An Analytical Case Study of Domestic Water Consumption in Selected Wards of Pune Municipal Corporation

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Abstract: This paper surveys the main issues in the literature on residential water demand. Several tariff types and their objectives are analyzed. Then, the main contributions to the literature on residential water demand estimation are reviewed, with a particular attention to variables, specification model, data set, and the most common econometric problems. The paper concludes with comments on future trends and a summary of the contents of the study. This study estimates the demand for domestic water in a fast-growing city of a developing country. The monthly data for 40 randomly selected households for a six-year period were used for the estimation. There were three price hikes during the study period, which provided adequate variation in the prices for an econometric estimation. A log–log model was selected as a proper specification for the demand function. Marginal price, difference price, income, and household size were used as the independent variables. After correcting the data for auto-correlation and heteroscedasticity, theŽ nal model was estimated. Results show all the expected signs with statistical significance. Price elasticity (marginal) and income elasticity for water in the study area are estimated to be 20.34 and 0.08, respectively. Thus, our present findings confirm the previous findings that water is neither price- nor income-elastic. Given these responses, a price hike may not help conserve water in the study area. However, very low price responsiveness can be used to increase water revenues of the municipality. This present paper attempts to review the tariff structures present in PMC, and comparative analysis of water budget. The objective of the present paper in this context is to analyze the pricing pattern of water supply.

Key words – **nal model, price elasticity, income elasticity, water budget.**

I. Introduction:

The study is focusing on the current scenario of water supply system and the water problems and the general views of the Pune citizens on water conservation. The researchers have used survey and experiment based research methodology to carry out this research. In this research, peripheral wards have been selected because while studying various aspects of the water supply it is observed that the area which are lying towards the outskirt are suffering from many problems like, water shortage, illegal connections and despite the supply of less quantity of water, fewer water conservation methods are being practiced.

II. Objectives of the study

    i.   To study ward wise water consumption in Pune city.
    ii.   To know the problems faced by citizens with respect to the water supply system.

III. Limitations of the study

The study is limited to the peripheral area of the PMC where researchers observed the maximum water problem. The study does not cover each and every household of every ward within the PMC. Though the researcher surveyed the slum areas but this study does not cover the slum areas because they have a different tax policy, for example, water tax, service tax and water rate, etc.

IV. Typology and Methodology to analyze water issues

This research study is related to the water distribution system in the Pune city. It utilizes both primary and secondary data. The secondary data utilized is already available information (both published as well as unpublished). However for the primary data, such a facility is not available and it has to be collected by the survey method. For getting correct result there should be correct process of obtaining the nature and size of sample which has been adequately explained. Purposive, quota and convenience sampling techniques, involve the selection of respondents which is based on the important characteristics under study such as where they live, position in society, specific knowledge related to the research problem etc.

a) Primary data

The researcher has used survey and experiment based research methodology to carry out this research. In this research, the researcher has collected about 400 samples from 144 wards for an analyzed water supply, water demand and water problems which the residents are facing. Due to the time constraint It was not possible to identify the perfect sample population and conduct

door to door survey, hence the researcher selected some of the area and some of the societies which are suffering from water problems with high intensity.

b) Secondary data

Regarding the data pertaining to citizen's population, infrastructure facility of water supply department (Pipeline, Pumping stations, Valves) have been collected from the reliable sources. The secondary data regarding natural resources, water purification Plant, water distribution network, water connection, water tankers, and reservoirs were also collected from relevant to current water supply scenario.

- The ward wise population data has been collected from the Pune Municipal Corporation office. Pune. Citizen's population data in year 2011.
- Natural Sources of Water Data: The natural sources of water data for Pune city is collected from Water distribution department of PMC office. Natural water sources are divided into rivers, lakes, dams and ground Water. Further data related to number of rivers, number of lakes, number of dams, and number of dug well and bore well have been collected.
- Dam data: The dam storage capacity data & usable capacity data have been collected from the Irrigation department, Pune Station.
- Water Distribution Network : The water distribution network is divided into number of water distribution zones, total length of pipelines, number of water treatment plants, number of pumping stations, number of chlorinators, number of gravity storage reservoirs, data collected from the water supply department and Pune Municipal Corporation office .

