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RESEARCH PAPER

Study on willingness to pay for sewage water treatment in Karnataka: A contingent valuation method

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Abstract: The present study attempted to analyze the socio economic characters and willingness to pay for sewage water management by the households residing near sewage channel in Hubballi-Dharwad, Mysuru and Bengaluru Metropolis. The primary data required for the study was collected from the households during the month of January- February, 2021. A set of 15 households were selected randomly under each municipal corporation was interviewed. Based on the Continent valuation method (CVM), this study assesses household's willingness to pay for sewage treatment in Hubballi-Dharwad, Mysuru and Bengaluru. It was evident from outcomes of the study that lower level of education and income status of the households were the most vital factors responsible for their settlement near sewage channel due to deprived economic status. The prime variable for estimation of Willingness to pay (WTP) function is household income of the individual. It was observed that the coefficient of household's income turned out to be significant and positive. This implies that higher income has a causal link with higher willingness to pay. Awareness level of the individual regarding sewage treatment is also key determinant.

Key words: Contingent valuation, Sewage treatment, Tobit model, Willingness

Introduction

Water is one of the most important resources on earth. All plants and animals must have water to survive. If there was no water there would be no life on earth. About 97 per cent of the water on the earth is salt water and only three per cent is fresh water, slightly over two-thirds of this is frozen in glaciers and polar caps. The remaining unfrozen fresh water is found mainly as groundwater, with only a small fraction of it is present above ground (surface) or in the air. The increased water needs for life poses greatest challenge on account of its increased demand with rise in population, process of economic development and shrinking supplies of water due to unreasonable and over exploitation and pollution.

Water scarcity can be a result of two mechanisms: physical (absolute) water scarcity and economic water scarcity, where physical water scarcity is a result of inadequate natural water resources to supply a region's demand and economic water scarcity is a result of poor management of the available water resources sufficiently. According to the United Nations Development Programme, the latter is found more often to be the cause of countries or regions experiencing water scarcity, as most countries or regions have enough water to meet households, industrial, agricultural and environmental needs, but lack the means to provide it in an accessible and efficient manner.

In India according to (Anon., 2016), urban centres generate mainly about 61,174 million liters/day of sewage water. However, the treatment capacity available for sewage water is only 22,963 million liters/day. Because of gap in sewage treatment capacity, about 38,791 million liters/day of untreated sewage water (62% of the total sewage water) is discharged directly in to the nearby water bodies, leaving a big gap in the treatment of sewage water within the municipal corporation limits. In the near future, there is need for extensive sewage network for collecting and transporting the sewage generated to the nearby sewage treatment plants (STPs) for the treatment. The strict implementation of policies, examination of latest technology and regular operation and maintenance (O & M) of existing STPs, promoting decentralized sewage treatment plants for treatment of domestic sewage generated from households, rural and urban population and reuse of treated sewage for non-portable purposes like flushing, gardening, its use in agriculture etc would surely help the municipal authorities to achieve better sewage management. (Singh *et al.* 2018)

Chennai Metro Water Supply and Sewage Boards (CMWSSB) demonstrated zero water discharge programme in which sewage generated is treated and reused. As of 2018, 15% of Chennai water demand was met from recycled water (Anon., 2018). About 40% of newly built houses water demand and 8% of industrial water demand was met from treated sewage water (Anon., 2018). Recent study in Bengaluru revealed that, about 67% of household respondents expressed their willingness to buy recycled water (Ravikumar, Nautiyal and Scshaiah, 2018). Sewage treatment has great potential, and it may be feasible for the users and governments to cosponsor setting up Sewage Treatment Plants (STPs). In fact STPs are prerequisite to overall development of Metropolitan cities. Hence, the present study was focussed on the following objective:

To find out households willingness to pay (WTP) for the maintenance of a decentralized STPs that treat domestic and other wastewater "grey water" for non-portable reuse.

