CHAPTER 4

CRITICAL EVALUATION OF SERVICE PERFORMANCE USING DEVELOPED INDICATORS

4 CRITICAL EVALUATION OF SERVICE PERFORMANCE USING DEVELOPED INDICATORS

Level of service is an important aspect for the performance evaluation from the suppliers as well as consumers' point of view. This aspect directly relates the perceived benefits of the services provided which the users' entertain against the cost paid by them or spent by the suppliers. Similarly, the management aspects involve the administration capabilities for the supply of various services to the users.

Sustainability of source, adequacy of water, reliability of water supply, acceptable water quality amongst the users', awareness in users' for water supply services, etc. are some key indicators used for the performance evaluation of various RRWSS in the present chapter.

4.1 Sustainability of Source

Most of the water supply schemes were traditionally designed based on locally available water source. However due to non-perennial surface water source during summer it became dry, was not uncommon in many water supply schemes. Similarly, with the increase in ground water withdrawal; the ground water table progressively declining. Therefore in schemes based on ground water sources, Due to decline in water table and deterioration in the quality of ground water, source failure is very common. In summer, these sources are also getting dry and water supply fails.

Gujarat is having 1100 km long coastal belt. Due to over withdrawal of the ground water, sea water intrusion takes place and ground water become saline.

Some of the schemes which were designed based on small ponds or water supply from branch irrigation canals were also failed due to non

sustainable source in overstressed summer season. Also, the quality of surface water in some of the industrial and urban belts is deteriorating due to pollution problems.

Therefore, for the sustainability of any water supply scheme, it is very much necessary to select the appropriate and reliable source.

4.1.1 RRWSS Variav Group, Surat

The source of RRWSS Variav group, Surat, is intake well which is located in the u/s of causeway constructed on river Tapi, near Surat city. The river Tapi is having main catchment in the state of Maharashtra; a second largest Ukai dam of Gujarat is constructed on this river. Kakrapara weir is also situated on this river. River Tapi is perennial moreover, due to Ukai and Kakrapara weir and the sufficient quantity of water is available throughout the year. The cause way is constructed on river Tapi near Surat city and has a storage capacity of 31 MCM which is adequate with the water requirement of Surat city as well as rural and other users. So, source is sustainable as far as the water availability is concerned. However, due to the construction of another well for potable water demand of the Surat city and high silting rate, some issues of source sustainability are also raised in past few years.

The river Tapi has faced floods for many years, for example in the year 1968, 1974, 1998, 2002 & 2006. During the flood, silting rate increased which may affect in longer time.

It has been stated by Central Pollution Control Board that the stretch of the river Tapi, that passes through the city of Surat is moderately polluted. Tapi waters at Ukai Dam and at Mandvi were upgraded to Class A (drinking water source without treatment but after disinfection) in 1997 from class B (useful for outdoor bathing only) in 1991. The waters at Kathor Bridge after entering the city are put under

class B. It has been observed that there has been a rise in the COD (Chemical Oxygen Demand) level at all three locations namely, near Ukai dam, Mandvi & Kathor Bridge.

During the flood high turbid water may disturb the filtration plant. Algal growth has also been observed due to stagnation of water in source, which may deteriorate the quality of source water.

4.1.2 RRWSS Gadhada Group, Bhavnagar and RRWSS Ishwaria Group, Amreli

These water supply schemes have a main source Pariej and Kanewal tanks. The tanks are filled from the Limbassi branch of the Mahi irrigation project. Vegetative growth in this tank is very high and that is not regularly removed. This vegetative growth is not only affecting the quality of water as well as functioning of intake structure. During the consecutive draught years, the source may fail, for example, during 1985 to 1987, Gujarat has faced draughts. The silting process may reduce live storage of the pond and in long term it requires desilting process.

4.1.3 RRWSS Mandvi Group, Kachchh

The Mandvi group RRWSS is designed on the bulk water supply pipe line to Kachchh by NC 11 and NC22. These pipe lines are filled from an intake structure constructed in Malia Irrigation branch of Sardar Sarovar Project. So, source is sustainable. After facing earthquake in year 2001, in this region, Government gave higher subsidies for industrial development. Many industries came after this earthquake. The main water supply source is also this bulk water supply lines. The irrigation project recovers higher revenue or water charges from these industries for water supply as compared to drinking water supplies. So, industrial

withdrawal of water is much higher as compare to the quantity at design level. So, tail end villagers may not get sufficient water from this source.