V. Problem Statement

The PMC is facing a serious water problem to meet the ever growing water demand. The societies located at the peripheral areas of the PMC and situated at a higher elevation do not get adequate water. There is a great uncertainty regarding the future demand and supply which will result in an unsustainable gap between the water supply and water demand for many years.

This paper focuses on the analysis of water utilization and the problems faced by the citizens. The maximum data was collected from the outskirt areas of the PMC.

VI. Study area:

The Pune Municipal Corporation (PMC) administers the city. The Pune Municipal Corporation (PMC) was established on 15th February 1950.The PMC controls the whole administration of Pune. For administrative convenience, the Municipal Corporation of Pune city has been divided into four zones which include 14 Ward Offices (having 144 wards). Each ward office includes more than 9 sub wards. This work measures the demand, supply and problems of the drinking water in Pune Municipal Corporation. The demand for drinking water is continuously increasing due to the growth of population, industrialization and commercial units. The drinking water is not provided on a sustainable basis in the Pune municipal corporation. The study revealed that despite an enough amount of water being supplied which is sufficient for the PMC population but a scarcity of water is being experienced especially in the summer season and this is greatly due the wastage of water, illegal connections and improper management of water by the PMC.
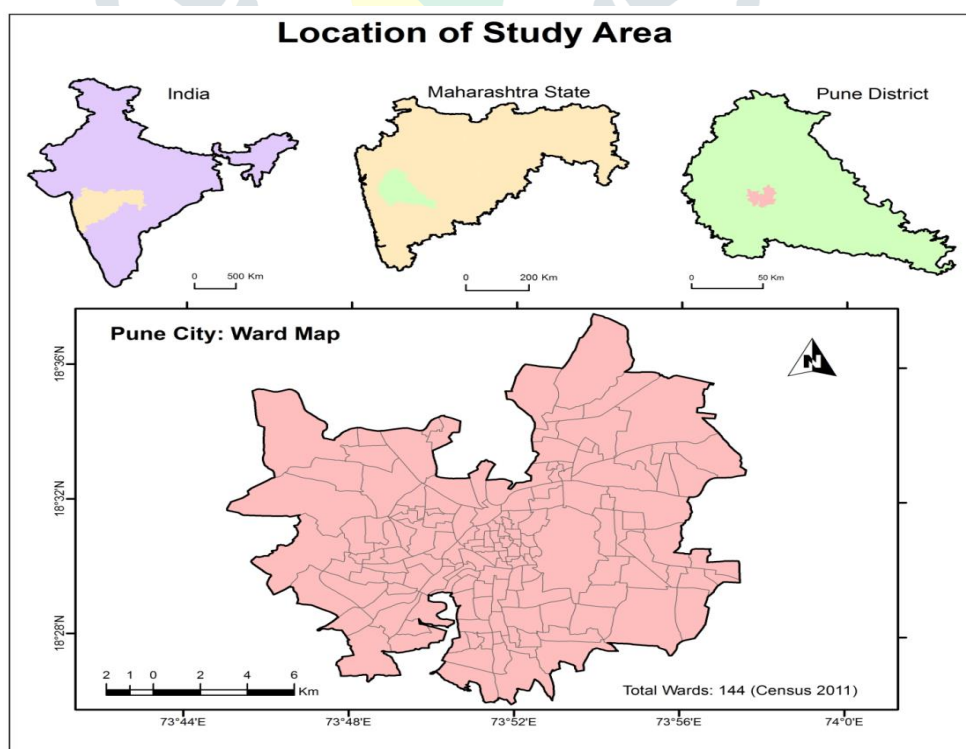