Material and methods

The primary data for Contingent Valuation Method (CVM) were collected through face-to-face survey with structured interview schedule A set of 15 households were selected randomly from each municipal corporation and one

representative from each household who was involved in household decision was interviewed. The schedule was designed to elicit responses in three information categories: a) Attitudes, knowledge and behaviour, b) Economic valuation questions and c) Socio-economic characteristics to estimate average willingness to pay by households resided near sewage channel for the management of sewage and its treatment..

Tools of Analysis

Contingent Valuation Method

Contingent valuation method is a technique that allows the value of environmental goods or services to be estimated. (Tuner, 1999; Ludamani, 2017) noted that the CVM required the individual's performances according to some environmental resources or change in resource status by answering the questions about hypothetical choices.

Generally, as the environmental goods and services have no prices in the markets, the willingness to pay (WTP) method for improving the quality of sewage water services is possible by establishing Sewage treatment plants (STPs) in different municipal corporations has been used as an alternative substitute price. Then the proposed amount was to be reduced by certain percentage. The procedure was repeated until the respondent provided positive answer. Among many different formats used for this method, the bidding game format was used in the study. The values ranged from zero to 700 for improving the quality of sewage services.

The WTP was estimated with the addition of the variables described as below,

WTP_i = $f(Q_i, Y_i, T_i S_i)$ ……(i)

i = individual

WTP_i = Willingness to pay

Q_i = Quality/ quantity of sewage

Y_i = Income level

T_i = The index of taste

S_i = a vector of relevant socioeconomic factors

Despite the biases associated with the CVM, it is one of the widely accepted methods to assign money value to non-use values of the environmental amenity, values that do not involve market purchases and may not involve direct participation. These values are sometimes referred as "passive use" values. The CVM used to estimate both use and non use values, and is the most widely used method for estimating non-use values of environmental amenity.

To estimate the maximum WTP for sewage water management the following models has been used.

Linear regression model:

A linear regression model was used to analyze the factors influencing willing to pay in the selected municipal corporation and socioeconomic factors determining the effective waste water management. The empirical model used for estimation was of the form of equation (i)

$$WTP = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + e \quad \text{.....(i)}$$

Where,

Y = Willingness to pay (WTP)

X_1 = Gender (GN)

D_1 = Intercept dummy (1 for male , 0 other wise)

X_2 = Age of the respondent in years (AG)

X_3 = Education (ED)

X_4 = Family size (FS)

X_5 = Household Income (HI)

X_6 = Environmental awareness (EW)

D_6 = = 1 if the respondent is aware about sewage water disposal and related services, 0 otherwise

X_7 = Household Expenditure (HE)

β_1, β_2, β_3, β_4, β_5, β_6, β_7 are the relevant parameters of the model

Tobit model

Tobit model was first used by (Tobin, 1958; Ludamani, 2017). It is censored normal regression model. Its estimation is related to the estimation of the censored and truncated normal distribution. Here the Tobit model was employed to study the maximum willingness to pay by households near the sewage channel in the municipal corporation area. The dependent variable was the willingness to pay of individual, which was defined as Y=1 if households were willing to pay, and 0, otherwise. The Tobit model was specified as per equation (ii)

$$WTP = \beta_0 + \beta_1 HI_i + \beta_2 AG_i + \beta_3 ED_i + \beta_4 GN_i + \beta_5 FS_i + \beta_6 AW_i + \beta_7 HE_i + U_i \quad \text{.....(ii)}$$

Results and discussion

The impact of open sewage on households near to sewage channel in each selected cities was carried out. The general characteristics of households near sewage channel are presented (Table 1). The average age of the respondents across Hubballi-Dharwad, Mysuru and Bengaluru cities was between

Description and expected signs of explanatory variables used in Tobit model

Explanatory variables (X_i)	Explanation	Expected sign
Household Income (HI)	Monthly income of the family (in rupees)	+
Age (AG)	Age of the respondent in years	-
Education (ED)	Level of educational attainments of the respondents in years	+
Gender (GN)	=1 for male respondents, 0 otherwise	+/-
Family size (FS)	Total number of members in the Family	-
Environmental awareness (EW)	= 1 if the respondent is aware about sewage water disposal and related services, 0 otherwise	+/-
Household Expenditure (HE)	Monthly spending of the family	

