coli forms are present in the positive tubes then they were tested for the presence of E.coli (Escherichia Coli). E.coli is considered one of the lethal types of bacteria present in the water distribution system.[2]

For chemical analysis the following parameters were tested for the fitness of water samples. These include pH, hardness, alkalinity, total dissolved solids. The water samples were also tested for the heavy metals which include potassium, magnesium, calcium, sodium, chlorides and sulfates. These metals are tested on Atomic Absorption spectrometer and ion chromatograph.

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[2] A detailed note on the water quality parameters is given in chapter 4

There are approximately fifty parameters which according to guidelines of W.H.O should be tested for water quality. In this study only the basic parameters are tested which is the basis for a drinking water sample to be fit or unfit.

Willingness to pay

Willingness to pay for improvement in water quality will be measured through contingent valuation survey. Contingent valuation studies are not new to evaluate consumer's willingness to pay for improvement for environmental quality. Contingent valuation is a method of estimating the value that a person places on a good, usually one that is not sold in markets, such as environmental quality or good health. The approach asks people directly what they are willing to pay for the good, or what they are willing to accept to give it up, rather than inferring this from observed behavior. The commodities most often valued using this technique include public goods such as improvements in air and water quality, and private non-market goods such as reductions in risk of death, days of illness avoided or days spent hunting or fishing. The questionnaire design is adapted from Gunatilake et.al (2007).

Model for willingness to pay

Different studies have taken into account different techniques which are used widely to measure willingness to pay for water quality. Logit models (Sattar 2008), Tobit models (whitehead 2003), symmetrically trimmed least squares (Kwak et al .1997) and ordinary least squares have been used most commonly. All of the mentioned methods have their own positives and negatives.

Ordinary least squares are one of the most least preferred methods to use when it comes to estimating willingness to pay. The reason for OLS to be less preferable is that the estimates become inconsistent when the dependent variable data occurs with a negative or a zero value. The OLS estimates hence could not capture the full effect of the qualitative data expressed as quantitative data

Tobit models are preferred for estimating the willingness to pay. The reason to use the Tobit models is that they are designed in such a way that they capture the full effect of the variable. Hence the coefficients that are inconsistent and biased in OLS are consistent in Tobit regression.

A recursive Tobit model is used for the estimation of willingness to pay for improvement in water quality.

WTP= F (Income per head, Perceived quality, Average Bill, Education of Head of family, Original water quality, Filter cost, Bottled water cost , Health Expenditure)

Perceived Quality = F (Purification, Purification Method, Bottled water, Disease, Original Water quality)

Sampling Framework

The sampling frame consists of all the domestic households that are being billed by WASA Lahore. The correct number of households was not available but an estimate was made using the available data.

Sampling is being carried out in two stages. In first stage the areas covered by WASA are divided on basis of towns.

WASA operates in six out of nine towns of the local government of Lahore. These towns are:

1. Aziz Bhatti Town
2. Ravi Town
3. Shalimar Town
4. Allama iqbal Town
5. Nishter Town
6. Gunj Bux Town

After dividing the areas on the basis of towns in the second stage sampling was conducted in each town. Systematic sampling with random start was conducted after proportionately allocating the sampling units on the basis of domestic household connections (both metered and UN metered). The data is based on the estimates made by WASA in their monthly report of MAY-JUNE 2008.

There are 498891 domestic household connections registered with WASA. Out of these 243234 households have metered connections and the remaining 255757 have un metered connections. The sample size includes both the households with metered and un metered connections.

The sample size is determined by the following formula:-

$$\textbf{Sample size} = N.z^2v^2 / N.d^2+z^2v^2$$ [3]

Where:

N= population

Z= variant

V=variability

D= error

With the above formula the sample size is determined to be 99 households.

The households are proportionately allocated on first stage of sampling i.e. at town level. The town with highest number of connection gets the highest weight in the sampling. On the second stage as the data was limited so random sampling was done in order to capture the effect from all the respective subdivisions of the town.

