WATER DEMAND IN RESIDENTIAL HOUSEHOLDS IN BENGALURU URBAN

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ABSTRACT

The research paper presents the growing issues pertaining to increasing in water demand, also identifies the association between the income of the people and the amount of bill they are paying. Different price slabs which can control the excess usage of water. The researcher also finds out that technology can control the loss of water; also change in behaviour can control the excess usage of water. Water conservation can resolve the issues related to scarcity of water at the household level, the reasons for scarcity is excess consumption of water, non-adoption of technology etc. The issue with increasing water demand at households can be addressed by behavioural level.

Keywords: Water Demand & Conservation Measures.

Introduction

Bengaluru city had 261 lakes in 1961, at that time urbanization was not developed, but in the later period we saw that Sholay Lake was converted to football stadium, Sampangi Lake was changed into the sports stadium, Chellaghatta Lake has been changed to Golf course, and residential layout is constructed in place of Miller Lake etc. Lakes are the natural topography which is the prime reason that the rainfall is not captured and supply is reduced, the water flow is assisted by a canal system called rajakaluves. There is no proper water flow which has resulted in overflow on roads and houses. The city depends on Cauvery for water supply; remaining is captured from groundwater and a tanker, most of the water is imported. As per the studies, 150 litres is used for daily consumption but the supply of water is 65 litres, this shows the supply of water is limited. It is seen that demand is going to be 2314 MLD by 2025 compared to the supply of 1800 MLD (Saldanha, 2016).

Review of Literature

Grech (1987), focuses on the importance of the environmental issues in terms of an increase in water demand in Maltese Island. Secondary data from NSO was taken into consideration to know the water conservation in Maltese Island. The data was collected through 432 self-completion questionnaire surveys, water dairies were used with the sample of 30, the amount of water used was known by the metering of individual households, also comparing the data from the questionnaire and water dairies. The water consumption was also collected using water dairies; purposing sampling strategy was used to collect the data from the respondents. IBM SPSS Statistics 20 was used to analyze the data collected; apart from the tool, Chi-square test was used as the statistical method to present the data, using crosstabs and to check the significance between the variables. It was seen that compared to others countries the household water consumption in Maltese was high in terms of percentage the consumption of water was 9 percent for toilets, 2 percent for car washing, 20 percent dishwashing, 2 percent garden watering, laundry 18 percent, 34 percent was used in shower and 15 percent was used in taps. The consumption totally depended upon the number of families in the households as the usage was more when the number of persons was more, it was also seen that the persons with higher income consumed more compared to low income.

Awadalla and Razzak (2004), examines that the population of the Jeddah city in Saudi Arabia has expanded due to urbanization; this increase in the population requires more water supplies in order to meet the demand. In order to conduct the study simulation model is used which was developed by the Institute of Water Resources Municipal and Industrial Needs (IWR-MAIN). The data was collected through a questionnaire and interviews which were divided into various cities of Jeddah; the number of respondents was 307 for the questionnaire which was later on transferred into the database for analysis. It was found that the amount of water used can be reduced using various water conservation methods beginning with the reduction of water use were in the water is consumed by households and residence, education and awareness can be a form of water conservation if the practice is done by the younger generation they grow up with knowledge of water conservation and apply towards their lifestyle. Education programme was also conducted to help the people know how the water can be used and conserved, it is also seen that books on water conservation have been distributed to the people of Jeddah city. Apart from the above methods used for water conservation, modern technology in the taping system can be used such as aerators, low flow shower heads, toilets with low flush volume, pressure regulators, and appliances which are water efficient. Retrofit schemes can also be used like toilet dams, displacements bags, and bottles, shower flow with restrictors and faucet aerators.

Cader (2004), analyses the demand for water in the city of Kansas. The paper explains the factors such as own block price, per-capita income, population, annual precipitation and the annual average temperature on the likelihood of consumption in different blocks. The paper examines the block rates in 8 different regions; the block prices were obtained from Kansas Municipal Water Use Publication, more than 2000 publications were used in the form of data so basically the source of data was secondary. The data were analyzed and variance for per-capita income in all regions was checked, also the differences in variance, while protecting the Type I error probability null-hypothesis of this test is that the variance in per-capita water consumption is homogenous across the regions in Kansas the null-hypothesis was not rejected. The variables were significantly impacting the individual block effects; the results also showed that the consumption will be reduced due to increase prices. So the study was concluded as per-capita consumption was given more importance and was considered an important research area, the economic activities were dependent on nature and climate may influence the water consumption.

Worthington and Hoffwan (2007), the study focuses on residential water demand analysis, the demand has increased with various factors like population growth and urbanization. Hence, the suppliers placed pricing structures to control water consumption. Secondary data was used to collect the data. The ordinary least squares (OLS), generalized least squares (GLS) were used to analyze the data. The findings in the particular study are that the residential water demand modelling has been obtaining consistent, reliable and useful measures of the price. Their residential water may be low under the income elasticity; there is also the importance of sample or specification bias. The price elasticity is seen higher in summer than in winter, there is a need to work in this area residential water demand is basically a primary factor as the demand for water is from other industries as well.