44 and 45 years. The family size of respondents in twin cities was more towards nuclear type and was between 4 and 5 in the selected cities under study. As majority of them in all three cities Hubballi-Dharwad (73.33%), Mysuru (66.67%) and Bengaluru (60.00%) adopted nuclear family while, only 27 to 40 per cent of them adopted joint family pattern. This indicated that, household's inclination was more in favour of nuclear type family in recent years. As far as the educational status was concerned, 13.33 per cent of the respondents, in Hubballi-Dharwad and Bengaluru were illiterates and it was relatively more in Mysuru (20.00%). In case of Hubballi-Dharwad about 33 per cent of them attained primary education against about 27 per cent in Bengaluru and Mysuru. The secondary and collegiate educational attainments of household heads together was more among Bengaluru (60.00%) while it was relatively (about 53.00%) less in case of Hubballi-Dharwad and Mysuru cities. This indicated that, the education was most important factor that determined the occupational pattern and this intern determine income of household. It was observed that most of the respondents were employed in private sector service as contract labour in construction works and were daily wage earners thus, majority of them belonged to medium and low income groups in all three cities under study.

It was evident from the results of the study that lower level of education and lower income level of the respondents were the major factors responsible for their settlement near sewage channel due to poor economic status. The respondents found to prefer the area near sewage channel for settlement due to availability of sites at lower prices. Among the entire respondents some of them just acquired unoccupied Government area for construction of house. The average distance to sewage channel from their residence was just 60 m in Hubballi-Dharwad, 120 m in Mysuru and 180 m in Bengaluru. This indicated that they were residing just adjacent to sewage channel, frequent health

Table 1. General features of households near sewage channel in Hubballi-Dharwad, Mysuru and Bengaluru cities

Particulars	Unit	Hubballi-Dharwad twin cities (n=15)		Mysuru city (n=15)		Bengaluru cities(n=15)	
		Average	Percentage	Average	Percentage	Average	Percentage
Age of the respondents	Years	43.67		44.40		45.20	
Size of the family		4.40		4.33		4.01	
Male	No.	1.7	38.64	1.9	43.88	1.44	35.91
Female	No.	1.5	34.09	1.4	32.33	1.31	32.67
Children	No.	1.2	27.27	1.03	23.79	1.26	31.42
Family type							
Joint family	No.	4	26.67	5	33.33	6	40.00
Nuclear family	No.	11	73.33	10	66.67	9	60.00
Education level							
Illiterates	No.	2	13.33	3	20.00	2	13.33
Primary	No.	5	33.33	4	26.67	4	26.67
Secondary	No.	4	26.67	2	13.33	6	40.00
College	No.	4	26.67	6	40.00	3	20.00
Occupational structure							
Government service	No.	5	33.33	4	26.67	2	13.33
Private service	No.	7	46.67	8	53.33	9	60.00
Business	No.	3	20.00	3	20.00	4	26.67
Average income of family	₹/month		25,976		28,706		31,436
High income group	No.	4	26.67	4	26.67	5	33.33
(>₹30,000)	₹/month		32,151		34,514		36,876
Medium income group	No.	5	33.33	6	40.00	6	40.00
(₹20,000-30,000)	₹/month		24,432		26,387		28,342
Low income group	No.	6	40.00	5	33.33	4	26.67
(<₹20,000)	₹/month		18,768		19,161		19,553
Type of house	No.						
Owned		10	66.67	8	53.33	6	40.00
Rented		5	33.33	7	46.67	9	60.00
Distance to sewage channel	Meter	60		120		180	
Willingness to change the present residence							
i Owned	No.	10	66.67	8	53.33	6	40.00
Yes	No.	4	40.00	4	43.75	3	50.00
No	No.	6	60.00	5	56.25	3	50.00
ii Rented	No.	5	33.33	7	46.67	9	60.00
Yes	No.	4	80.00	5	71.43	6	66.67
No	No.	1	20.00	2	28.57	3	33.33
Precautionary measures from corporations to avoid harmful effects							
Yes	No.	3	20.00	5	33.33	4	26.67
No	No.	12	80.00	10	66.67	11	73.33