The sampling allocation is given in table 3.1:

Table 3.1: Allocation of Sampling Units

Town Name	*Sampling Unit*	*Subdivision/ Area*	*Sampling Unit*
Allama Iqbal Town	21	Allama Iqbal Town	6
		Johar Town	6
		Ichhera	5
		Samanababd	4
Aziz Bhatti Town	6	Tajpura	3
		Mustafabad	3
Gunjbux Town	27	Islampura	5
		Ravi Road	5
		Gulberg	5
		Mozang	5
		Faisal Town	4
		Garden Town	3
Nishter Town	10	Green Town	6
		Township	4

[3] Caisley and Kumar (1998)

Ravi Town	20	Shahdara	6
		Farkhabad	4
		Misrishah	5
		Shadbagh	5
Shalamar Town	15	Baghbanpura	8
		Mugalpura	7
Total	***99***		***99***

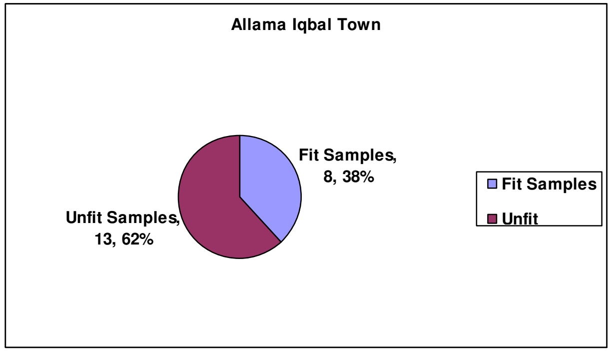
Estimation and Results

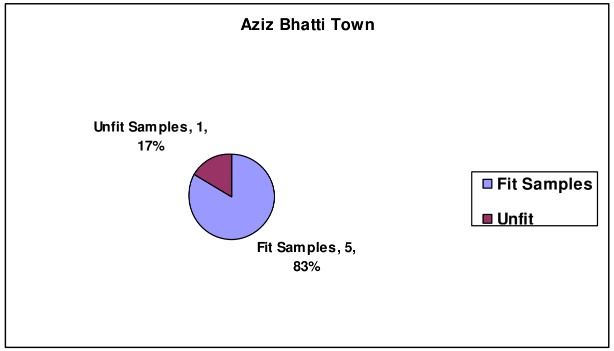
Water Quality

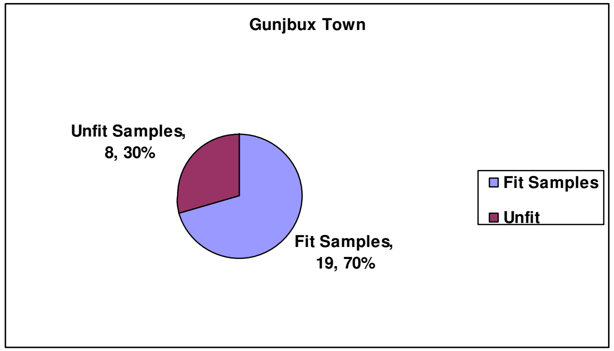
The water quality results of water samples showed that out of 102 samples colleted from different towns showed that fifty four drinking water samples are fit for consumption under the tested parameters. These parameters were compared with the WHO guidelines for drinking water quality. Out of these 102 samples 3 source samples were also tested in order to get an overview of the water being supplied. These samples were found to be fit for consumption. Out of the remaining 99 samples 51 were considered fit on the basis of WHO guidelines. The chemical and bacteriological tests for these samples were within range. For the remaining 48 samples the chemical content was in range as prescribed by WHO, but the bacteriological contamination made those samples unfit for consumption. All of the unfit samples showed contamination for bacteria, both total and feaceal. E.coli test for all the samples came out to be negative. According to results[4] most of the samples were given not fit for consumption because of presence of bacterial contamination in the sample. Only two samples showed chemical contamination with higher ranges of TDS. For a sample to be fit for consumption there should be no presence of bacterial coli forms in the sample. Area wise perceived and actual water qualities are shown in the following pie charts. The numbers show that the out of 99 only 27 households are satisfied with the quality of water whereas the remaining 72 show their dissatisfaction.