Dolnicar and Hurlimann (2010), the paper focuses on attitudes towards water conservation, water conservation behaviour, water efficient appliances and their behaviour towards it and use of water-efficient appliances in Australia. The online survey was conducted; participants were sent an email inviting them to study the online panel. There were 1495 who participated in the survey, quota sampling was used as the sampling method and the study was conducted in 8 places of Melbourne i.e. Adelaide, Brisbane, Darwin, Mallee, Melbourne, Perth, Sydney, and Toowoomba. The findings suggests that Australians have a very positive attitude towards water conservation and efficient appliances, but the same has not been converted into action, people say that water conservation is very important but the same is not implemented and there is no improvement seen. Re-use of water is hardly done, at the time of survey's respondents have a positive attitude towards the work but it's not the same when they are doing it practically. The Australians are not ready to put their money for the appliances to be installed, so it is required for the people to change their attitudes towards the conservation of water.

Objectives of the study

- To study the various usage of water and the measures adopted to conserve water in the households of Bengaluru.
- To examine the effects of differential pricing and the water demand.

Hypothesis

- H0: There is no significant relationship between different price slabs and water demand.
- H1: There is a significant relationship between different price slabs and water demand.

Methodology

The study is based on primary and secondary data. The stratified sampling method is used to collect the primary data. Wherein outline questionnaire and interviews were administered to 152 household respondents. The data collection was divided into areas covering Cauvery water supply, bore wells and water supplied through treatment plants. The study also made use of secondary data from NSS Survey, BWSSB, BBMP, and Karnataka Economic Survey.
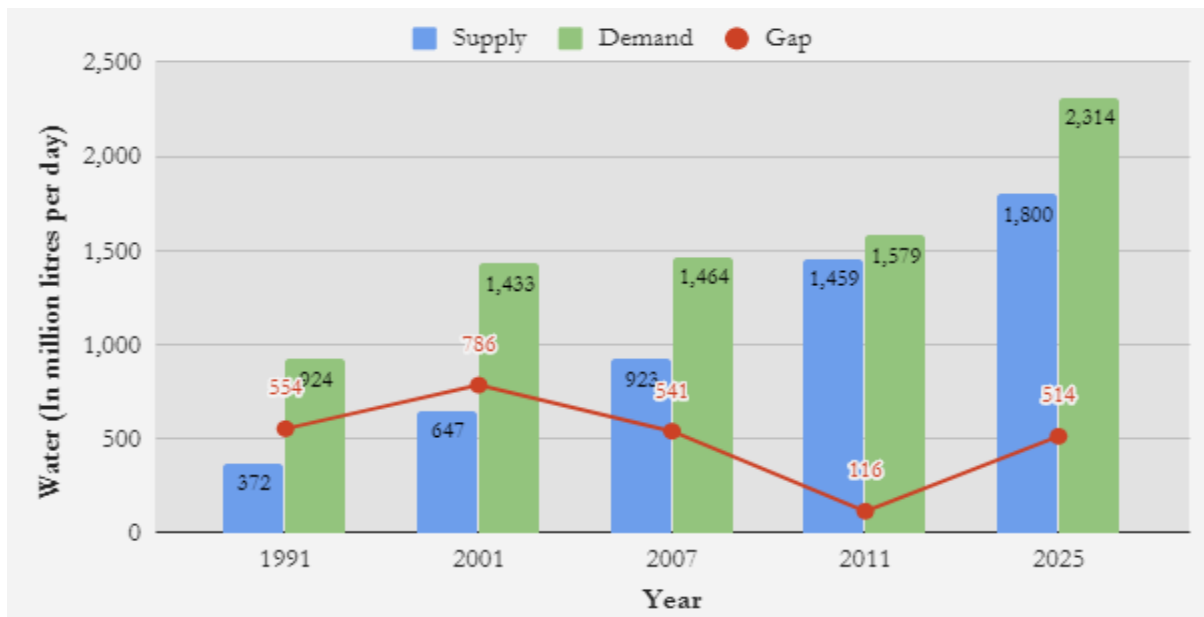
Water demand in Bengaluru

Fig.1. Projected Demand and Supply gap in Bengaluru city.