4.2 Adequacy for Water Supply

In June 2002, Government approved relaxation of 'coverage' norms under ARWSP to provide for 55 lpcd with a source within 0.5 km in the plains and 50 meter elevation in the hills after coverage of all NC/PC rural habitations in that State is achieved as per the then existing norms of 40 lpcd with a source within 1.6 km and elevation of 100m. This relaxation was subject to the condition that beneficiaries of the relaxed norms were willing to share a part of the capital cost (which should not be less than 10%) and shoulder full responsibility for subsequent operation and maintenance. The norm of 40 lpcd for humans is based on the following requirements:

Table 4.1 Potable Water Quantity Requirement for Various Purposes

(Source: Manual on Water Supply and Water Treatment, 1999)

PURPOSE	QUANTITY IN LPCD
Drinking	03
Cooking	05
Bathing	15
Washing utensils and house	07
Ablution	10
Total	**40**

The norms have been established by the Government of India in order to attain a network facility for providing an acceptable level of water consumption within a stipulated time frame. However, the term 'acceptable level' is crucial and subjective as it decides the level of

satisfaction in evaluation of service performance of the water supply program. Therefore, in the face of resource constraint, the tendency is to impose economy measures. It is also observed that most of the RRWSS in the state of Gujarat are designed to supply 40 lpcd for the initial phases and at a later stage it may consider 70 lpcd norms.

Further, it is difficult to evaluate the 'adequacy of water supply' for different groups in RRWSS, as number of villages and habitations involved are more in numbers as well as their locations vary from headwork. Therefore, in selected RRWSS, adequacy of water is checked by analyzing technical data provided by GWSSB and by carrying out user data survey in certain villages. The results of the user data survey is grouped in the three categories namely, villages located near headwork- Head Villages, villages located near medium distances from the headwork- Intermediate Villages and villages located away from headwork- Tail Villages. (Note: Approximation is carried out on map and advice of GWSSB officials are used for judging the distances from headwork)

4.2.1 RRWSS Gadhada Group, Bhavnagar

In RRWSS Gadhada group, Bhavnagar, the demand assessment was planned at 46 lpcd from Mahi-Pariej project, and upon the receipt of water from Narmada canal project, it can be considered 70 lpcd. During the study period it is observed that only 49 villages are taking water from 67 villages and 1 town, as per design. The villages not taking water depend upon bores/ local source. It is also noted that the common bore and pumping stations are receiving free electricity. It is also noted that some of the villages mix their bore water with the GWSSB water supply to augment their supply.

The total quantity of raw water as per actual design is about 7.07 MLD (presently about 6 to 6.5 MLD) but the quantity of water received is averaging to 5.5 MLD.

During the field visits, in several villages, the actual water available is found about 90 to 100 lpcd.

Table 4.2 Number of Responses of Users' Data Survey for 'Adequacy of Water' in RRWSS Gadhada Group, Bhavnagar

Category of Villages in RRWSS, Gadhada Group, Bhavnagar	Total Number of Responses collected
Head Village	120
Intermediate Village	168
Tail Village	271
Total	559

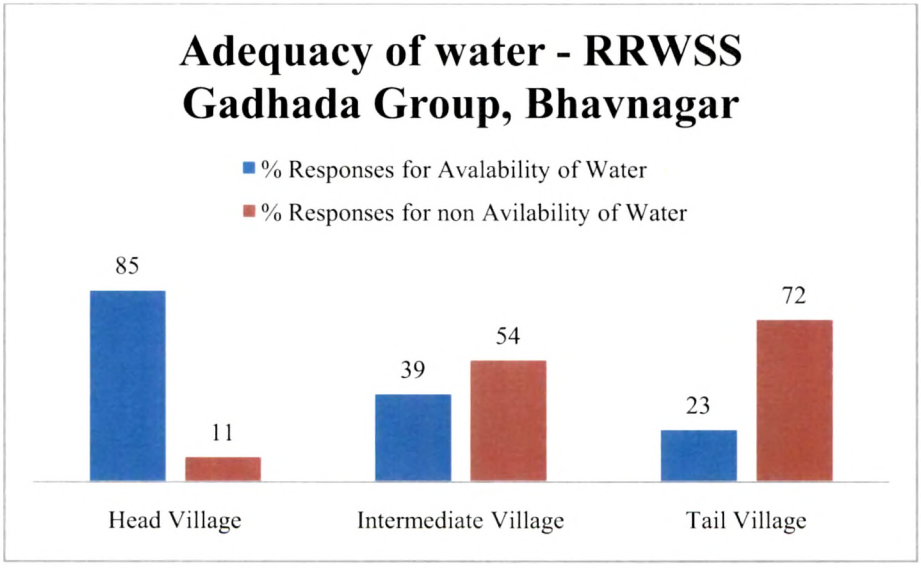


Figure 4.1 Graph showing the % Responses for 'Adequacy of Water' in RRWSS Gadhada Group, Bhavnagar