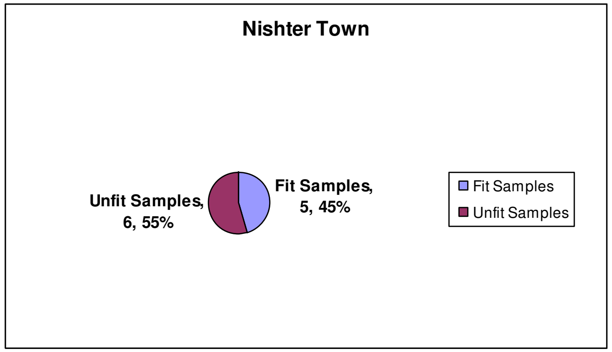
[4] Results of water quality parameters are shown in appendix for reference and comparison with the water quality guidelines mentioned in Chapter 4.

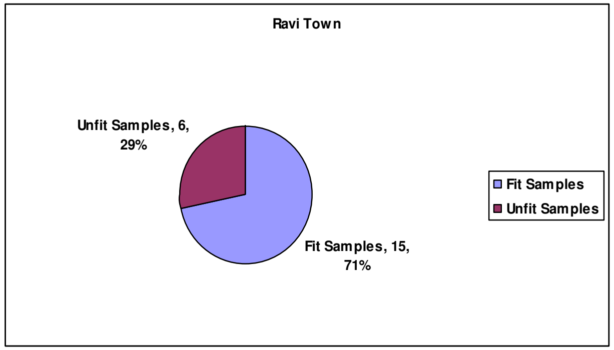
Graph 5.1: Area wise Actual Water Quality