Source: Alison Saldanha, 2016

From the above figure, it is seen that the supply never meets the demand, the increase in demand is trending the interest for water is in every case high with as the supply is limited. According to the sources, the demand will be increasing in future with the above factors mentioned, which are responsible for the increment in water request. The supply is limited from surface and groundwater which is also getting depleted rapidly, the supply has to be managed by the policymakers and the supply has to be increased by water authorities by catching the rainwater with better storage. The rainwater should be captured from the demand side as well, as individuals can receive for rainwater collecting in their family to control the expanding request with the accessible supply.
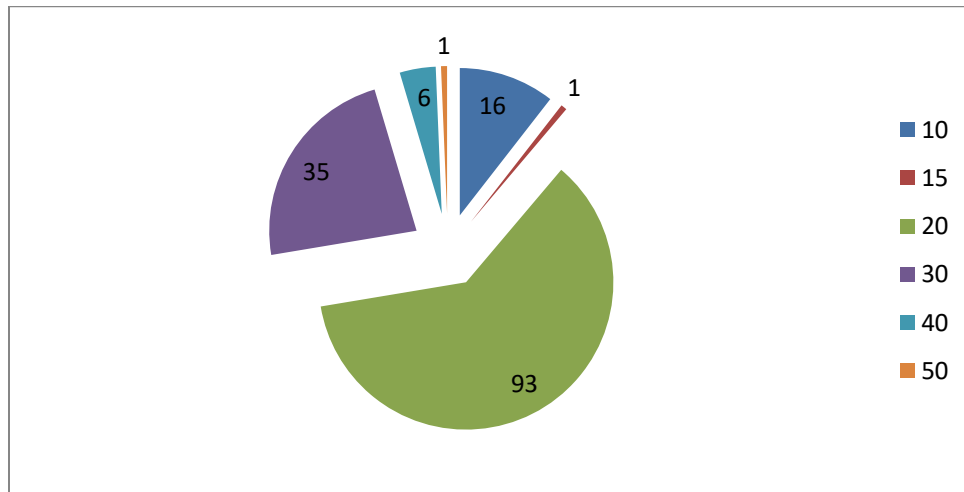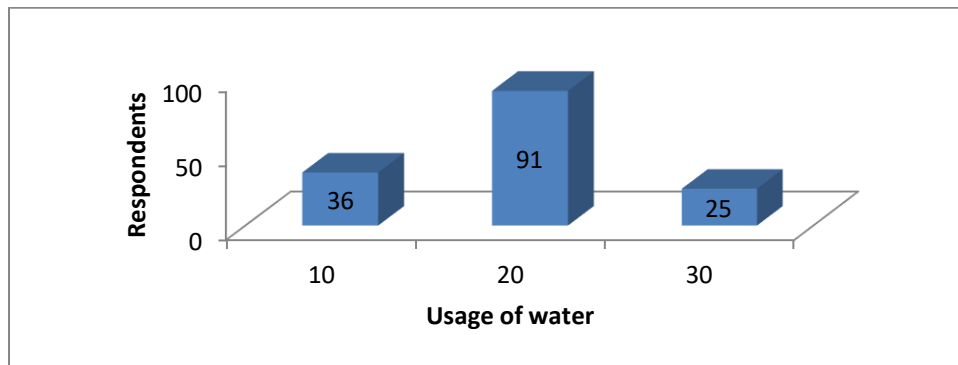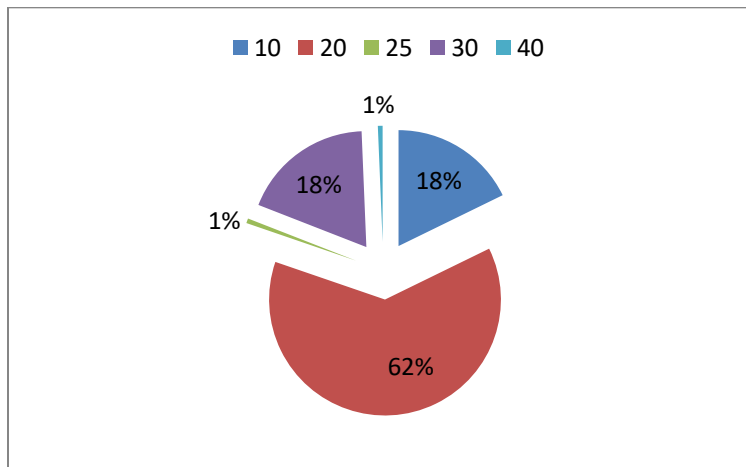