problems were observed and were susceptible to frightening health problems. Though, majority of the respondents were willing to change their residences far away from sewage channel but was not feasible option for them as they already owned house and besides high cost of sites in other localities. While, the households stayed in the rented houses showed willingness to change their residence away from the sewage channel. Regarding precautionary measures initiated by municipals from time to time like regular cleaning of sewage channel filled with mud, silt, bricks, plastic bottles, disposed medical waste (as needles, syringes and nails) and pieces of wood etc. Spraying of chemicals to manage mosquito's as high as about 80.00 per cent, 66.67 per cent and 73.33 per cent of respondents, respectively in Hubballi-Dharwad, Mysuru and Bengaluru indicated that no such regular measures were taken to avoid harmful effects of open sewage channel filled with solid wastes in their locality.

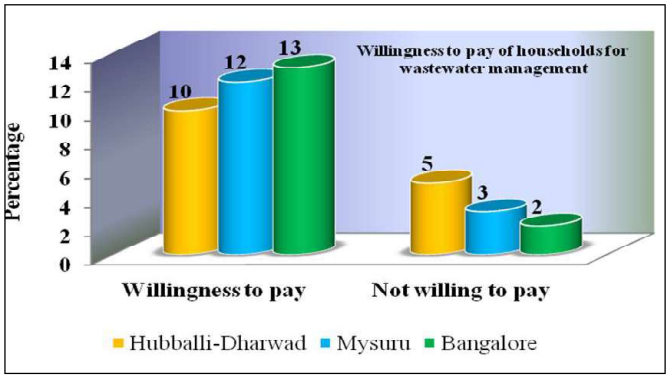
This indicates deprived attention towards these areas near open sewage with respect to precautionary measures to protect from ill-effects of open sewage channel indicated negligence of municipal corporations especially, in case of open sewage near the residences especially at slum area in Hubballi-Dharwad, Mysuru and Bengaluru. These findings are in agreement with results obtained by (Rajapakshe *et al*., 2007).

The response of households towards willingness to pay or contribute towards corporation fund for sewage water management services is recorded (Table 2 and Fig 1.) pertaining to whether households are willing to contribute monetarily to get a better sewage water management services (such as regular maintenance of sewage canals through removal sludge/solid waste, frequent fumigation, etc) revealed that in Hubballi-Dharwad, 66.67 per cent of respondents were willing to contribute and while, only 33.33 per cent of them were not ready to pay any amount as service cost. In Mysuru, majority 80 per cent of respondents were ready to pay any amount and while, 20 percent of them are unwilling to pay any amount as service cost. In Bengaluru, majorities 86.67 per cent of the respondents were ready to pay amount and the additional 13.33 per cent of households were unwilling to make payment towards service cost. The respondents stated various reasons for their unwillingness to pay for sewage management/services. Among those, most of them opined that, the government has to pay for such improvements. During survey, many households said that they did not believe that, the municipality put the resources to acceptable use and the people with higher incomes be made to pay for better sewage management. The majority of respondents in Bengaluru and Mysuru were ready to pay compared to respondents in Hubballi-Dharwad. This was due to the intensity of problem in Bengaluru and Mysuru and also their better awareness of its ill-effects.

The willingness to pay towards sewage management was shown in terms of the cost or payment which households were ready to make and are presented (Table 3). When the respondents were asked to indicate their willingness to pay there was variability in the amount contribution between households. Among the households who were willing to pay

Table 2. Willingness to pay of households for sewage water management

Willingness to pay	Hubballi-Dharwad twin cities		Mysuru city		Bengaluru city	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Yes	10	66.67	12	80	13	86.67
No	05	33.33	03	20.00	2	13.33
Total	15	100.00	15	100.00	15	100.00