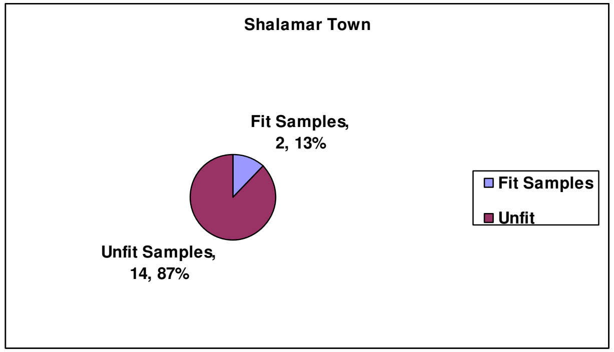




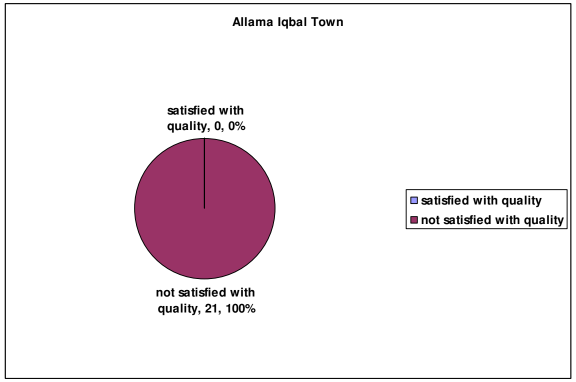


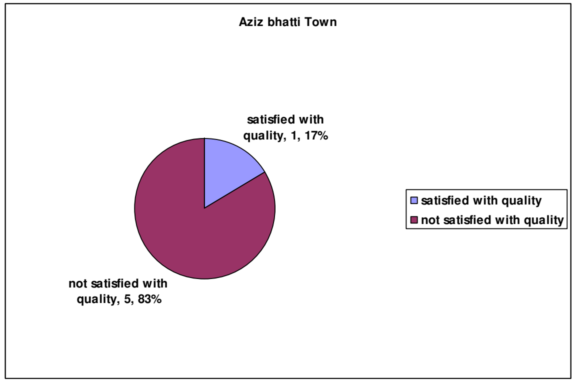


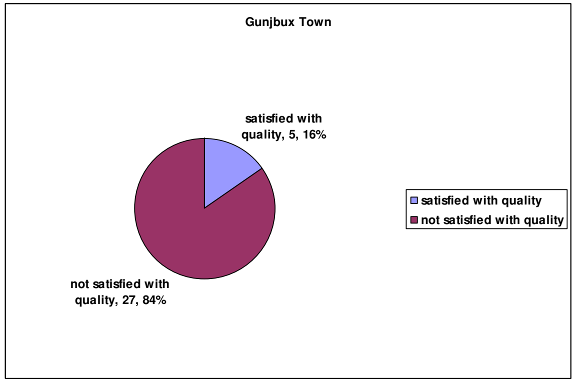


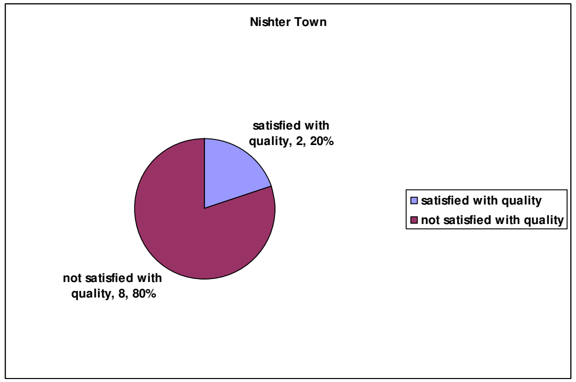


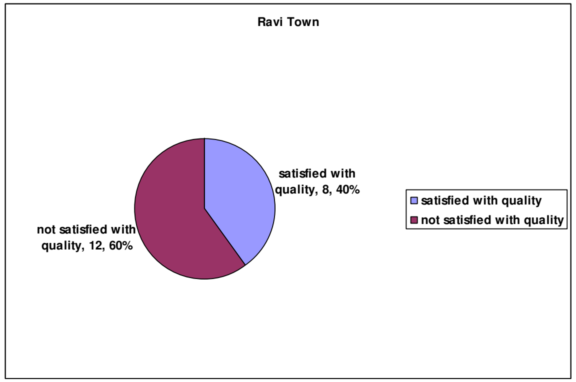
Graph 5.1: Area wise Perceived Water Quality

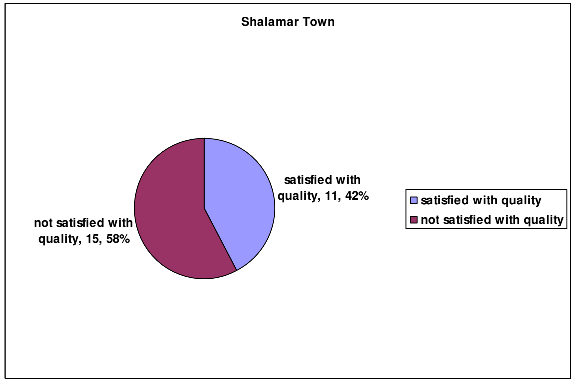












Estimation of willingness to pay

The estimated equation of perceived quality explains 57 percent of the variation in quality of water. The results for the equation are given in table 5.1:

Table 5.1 Estimation of Perceived Quality

Dependent Variable: Perceived Quality
Method: ML - Censored Normal (TOBIT) (Quadratic hill climbing)
Included observations: 99

	Coefficient	Std. Error	z-Statistic	Prob.
C	0.651088	0.198667	3.277281	0.0010
PURIFICATION	-1.397496	0.536324	-2.605696	0.0092
PURIFUCATION METHOD	-0.005059	0.276482	-0.018299	0.9854
BOTTLED WATER	-1.144404	0.404230	-2.831069	0.0046
DISEASE	-0.175649	0.096830	-1.813999	0.0697
ORIGINAL WATER QUALITY	0.176077	0.230933	0.762460	0.4458
	Error Distribution			
SCALE:C(7)	0.799030	0.127468	6.268480	0.0000

R-squared	0.578232	Mean dependent var	0.272727
Adjusted R-squared	0.550726	S.D. dependent var	0.447628
S.E. of regression	0.300036	Akaike info criterion	1.233097
Sum squared resid	8.281983	Schwarz criterion	1.416591
Log likelihood	-54.03832	Hannan-Quinn criter.	1.307339
Avg. log likelihood	-0.545842		
Left censored obs	72	Right censored obs	0
Uncensored obs	27	Total obs	99

Purification

The estimated equation showed a negative sign for the purification of water. This sign is theoretically correct because if the drinking water quality is good then the household would not try to purify it as the household is already receiving quality drinking water.