4.2.2 RRWSS Ishwaria Group, Amreli

As per the design of the scheme, rate of water supply is 70 LPCD considering the water available from Narmada canal based project (partially), which is confirmed during the site visit that the actual rate of water supply is 70 LPCD as per GWSSB staff. For assessing the total quantity supplied water, the number of hours are calculated for pumps at headwork for certain month data, this shows the average of about 5 MLD water supply, which is in slight shortage of the estimated about 6 to 6.5 MLD for population estimates. However, it is also noticed that only about 39 villages were supplied the water as 12 villages are not taking water and rely on own/local source. Further, during the field visit, actual measurements are carried out at consumers' end, which counted about 100 to 140 LPCD. In the user data survey, the responses are satisfactory for Head and Intermediate villages, whereas in Tail end villages, about 60% respondents are getting adequate water.

Table 4.3 Responses of Users' Data Survey for 'Adequacy of Water' in RRWSS Ishwaria Group, Amreli

Number of Responses collected	Responses for Availability of Water	Responses for Non-Availability of Water	Total Responses
Head Village	66	3	69
Intermediate Village	163	35	198
Tail Village	121	82	203
Total	350	120	470
Remark # User not responded for this question are not considered for the evaluation purpose			

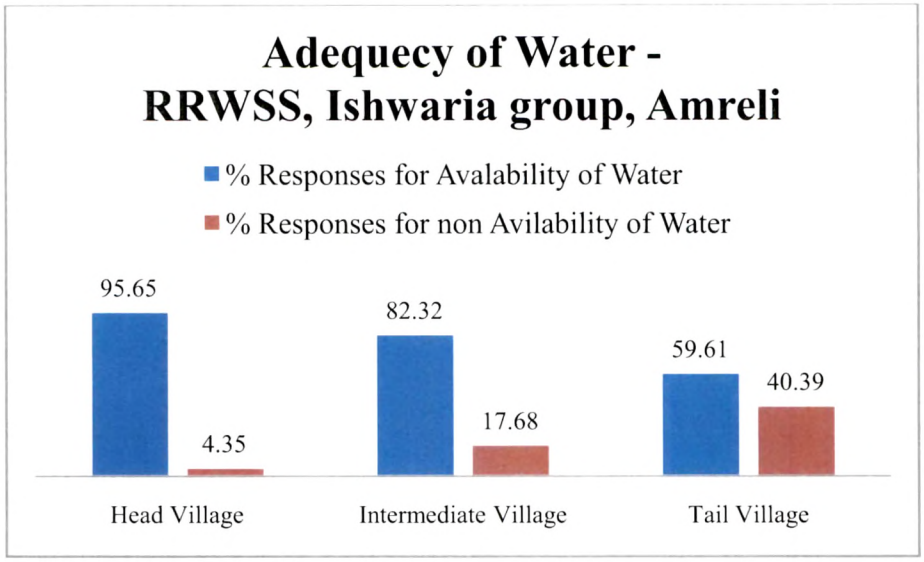


Figure 4.2 Graph showing the % Responses for 'Adequacy of Water' in RRWSS Ishwaria Group, Amreli

4.2.3 RRWSS Mandvi Group, Kachchh

In Users' data survey, about 462 responses were collected for the RRWSS Mandvi group. The variations for the availability and non availability of water are determined for Head, Intermediate and Tail end villages of the scheme. Table 4.4 is showing the overall distribution of responses collected throughout the scheme for categories of village with reference to its distance from headwork. Whereas from figure 4.3, it is revealed that the tail end villagers are mostly not receiving the water from the RRWSS; which may due to inadequate bulk water supply in the scheme.

Table 4.4 Responses of Users' Data Survey for 'Adequacy of Water' in RRWSS Mandvi Group, Kachchh

Number of Responses collected	Responses for Availability of Water	Responses for Non-Availability of Water	Total Responses
Head Village	174	66	240
Intermediate Village	34	67	101
Tail Village	2	119	121
Total	210	252	462
Remark # User not responded for this question are not considered for the evaluation purpose			