Figure. 1. Location of the study area

VII. Data analysis and interpretation

a) Analysis of domestic water consumption

The problems of the citizens with respect to water supply have been studied by checking the parameters as per capita water consumption, activity wise water consumption, and water conservation at different wards. Firstly, water consumption per person has been found out at different places also the quantity of water being consumed for different purposes per person at different areas has been found out to know the disparity in the use of water requirement at the ward level. To study the above mentioned parameters, first water consumption per person is found out at different wards along with water consumption per person for different use at different wards has been analyzed, further followed by the analysis of water supply at different places. Finally the overall citizen's satisfaction is analyzed through their rated responses. The citizens have rated different problems which have been studied in detail through the subsequent tables.

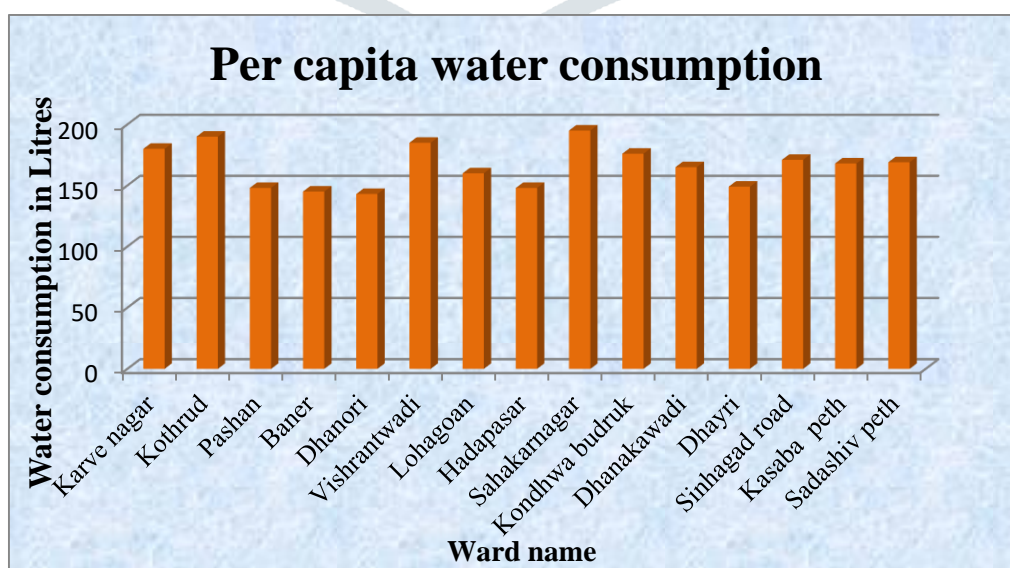### b) Per capita water consumption at various wards

An attempt has been made to measure the per capita water consumption through a survey at household level. To find out the consumption, availability, access and methods adopted for conservation of water in households in Pune City. This shows that the per capita water supply in the city is less than the Service Level Benchmark (194 liters lpcd), whereas it is 135 lpcd (litre per capita per day).

Table 1: Ward wise Per Capita Water Consumption

Sr. No.	Ward name	No of Respondents	Water consumption in liters per capita per day (LPCD)
1.	Warje, Karve nagar	50	180
2.	Kothrud	50	190
3.	Pashan	20	148
4.	Baner	10	145
5.	Dhanori	20	143
6.	Vishrantwadi	60	185
7.	Lohagoan	20	160
8.	Hadapasar	60	148
9.	Sahakarnagar	20	195
11.	Kondhwa budruk	10	176
12.	Dhanakawadi	20	165
13.	Dhayri	10	149
14.	Sinhagad road	20	171
15.	Kasaba peth	10	168
16.	Sadashiv peth	10	169
17.	**Total =**	**400**	**Average = 166. 13**

(*Source: Household survey data*)

Table 1. Shows per capita water consumption of water in selected areas of Pune city. It is very obvious from the table that in all the samples, the water consumption (indication of availability of water per capita) is much higher than what is recommended by CPHEEO, 150 lpcd. It is to be concluded that the usage of water is lowest at fringe areas and highest at the core area of Pune City.