Fig.1.1. Drinking water consumption in households

Figure 1.1 analyses the conduct of the general population towards the water utilization as a portion of the propensities were contemplated drinking water and it is seen that 93 of the respondents use 20 percent of water for drinking apart from there other activities, 35 respondent use 30 percent of their water for drinking. 16 respondents use 10 percent of their water for drinking, 6 respondents use 40 percent of their daily water for drinking as the family size is more compared to others. One respondent uses water of 50 percent for drinking and one of the respondent's uses 15 percent of water for drinking. The usage of drinking water depends upon the size of the family, it is seen that most of the members whose family size is more have consumed more water for drinking apart from the other respondents.
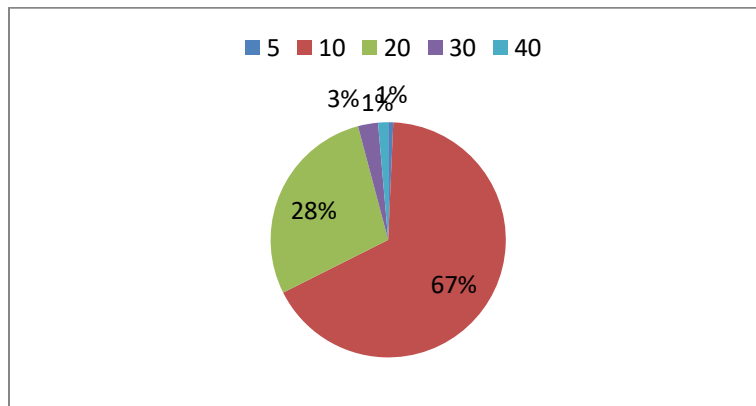
Fig.1.2. Cooking water consumption in households.

The above Fig.1.2. analyses the water usage pattern for drinking, the cooking pattern was analyzed it is seen that 91 respondents use 20 percent of their daily water for cooking, 24 respondents use 30 percent of water and 36 respondents use 10 percent of their water for cooking. The indoor water usage is seen accurate and there was no excess consumption of water compared to the usage made for other purposes, it is seen that there is no high usage of water and it is done based upon the requirement but the same water can be re-used which is not been done.


Fig.1.3. Bathing water consumption in households.

In Fig.1.3 it is seen that 95 respondents use 20 percent of water for bathing; next 28 respondents use 30 percent of water for nothing. Pursued by 27 respondents who utilize 10 percent of water and the rest of the 2 respondent utilize 25 percent and 40 percent of water for showering. The usage of water is more with some of the respondents as the same can be stopped by reducing the excessive use of water, thereby the reduction in more usage can conserve water and the water demand can be controlled.

Fig.1.4. Toilet water consumption in households.

Fig.1.4 analysis the water usage for toilets have also been studied, 67 percent of respondents use 10 percent of their water in toilets, followed by respondents of 28 percent use 20 percent of water. Respondents of 3 percent utilize 30 percent of the water for toilets and the remaining percentage of the respondents use 40 to 5 percent of water. It is seen that the consumption of water is more under this category as people do not use modern technology for their toilets, replacement of dual flush toilets can conserve the water in the residential households.
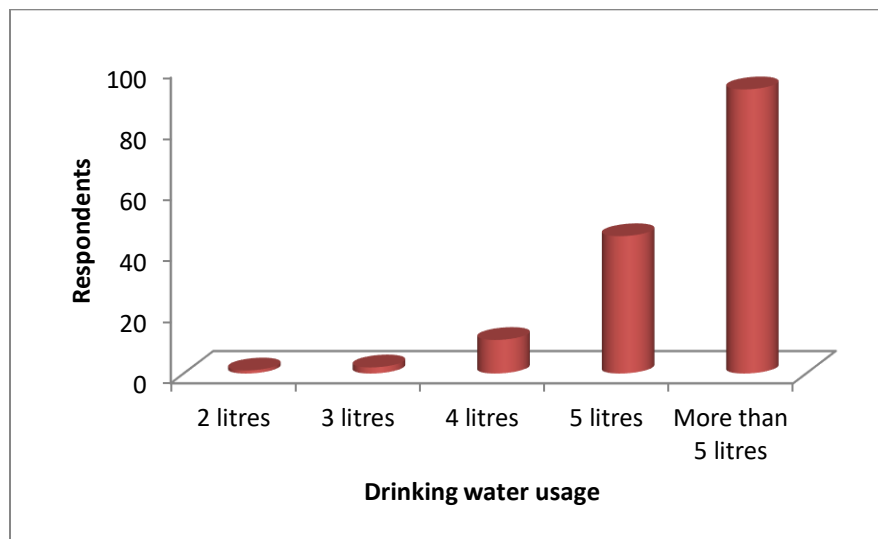

Fig.1.5. Drinking water usage in households.

Fig.1.5 portrays the water used for drinking in households it is seen that more than 61 percent of the respondents use more than 5 litres of water each day, followed by 30 percent of respondents who use 5 litres of water for their drinking. Respondents of 7 percent consume water as 4 litres

in a day, 2 percent of respondents mentioned that they consume 3 litres of water in a day and finally 1 percent of respondents consume water as 2 litres for drinking. The usage pattern differs among the people as the family size is different and some people consume more water for drinking, the drinking water depends upon the quality of water. It was also studied that most of the people use bottled water, if there was the difference in consumption of drinking water as people do not wish to consume tap water for hygiene purpose, respondents of 99 percent mentioned that they use bottled water and not the tap water.