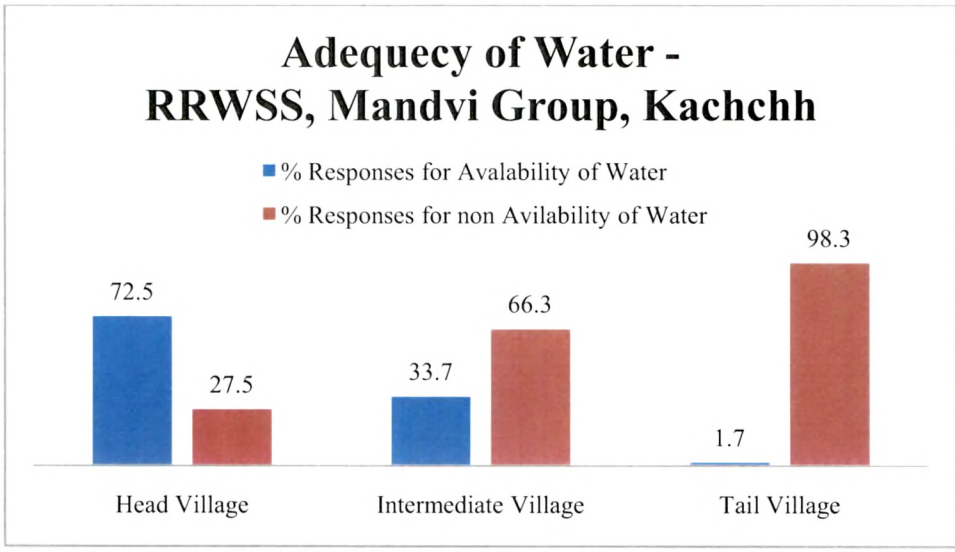


Figure 4.3 Graph showing the % Responses for 'Adequacy of Water' in RRWSS Mandvi Group, Kachchh

Further, the study has also been carried out for the overall availability of water and its variations through various seasons, that is, monsoon, winter and summer. The figure 4.4 clearly indicates that the services for overall availability of water is more in case of RRWSS Variav group compare to RRWSS of Saurashtra and Kachchh, where water is scarce. Also, in RRWSS Variav group, water is available in adequate for summer season, which is not the case in schemes of Saurashtra. The RRWSS Mandvi group is seriously suffering from inadequate water availability point of view in most seasons of the year.

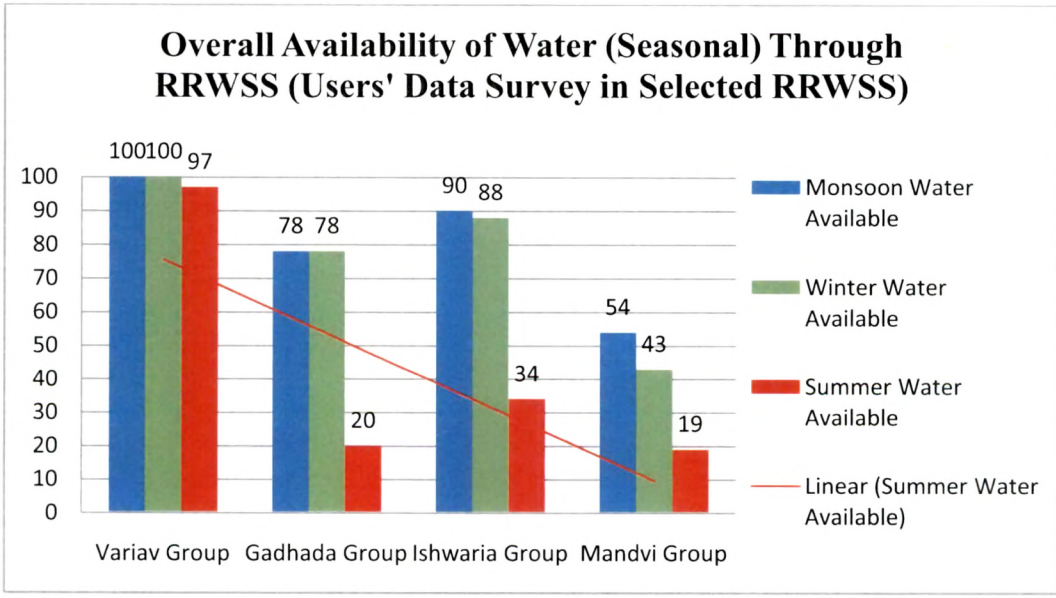


Figure 4.4 Graph Showing the % Responses for 'Overall Availability of Water' Through Various Seasons in Selected RRWSS

4.3 Reliability for Water Supply

Reliability is not a simple indicator to assess, and yet in terms of users' satisfaction which is ultimately more important for the sustenance of water supply scheme. The assessment of reliability is quite complex in practice of water supply as it rely on several variables. For example, if the pump is not working for one or two days, but the supply tank (ESR) is large enough to supply at all taps, then there is no impact on reliability. Similarly, if a feeder pipe breaks, and one of the many regions' taps are not receiving water, still as most users' are receiving water except those 5-7% users, but most users are still happy with the service. If another main pipe, such as rising main, breaks and all users are not receiving the water for few days, then it is considered as serious problem. Therefore, a reliability of service needs to be measured carefully for a particular scheme.