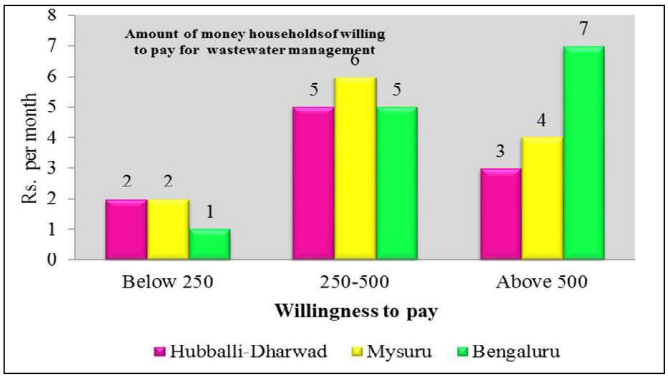


Fig. 1: Willingness to pay of households for sewage water management

Table 3. Amount of money households willing to pay for sewage water management (₹/month)

Amount (in ₹)	Hubballi-Dharwad twin cities		Mysuru city		Bengaluru city	
	No.	Percentage	No.	Percentage	No.	Percentage
Below 250	02	20.00	02	16.67	01	7.69
250-500	05	50.00	06	50.00	05	38.46
Above 500	03	30.00	04	33.33	07	53.85
Total	10	100.00	12	100.00	13	100.00

revealed indicated that majority (50.00%) were willing to bear the cost between ₹ 250 to 500 per year both in Hubballi-Dharwad and Mysuru cities, followed by (30 to 33%) willing to pay above 500 and whereas, only (about 17% to 20%) of them were willing to pay less than ₹ 250 for managing sewage water in both the cities. While, in Bengaluru, 53.85 per cent of the households were ready to pay above ₹ 500 and the remaining (38.46% and 7.69%) households were willing to make payment between .250 to ₹ 500 and less than ₹ 250, respectively. (Paola *et al*., 2018) found that about 25% of the samples (96 respondents) are not willing to pay for the wastewater reuse project. The WTP then increases regularly up to 360 respondents, with the tail respondents willing to contribute a higher amount: only one respondent selected 500 $, two respondents 300 $, and four 250 $ respectively. These findings are also in accordance with results obtained by (Vasudha and Sukanya, 2019).

For the estimation of WTP of the respondents, WTP was regressed on income, socioeconomic characteristics and environmental awareness of the household respondents. The regression results of WTP for the services of Sewage treatment plants (STPs) are shown in (Table 4). The most important variable for the estimation of the WTP function is household income of the individual (HI). It is reasonable to assume that higher the per capita income of the household higher will be the access to the assets and WTP. It can be seen from the Table 4 and 5 that the log likelihood ratio statistic was significant at one per cent, indicated that at least one of the variables has coefficient different from zero. Therefore, it can be concluded that the Tobit model used has integrity and was appropriate. In all the three cities the coefficients of HI turned out to be significant and positive. The significant and positive coefficient of HI implies that higher the value of HI, higher will be the WTP for the STPs. In Hubballi-Dharwad, the other independent variables like ED (0.02919), GN (0.86664), FS (0.01780) and EW (0.61708) were found to be significant and positive. The coefficient of environmental awareness was found to be positive and significant. This implies that, if an individual is more aware about the sewage treatment he/she will be willing to pay more. Whereas the coefficients of AG and HE turned out to be significant and negative. In Mysuru, the other independent variables like AG (0.028653) and FS (0.022440) were found to be significant and positive. Whereas the coefficients of ED (-0.000582), GN (-0.625838), EW (-0.467750) and HE (-0.000086) turned out to be significant and negative. While in Bengaluru, the other independent variables like FS (0.06791) and EW (0.17915) were positive and not significant. Whereas the coefficient of AG (-0.02268) had significant and negative impact on WTP. This implies that young age people willing to pay more than elderly people. The other coefficients like ED (-0.29603), HE (-0.00017) were found negative and significant. The coefficient of dummy variable for GN (-0.23111) was found negative and significant impact on WTP. This implies that female respondents are willing to pay lower than male respondents given a superior role of males in decision making. These findings are similar in agreement with (Bilgic, 2010; Vasudha and Sukanya, 2019).