Outdoor Usage: People have very less usage of water towards flowering; most of the respondents have said that they don't utilize water for flowering. 11 respondents agreed that they do utilize 20 percent of their water and 22 respondents agreed that they do utilize 10 percent of water for flowering. It is also observed that very few use water for car wash since they don't wash car by themselves rather they send it to car washer.
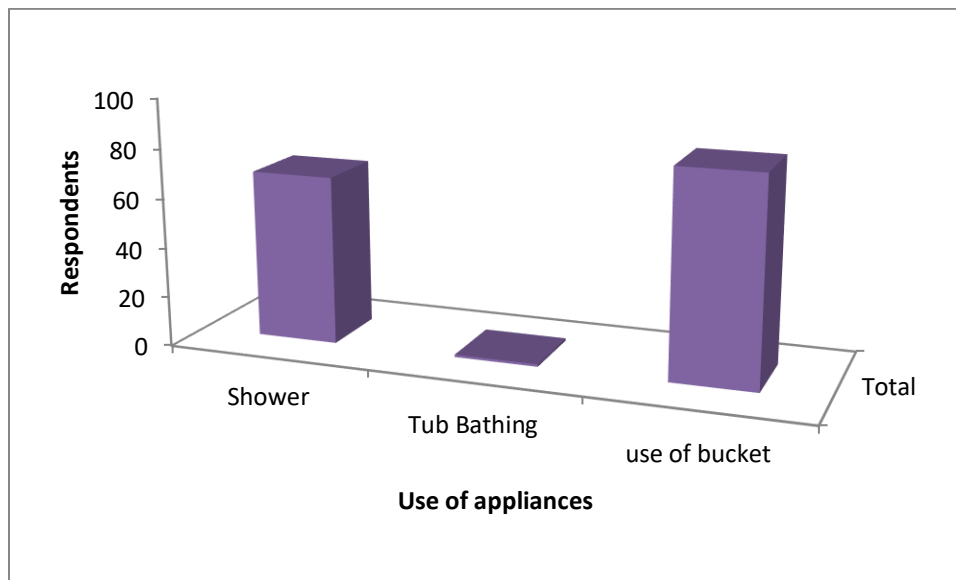

Fig.1.6. Usage of water appliances.

In above fig.1.6 analyses that the individual cleanliness the more of the respondents utilize water through the pail, respondents of 54 percent utilize container while washing up it's an extremely good form of behavior as the same can consume more water compared to the usage of other appliances which may lead to loss of water. 45 percent of the respondents use the shower for bathing and 1 percent of the respondent's use tub bathing. Shower usage, if it is used for a longer time, can lead to water loss, tub bathing percentage is very less so it is seen that loss of water is avoided here.
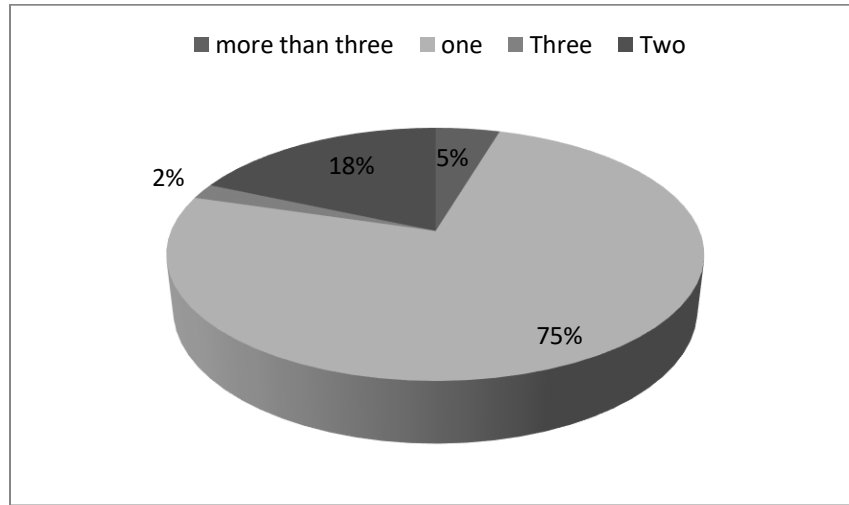
Fig.1.7. Water usage in buckets per day.

In the above figure, it is seen that 75 percent of the respondents use one bucket of water while washing, trailed by 18 percent of respondents who used two buckets of water. It is seen that 5 percent of respondents use more than 3 cans of water while washing and 2 percent of the respondents use more than 3 containers of water. The utilization of water is less while washing as most prominent respondents uses only a solitary bowl of water and there is no wealth usage of water, yet a part of the respondents use more than 3 pails that are from its prompts loss of water.
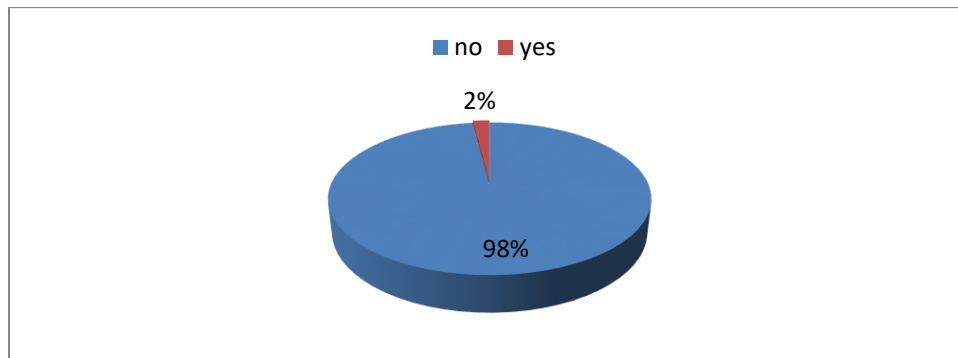