(*Source: Household survey data*)
Figure 2: Ward wise Per Capita Water Consumption

The Figure 2 shows Ward-wise per capita (Per person) water consumption in the Pune city. The above said graph shows the highest consumption of water at Ghole road and Hadapsar. It is followed by Dhanakwadi, Yerwada and Bibwewadi etc. and the remaining wards have a consumption of more or less equal.
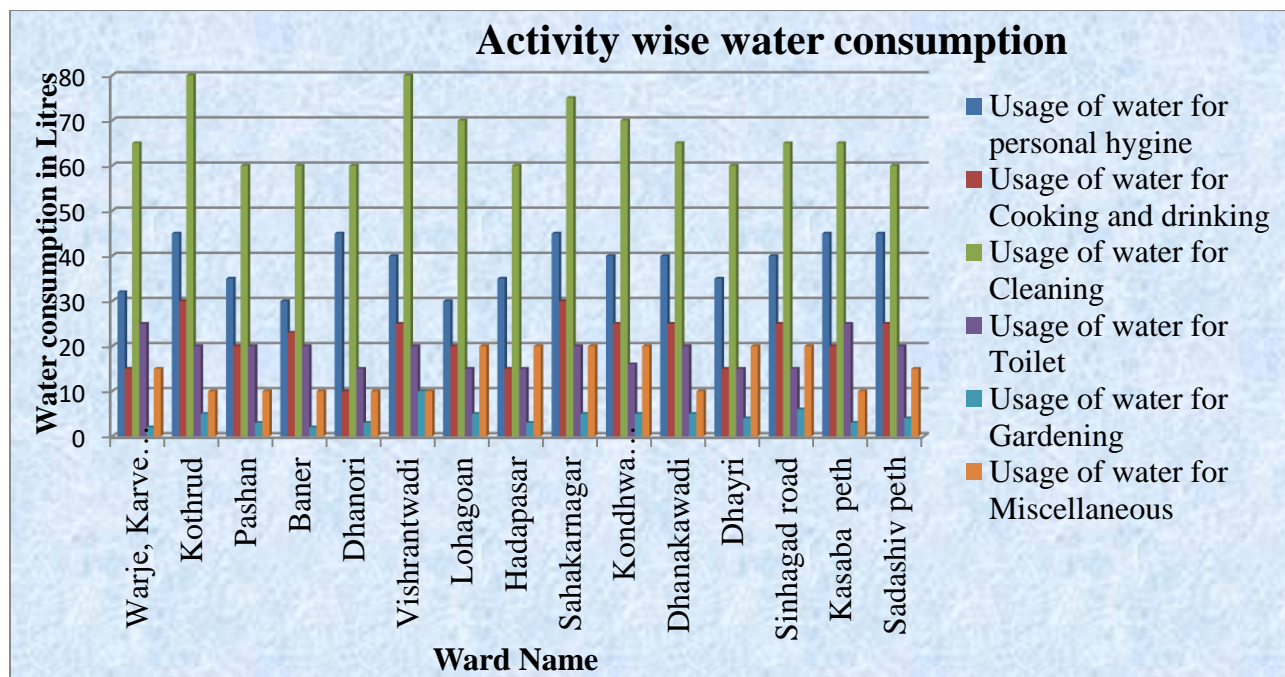
c) Activity-wise Consumption of Water

Table 2: Activity-wise Distribution of Water Consumption in various ward level (Average consumption by per person/ day)