Purification method

The sign for purification method is negative that if the household adopts any of the procedures of boiling, filtering or both of the methods, shows that they are not satisfied with the quality of water. Although this variable is statistically significant in this model but is of importance when perceptions about water quality is to measured.

Bottled water.

The use of bottled water is also negatively related to the perception of water quality. The priori sign is also negative and shows an inverse relationship and dis satisfaction of water quality being supplied to the consumers.

Disease

Water borne disease also affects the perceptions about quality of water. If the houses hold is continuously having diarrhea, typhoid or any other water borne disease it would show its satisfaction about water quality.

Original water quality.

Original water quality shows that the perceptions of the households about water quality are the same. The positive sign shows that the water quality as described by the household is true. The small value of co efficient shows that the explanatory power of original quality is less. This shows that the household still have some doubts about the water quality which make them use different coping strategies to ensure clean drinking water.

The joint estimation of willingness to pay and water quality equation showed that the model explains 23 percent of variation in the dependent variable. For a better insight of the impact of perceived water quality the data form the survey is used instead of the fitted variable in the previous equation. Also the perceived water quality and original water quality show the stated and the revealed preferences of the households.

Table 5.1 Estimation of Perceived Quality

Dependent Variable: WTPRUPEE

Method: ML - Censored Normal (TOBIT) (Quadratic hill climbing)

Sample: 1 99

Included observations: 99

	Coefficient	Std. Error	z-Statistic	Prob.
C	-225.9508	133.7677	-1.689128	0.0912
PERCAPITA INCOME	-0.007201	0.006110	-1.178496	0.2386
AVERAGE BILL	0.219444	0.090567	2.423015	0.0154
EXPENDITURE ON BOTTLED WATER	0.131074	0.079549	1.647723	0.0994
HEALTH EXPENDITURE	0.126305	0.144723	0.872741	0.3828
FILTER COST	-0.355822	0.306670	-1.160277	0.2459
EDUCATION OF HEAD	24.36486	10.53872	2.311938	0.0208
PERCIVED QUALITY	-167.0399	95.02478	-1.757857	0.0788
ORIGINAL QUALITY	113.3190	79.31276	1.428761	0.1531
	Error Distribution			
SCALE:C(10)	351.6399	33.15380	10.60632	0.0000

R-squared	0.238861	Mean dependent var	237.4242
Adjusted R-squared	0.161892	S.D. dependent var	293.4570
S.E. of regression	268.6547	Akaike info criterion	10.14176
Sum squared resid	6423607.	Schwarz criterion	10.40389
Log likelihood	-492.0169	Hannan-Quinn criter.	10.24782
Avg. log likelihood	-4.969868		
Left censored obs	35	Right censored obs	0
Uncensored obs	64	Total obs	99

Per Capita Income

The income variable shows a negative sign which is against the theory. The plausible interpretation of negative sign is that the willingness to pay of people does not depend entirely on income rather there are other factors that contribute to the willingness to pay. The negative sign also shows that a household with more income is not willing to pay more as compared to a household with less income.

Average Bill

The average bill shows a positive relationship in the model, showing that the increase in water bills would increase the willingness to pay. The households are willing to pay more water bills if they are ensured with improved quality of water supply. This factor also contributes to the negative sign of income that the people regardless of what their income is are willing to pay more if their monthly bills are increased.

Expenditure on bottled water:-

Expenditure on bottled water shows positive sign because any other money spent on coping strategies would be positively related to willingness to pay. Households are willing to pay for alternative sources of drinking water which shows that they are not satisfied with the existing water quality.

Health Expenditure

Health expenditure also shows a positive sign that the people would be more willing to pay if their monthly health expenditure increases due to water borne diseases. They would be willing to pay more if the water quality is ensured and results in decrease in water borne disease and their health expenditure.

Filter cost

Filter costs show a negative sign showing that with increasing filtration costs they would be less willing to pay more. The reason for this is that the repairing and maintenance costs for domestically installed filtration plants are not that high which allow the household to be less willing to pay for improvement in water quality.

Education of Head of Family

More educated people are more willing to pay for improvements in water quality regardless that if they are male or female.