Fig.1.8. Taps used in households.

Fig.1.8. In the wake of examining the quantity of taps in the family unit the spillages of taps were contemplated 98 percent of the respondents said that they don't face such issues yet respondents of 2 percent mentioned they face leakages, if such issues occur it is better to address as the same can lead to loss of water.
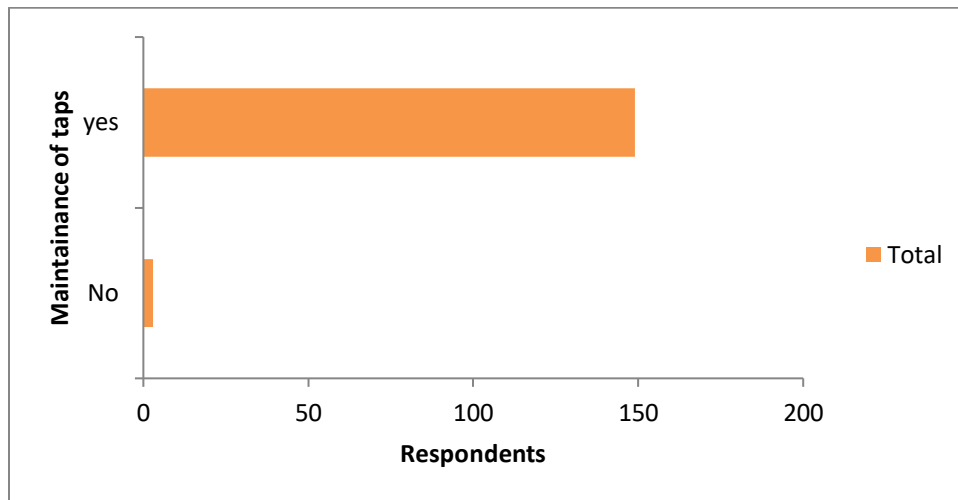
Fig.1.9. Maintenance of taps.

Fig.1.9.shows whether they maintain taps regularly from the leakages. 93 percent of the respondents mentioned that they do maintain and 7 percent of respondents mentioned they do not maintain the taps from the leakages reason being that their income is less to replace the taps with technology or repair the existing system they use.
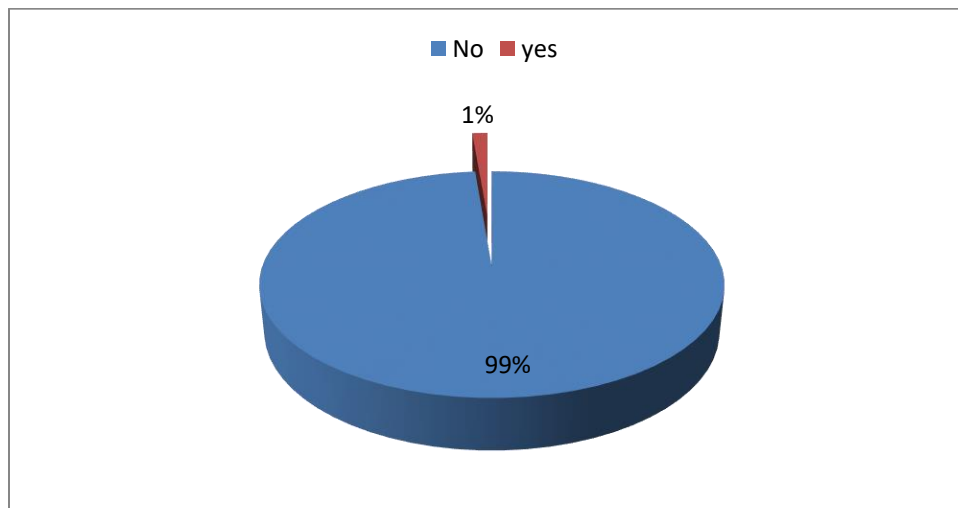
Fig.1.10. Rainwater harvesting.