Ward name	No of Respondents	Usage of water for personal hygiene	Usage of water for Cooking and drinking	Usage of water for Cleaning	Usage of water for Toilet	Usage of water for Gardening	Usage of water for Miscellaneous	Total
Warje, Karve nagar	50	32	15	65	25	2	15	154
Kothrud	50	45	30	80	20	5	10	190
Pashan	20	35	20	60	20	3	10	148
Baner	10	30	23	60	20	2	10	145
Dhanori	20	45	10	60	15	3	10	143
Vishrantwadi	60	40	25	80	20	10	10	185
Lohagoan	20	30	20	70	15	5	20	160
Hadapasar	60	35	15	60	15	3	20	148
Sahakarnagar	20	45	30	75	20	5	20	195
Kondhwa budruk	10	40	25	70	16	5	20	176
Dhanakawadi	20	40	25	65	20	5	10	165
Dhayri	10	35	15	60	15	4	20	149
Sinhagad road	20	40	25	65	15	6	20	171
Kasaba peth	10	45	20	65	25	3	10	168
Sadashiv peth	10	45	25	60	20	4	15	169
Total =	400	590	323	1000	286	68	225	2492
Percentage	-	23.60	13.09	40.35	11.35	2.64	8.92	100
Mean	26	39.33	21.53	66.66	19.06	4.53	15	166.13

(Source: Household Survey Data)

The data is collected through a structured questionnaire and targeted respondents were mostly housewives. The volume of vessels (bucket) in which households used to store water was measured and the number of vessels of water used in different activities was ascertained.

(Source: Household Survey Data)

Figure 3: Activity-wise Distribution of Water Consumption in various ward level (Average consumption by per person/ day)

Where running tap or piped water was used in some activities, the duration for which the tap remained open was arrived at and the quantity of water per minute coming out from the tap was measured. By multiplying the time with the quantity of water per minute, the amount of water used through running taps was arrived at. The amount of water used in toilet was assessed by volume of bucket used, and flush tank capacity. The assessment of quantity of water used in various activities was a difficult task because very few people could assure us of the quantity of water being used. The table 2. shows the activity-wise distribution of water consumption at various ward level (Average consumption by per person/day).

Among the wards, households from Kothrud and Sahakarnagar consume maximum utilization of water is more than 190 plcd and minimum usage of water is observed from out skirt area of Warje, Karvenagar, Pashan, Baner, Dhanori, Dayri, Hadapsar and that is 150 per capita per day. The maximum water utilization is for cleaning purposes (Cleaning Utensils, clothes and floor) which consume more than 40.35% water at household level in the Pune city. For personal hygiene utilization of water it is 23.60%. The water utilization for cooking and drinking purpose is 13.09%. The utilization of water for toilet is 11.35%, for gardening, the maximum utilization of water is 2.64% for miscellaneous purposes the maximum utilization of water is 8.92%.

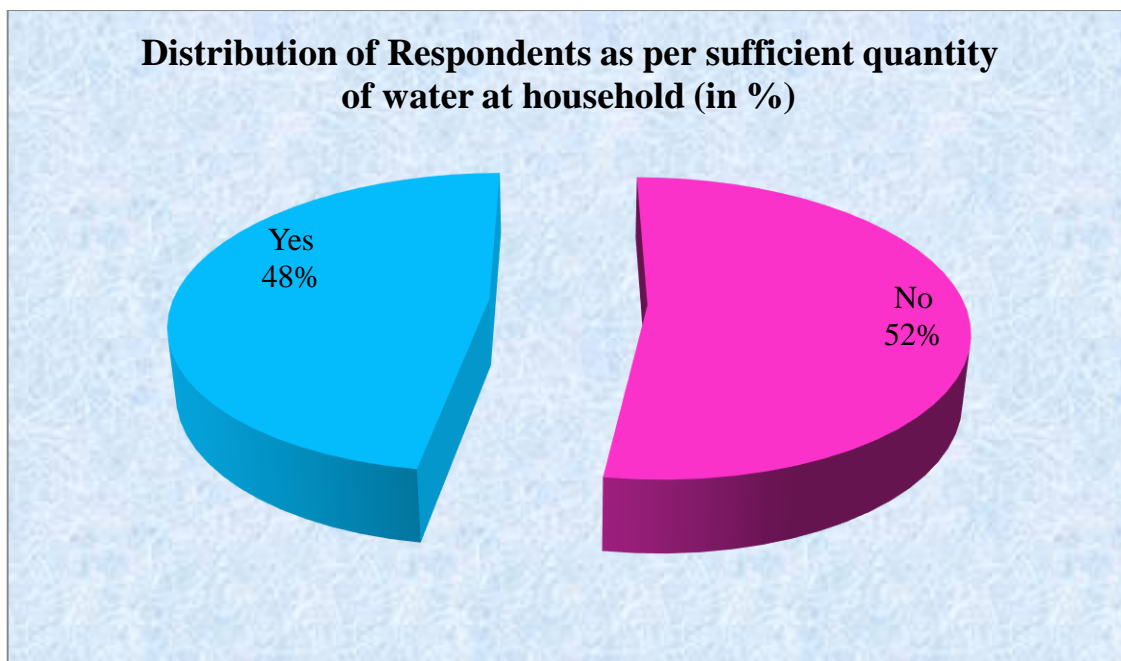**d) Sufficient quantity of water at household level**