Table 4. Regression results of WTP for sewage water management

Particulars	Parameters	Hubballi-Dharwad twin cities		Mysuru city		Bengaluru city	
		Coefficients	Standard error	Coefficients	Standard error	Coefficients	Standard error
Constant	a	0.66433	0.48010	0.27736	0.47611	2.28314	0.91756
Gender	X_1	0.55272*	0.25023	-0.54698***	0.14663	-0.21541	0.21496
Age	X_2	-0.02935**	0.01058	0.02499**	0.00731	-0.01915	0.01527
Education	X_3	0.02358	0.01402	-0.00028	0.00724	-0.26312**	0.08524
Family size	X_4	0.02198	0.02863	0.02119	0.02137	0.05953	0.03462
Household Income	X_5	0.25049*	0.13032	0.41081***	0.08322	0.00005**	0.00002
Environmental awareness	X_6	0.31871	0.27785	-0.41497**	0.15768	0.15722	0.21266
Household Expenditure	X_7	-0.00005	0.00004	-0.00008**	0.00002	-0.00015**	0.00006
Coefficient of determination	R^2	0.79	0.89	0.77			

Note: ***indicates significant at 1 per cent level
** indicates significant at 5 per cent level
* indicates significant at 10 per cent level

Table 5. Tobit regression results of WTP for sewage water management

Particulars	Hubballi-Dharwad twin cities		Mysuru city		Bengaluru city	
	Coefficients	Standard error	Coefficients	Standard error	Coefficients	Standard error
Constant	0.68836	0.43852	0.164827	0.401028	2.48388***	0.73593
Household Income (HI)	0.38545***	0.14083	0.471420***	0.077520	0.00006***	0.00002
Age (AG)	-0.03972***	0.01065	0.028653***	0.006407	-0.02268*	0.01254
Education (ED)	0.02919**	0.01383	-0.000582	0.006014	-0.29603***	0.07024
Gender (GN)	0.86664***	0.31149	-0.625838***	0.133421	-0.23111**	0.16822
Family size (FS)	0.01780	0.02610	0.022440	0.018397	0.06791	0.02769
Environmental awareness (EW)	0.61708**	0.29618	-0.467750***	0.134725	0.17915	0.16540
Household Expenditure (HE)	-0.00010**	0.00005	-0.000086***	0.000020	-0.00017***	0.00005
Log likelihood	-3.702	-3.215	-1.655			

Note: ***indicates significant at 1 per cent level
** indicates significant at 5 per cent level
* indicates significant at 10 per cent level

There are some contradictory results obtained in study with respect to the (GN) of the respondents Genius and Tsagarakis (2006). It was found that female respondents were more likely to pay for sewage treatment than male respondents. Whittington *et al*. (1993) had observed that higher income has a causal link with higher willingness to pay. Awareness level of the individual regarding sewage treatment is also key determinant.

Conclusion and policy implications

Sewage treatment has been subjected to considerable attention especially with respect industries and farmers for agricultural reuse. However, this study aims at extending it to domestic sector. This study utilized primary data that was beneficial in increasing awareness about sewage water management and its reuse among the households in the cities. This awareness is a direct determinant of contribution towards a cleaner environment around our surrounding. As economic theory, socioeconomic and demographic factors significantly determine whether a household will choose to participate in Contingent market.

- The coefficient of environmental awareness (Sewage water) was found to be positive and significant. This implies that, if an individual more aware about sewage treatment he/she will be willing to pay more. In fact as mentioned in this paper, Karnataka government could think of implementing (zero water discharge programmme in which all the sewage generated is treated and reused fully.) replicating mandatory framework used in Chennai.
- The households in the study area about 33.33%, 20% and 13.33% in Hubballi- Dharwad, Mysuru and Bengaluru were not willing to make payment for sewage water management. During survey, many households said that they did not believe that the municipality put the resources to correct use. To deal with lack of trust in urban local bodies, transparent and effective policy measures can be targeted.
- The respondents in all three municipal corporations about (67% to 87 %) of were willing to pay for water supply and sewage water treatment this encourages public participants/ households in urban decision making process and assist various planners and municipal authorities in formulating developmental plans for the clean environment.

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