Fig.1.10 portrays that the respondents were inquired if they practice rainwater harvesting at their household, 99 percent of the respondents do not practice the same but 1 percent of respondents practice rain water harvesting. It was seen in of the private family unit don't have an arranged arrangement of collecting precipitation water and a large portion of the water is getting wasted, if

the capacity is arranged if the storage is planned properly in the residence then the water can be kept and the same can be used.
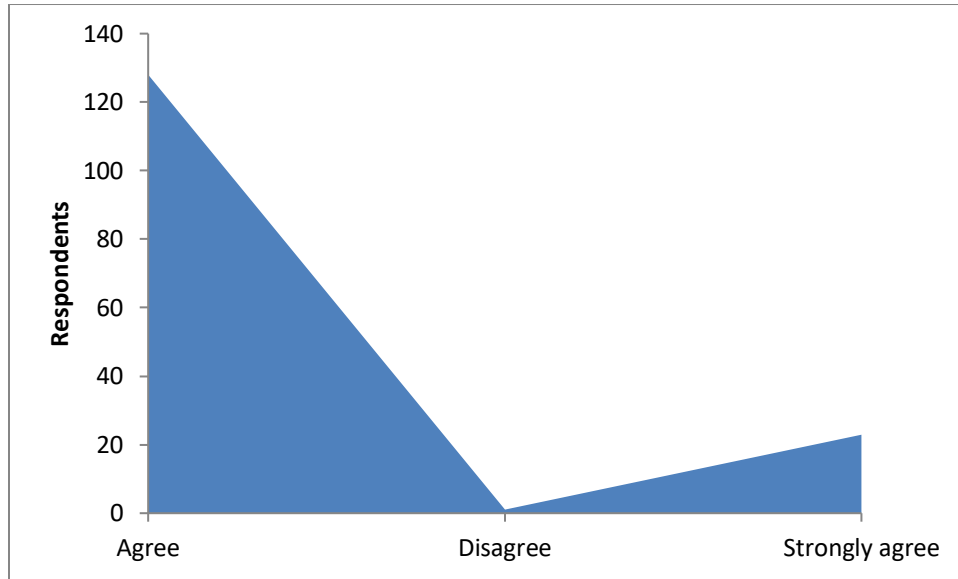
Fig.1.11. Indoor water conservation range.

From the above analyses we can see that respondents of 83 percent agree that adjustable water flapper can conserve the water, remaining respondents of 17 percent strongly agree with the use of adjustable water flapper. None of the respondents have mentioned neutral, disagree and strongly disagree. The range was analyzed in order to know the indoor water conservation behaviors of the people, other measured includes.

Fig.1.12.Outdoor water conservation range

The above analysis was on the question of usage of hose while washing the car can lead to water conservation, respondents of 85 percent agreed that it can conserve the water. Respondents of 14 percent strongly agreed and respondents of 1 percent disagreed as they have never encountered such conservation practice.
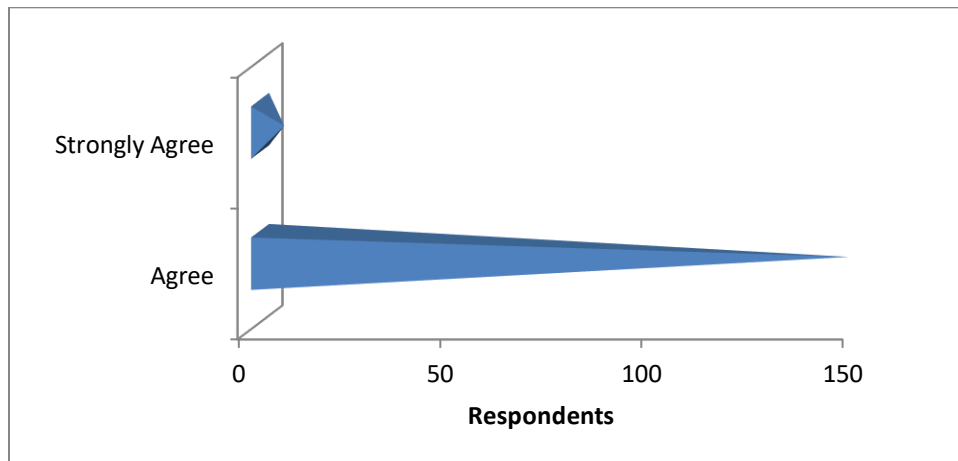
1.13. Chi-square showing there is a significant relationship between pricing slabs and water demand.

Df	2
Chi square calculated value	48.47
$X^2_{0.05}$	5.99

The table 1.13 shows that the calculated value is greater than the table value. The null hypothesis is rejected and there is a significant relationship between pricing slabs and water demand.