The average rate of water supply in the city appears satisfactory, but the distribution is not equitable. While some areas receive water supply round the clock, some areas hardly get water for an hour. Some high level areas do not get water through the pipe network and tankers need to be deployed in these areas. There is a wide disparity in the water supply rate and pressures.

The inadequate service storage, small and leaking old pipes and unfavorable topography result in inequitable distribution. The following Table 3 shows that 47.5 percent citizens are getting sufficient quantity of water at houses and 52.5 percent citizens are not getting sufficient quantity of water at houses. It is interesting to observe that though a majority of households consume water above the specified norms, they are not satisfied with the available supply. This is mainly because they are using excess amount of water in relation to available supply from the concerned municipalities or water authorities.

Table 3: Distribution of Respondents as per sufficient quantity of water at Household

Sufficient quantity at household	No of Respondents	In Percentage
Yes	190	48
No	210	52
Total	400	100

(Source: Household Survey Data)

Distribution of Respondents as per sufficient quantity of water at household (in %)

Yes
48%

No
52%

(*Source: Household Survey Data*)

Figure.4: Distribution of Respondents as per sufficient quantity of water at Household (in percentage)

e) Suggested ways for improving the Water Supply System in the selected area

Along with water conservation, it is also essential to improve water supply system as it is uneven, hence the citizen's views were taken, to know, the ways for improving water supply system. There are various ways for improving the water supply system as the development & utilization of new resources, implementation of water loss reduction program, regular checking of pipe and valve leakages, implementation of water metering system to optimize water utilization reducing wastage of water etc. and use of water saving appliances.

Table 4 represents the distribution of respondents as per their suggestion about ways for improving water supply system. It is seen that majority of citizens i.e. 83.53 percent suggest that the reduction in wastage of water is the best solution over water problems, after that 52.20 percent support to water loss reduction. Next few citizens 43.68 percent want to implement metering system which is very surprising. Further very few citizens 35.62 percent want to implement the development and utilization of new resources. They feel that optimized cost of commodity can conserve water and all others feel that it is a social responsibility of each and every person.