Perceived Quality of Water

The perceived water quality shows a negative sign with willingness to pay accounts for that the house hold will be less willing to pay if the household is satisfied with the existing quality of water.

Original Water Quality

This variable shows a positive sign in the model accounts for that if original water quality is considered to one of the determining factor the improvement in water quality would also improve the willingness to pay for the households

Estimation of Mean Willingness to Pay

The estimated equation is as follows:

*WTPRUPEE = -226.0321676 - 0.00703298005*INCOME PER HEAD + 0.2193841173*AVERAGE BILL + 0.1306458767*BOTTLE WATER EXPENDITURE + 0.1256281628*HEALTH EXPENDITURE - 0.3570451289*FILTERCO + 24.30043903*EDUCATION OF HEAD - 166.8744257*PERCIEVED QUALITY + 113.0951498*ORIGINAL WATER QUALITY*

The estimation of mean WTP is done by substituting the mean[5] values of all the included variables in the model

*WTP RUPEE =-226.0321676-(0.00703298005*5974.991) + (0.2193841173*521.9388) + (0.1306458767*202.0408) + (0.1256281628*91.22449) - (0.3570451289*73.62245) + (24.30043903*11.10204)-(166.8744257*0.265306) + (113.0951498*0.510204)*

WTP RUPEE =RS. 141.2338057492
The mean willingness to pay for the household survey is RS. 141

[5] The descriptive statistic of the survey and area wise descriptive statistics are given in annex.

The willingness to pay for respective towns is given in table 5.3:

Table 5.3 Willingness to Pay in Rupees of Various Towns

Town	Willingness to pay in Rupees
Allam iqbal town	75
Aziz bhatti town	194
Gunjbux town	206
Nishter town	89
Ravi town	75
Shalamar town	-79

The negative willingness to pay as shown for Shalamar town shows that the people are satisfied with the quality of water and are not willing to pay for the improvements costs. As shown in graph 5.1 that the people of Shalamar town are satisfied with the quality of water they are getting so they have negative willingness to pay.

Policy Recommendations

The results of the study show that there is a need of considerable improvement in water quality of Lahore which comes under WASA jurisdiction.

WATER QUALITY IMPROVEMENTS

The water quality results show an alarming situation for the households and water supplying agencies in Lahore. Improvement in water quality is to be addressed on urgent basis. This can be done by ensuring effective water management policies like monitoring and testing of water supply being provided to the households. Laying of new water pipelines and designing the water and sanitation projects in such a way that should prove sustainable for ensuring the sustainable quality water and reduce the risk of water borne diseases. Regular water monitoring surveys should be conducted so that the water quality should be ensured. Institutes such as Environment Protection Department, Pakistan Council for Water Research should take part actively in improving the performance of government institutions.

Water quality improvements would also affect the burden of disease on hospitals in the monsoon, where the hospitals are flooded with patients of water borne diseases. According to world health estimates (2002) every year on average there are 180,000 deaths in Pakistan due to dirreohal diseases.

TARRIF RESTRUCTURING

The restructuring of tariff is needed for the improper tariff practices. Almost 65% of WASA households do not have connections metered and are billed for the average rental vales according to the tariff blocks. This allows an uncertain burden on the demand of water supply. The current demand for water is 13.2 per capita per day for all the purposes like bathing, washing, watering etc. Whereas the water produced by WASA is 80.2 gallons per capita per day (WASA 2007). This allows for excess demands which the households create who have non metered connection. If they are charged for the true environmental and supply costs the burden of extra demand could be controlled. The willingness to pay calculated in this study could be used for effective pricing polices to cover the incurring losses and to ensure sustainable water supply. If we look at the WASA's current cost of operations the cost of production and supply are almost double than what is being charged by the consumers. None of the pricing blocks cover the full cost of supply. Also the WASA currently has a demand of 308MGD and produces 358 MGD but when the water is being supplied to the household 35percent of the water is lost during the course of supply, which not only creates the pressure of a shortage of 125MG but also a loss of 9.21 million in the last financial year 2007-08[6].

If WASA ensures both supply and quality of water, and the households are satisfied with the performance of management then WASA could yearly earn additional approximately 4.22million rupees form the household's willingness to pay.

[6] WASA Budget 2008

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