Findings

- The maximum usage of water is for drinking, cooking, and bathing. The remaining percentage is outdoor water usage, so it is seen that indoor water usage in more compared to outdoor water usage in Bengaluru.
- The study reveals that behaviours are not only factors responsible for the increase in water demand; technology, limited supply, and water conservation measures are also responsible factors for the increase in water demand in households.
- It was found that the bigger piece of the residential family units don't have a developed a system for rainwater harvesting, because of this reason most of the water is getting wasted.
- Income was a factor responsible for the loss of water, as many of the residents are not intrigued to adopt technology or maintain the leakages or loss of water from pipes, as their income is insufficient to replace the existing tap, water conservation appliances with the new technology.
- Different price slabs are methods, through which the demand can be controlled. The usage of water is reduced if the bill charges are high and the usage increases if the bill charges are less. The chi-square rejected the null hypothesis and proved there is a significant relationship between pricing slabs and water demand.

Conclusion

The behaviour of the respondents was analyzed taking in consideration of their usage in the daily activities, it was found that a large portion of the respondents use water at an average level and it is seen that high usage is avoided but few respondents consume more water towards indoor water usage. The implementing of the price slabs depends upon the earnings of the people. It was found that the bigger piece of the residential family units don't have a developed a system for rainwater harvesting, because of this reason most of the water is getting wasted. In the city, people do have water shortages and the same is constant, the same has to be addressed at policy levels. Due to storage issues, the rainfall is not captured, proper planning of the infrastructure can be an option to determine these issues as the limited supply of water is not meeting the current demand of the people. At the domestic level, behavioural level and consumption issue have to be addressed; policies and infrastructure are something related to the government, NGOs, local water bodies and the decision makers. These institutions should join together and make decisions and policies which benefit the society, the policies should be planned in such a way that the scarcity issues can be resolved. The government only cannot solve the problem so it is the individual participation that can look into their water consumption level, avoid excess usage, work upon the technology part and prevent loss of water. The study explains in details about the current water consumption in households, people should use technology and change their behaviours towards usage of water.

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Annexure

Table 1.1. Drinking water consumption in households.

Drinking water in percentage	Number of respondents
10	16
15	1
20	93
30	35
40	6
50	1
Total	**152**

Source: Compiled by researcher from primary data

Table 1.2. Cooking water usage in households.

Cooking water usage in percentage	Number of respondents
10	36
20	91
30	25
Grand Total	**152**

Source: Compiled by researcher from primary data

Table 1.3. Bathing water consumption in households.

Bathing water usage in percentage	Number of respondents
20	95
30	28
10	27
25	1
40	1
Total	**152**

Source: Compiled by researcher from primary data

Table 1.4. Toilet water consumption in a household.

Toilet water usage in percentage	Number of respondents
10	102
20	42
30	5
40	2
5	1
Total	152

Source: Compiled by researcher from primary data

Table 1.5. Drinking water usage in households.

Water usage for drinking	Number of respondents
2 litres	1
3 litres	2
4 litres	11
5 litres	45
More than 5 litres	93
Total	**152**

Source: Compiled by researcher from primary data

Table 1.6. Use of appliances while bathing.

Appliances used in bathing	Number of respondents
Bucket	82
Shower	69
Tub bathing	1
Total	**152**

Source: Compiled by researcher from primary data

Table 1.7. Buckets of water used while bathing.

Number of buckets of water	Number of respondents
More than three	7
One	114
Three	3
Two	28
Total	**152**

Source: Compiled by researcher from primary data

Table 1.8. Leakages in taps.

Leakages in taps	Number of respondents
No	149
Yes	3
Total	**152**

Source: Compiled by researcher from primary data

Table 1.9. Maintenance of taps.

Maintenance of taps	Number of respondents
No	10
Yes	142
Total	**152**

Source: Compiled by researcher from primary data

Table 1.10. Practice of rain water harvesting.

Rain water harvesting	Number of respondents
No	150
Yes	2
Total	**152**

Source: Compiled by researcher from primary data

Table. 1.11. Indoor water conservation measures at households.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Use of adjustable water flapper	26	126			
Turn off tap when not required	16	84			
Recycling of water	15	84		1	
Monitoring and repairing of leakages	18	82			

Source: Compiled by researcher from primary data

Table .1.12. Outdoor water conservation measures at households.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Use of hose while washing the car	21	129		2	
Check and repair the outdoor leakages	29	123			
Re-use of water	6	141	5		
Use of watering systems	7	145			

Source: Compiled by researcher from primary data

1.13. Chi-Square showing there is a significant relationship between pricing slabs and water demand.

Df	2
Chi square calculated value	48.47
$X^2_{0.05}$	5.99

Table of observed frequencies

Annual Income/Bill	Less than Rs.400	Rs.400 & above	Grand Total
Less than 2 Lakhs	54	11	65
2 – 5 Lakhs	14	49	63
5 Lakhs & above	10	14	24
Grand Total	**78**	**74**	**152**

Table of expected frequencies

Annual Income/Bill	Less than Rs.400	Rs.400 & above	Grand Total
Less than 2 Lakhs	34	31	65
2 – 5 Lakhs	32	31	63
5 Lakhs & above	12	12	24
Grand Total	**78**	**74**	**152**

Source: Compiled by researcher from primary data