Table 4: Various Ways for Improving Water Supply System

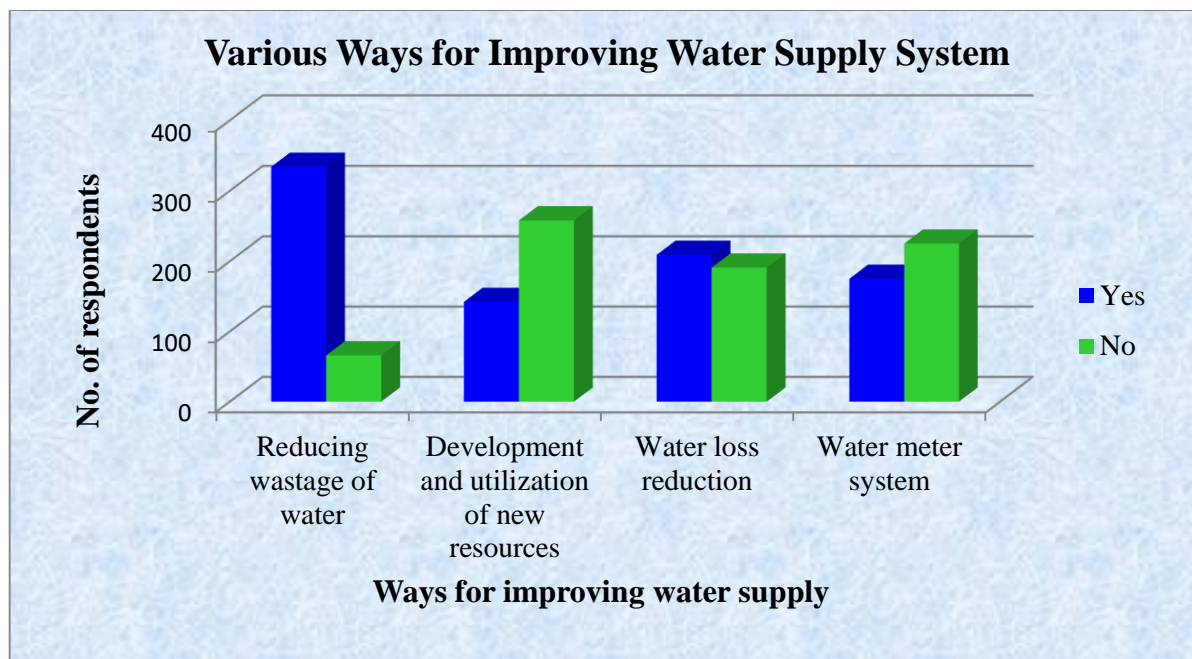| Various Ways for Improving Water Supply System	Yes		No	
	No. of respondents	In Percentage	No. of respondents	In Percentage
Reducing wastage of water	334	83.53	66	16.47
Development and utilization of new resources	142	35.62	258	64. 38
Water loss reduction	209	52.20	191	47.80
Water meter system	175	43.68	225	56.32

(*Source: Household Survey Data*)

Figure 5: Ways for Improving Water Supply System

VIII.   Conclusion

It is observed that the water consumption in Pune city is higher than the norms laid down by Bureau of Indian Standards. It has also been found out that in the Pune city, a majority of the households perceive that the above mentioned activities as most water wasting activities.

- The study reveals that only about 21% of the total households in these cities get 24 hours municipal water supply.
- It is observed that a majority of the residents are getting a very low water pressure due to topographical disparity of Pune City. All the above indicates that the citizens are facing a high degree of problem. Pune city has very old pipeline system so majority of problems are related to pipeline and valve leakages. Due to the topographical disparity of the Pune city, the citizens are facing inequitable water pressure problem.
- The per capita water consumption in selected areas varies between 148 -190 lpcd. It is very low at the outskirt areas like Warje, dhayri, Baner, Dhanori, Lohegoan, North-East part of Hadapsar and highest at the core area of Pune city like Kasba peth, Sadashiv Peth, Sangamwadi, Ghole road, Dhole – Patil road.
- The activity wise maximum water utilization is in the cleaning purpose (70-80 litres) followed by personal hygiene (40-50 litres), then cooking and drinking (15-30 litres) and then toilet (10-25litres). Naturally the area which is located in lower slopes are getting high amount of water and hence the usage for each activity increases and it is vice versa to peripheral area.
- About 48 % of the population is getting sufficient quantity of water and 52 % of the citizens are not getting sufficient quantity of water at houses.
- About 64.38% of citizens believe that the development of new resources will help to improve the water supply system followed by water meter system (56.32%).
- The People agree with the 1.73 point Likert scale for different punishment and reward system which will help to improve the water supply system.

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