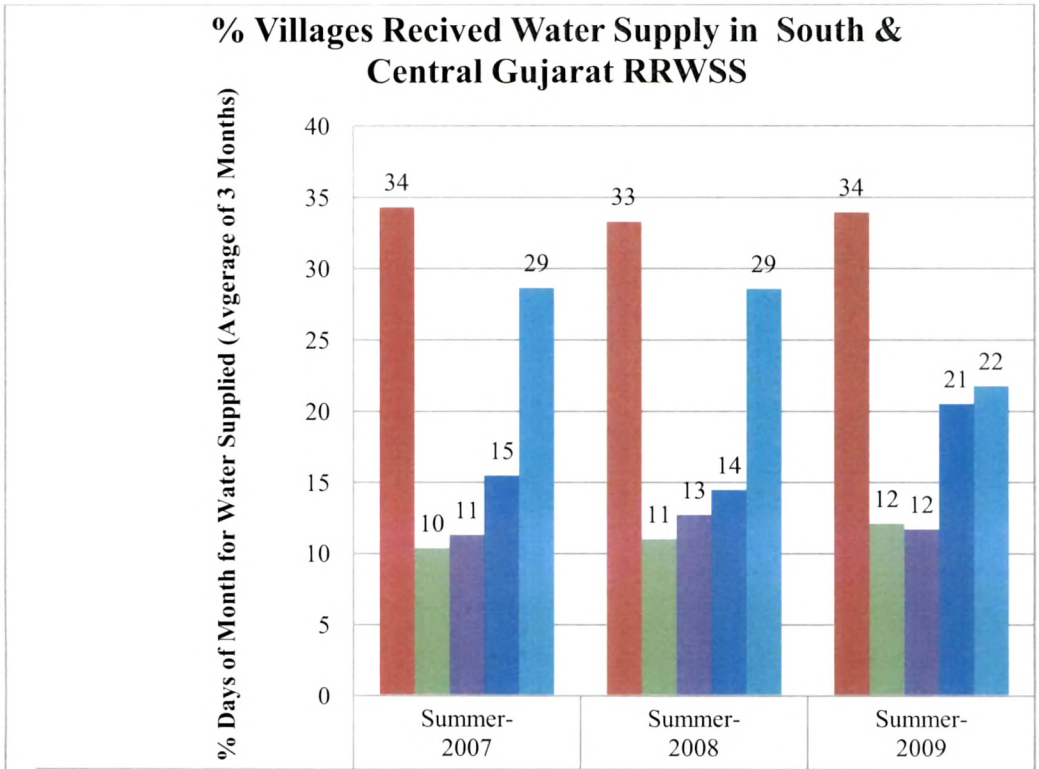
A characteristic of many Regional Rural Water Supply Schemes is that the bulk water supply is discontinuous, particularly in the case of stand-alone systems reliant on pumps, excessive water withdrawal from front end villages, inadequate water in source during summer, etc. The cause of the failure may or may not be beyond the control of local Pani Samitis. Therefore, in the evaluation process for RRWSS, indicator selected is for the percentage days of month for which water received, especially in summer season.

$$Indicator = \frac{Number\ of\ days\ water\ received}{Number\ of\ days\ in\ the\ Month}$$

For the evaluation of water supply reliability indicator, a group of regional rural water supply schemes of whole South & Central Gujarat are selected.

Table 4.5 Showing Frequency of Water Received in Number (Average) of Villages for Summer Season for South & Central Gujarat Schemes (Source: GWSSB)

South & Central Gujarat Schemes	Water received for number of days in month (Average of 3 months)				
Water Supplied	>27 days	24-26 days	20-24 days	<20 days	Villages not received water (may relied on local source)
Summer-2007	974	294	320	439	813
Summer-2008	939	310	358	408	806
Summer-2009	892	318	307	539	572



	Summer-2007	Summer-2008	Summer-2009
>27 days	34	33	34
24-26 days	10	11	12
20-24 days	11	13	12
<20 days	15	14	21
Villages not received water (may relied on local source)	29	29	22

Figure 4.5 Graph Showing % Villages Received water in Summer Season (Reliability of Water Supply) for South & Central Gujarat Schemes

Chart 4.1 and 4.2 are showing the gap of water for supply against the water demand in various RRWSS of Saurashtra and Kachchh region. The detailed analysis of water supplied or received through bulk water supply based on river Mahi and Narmada has been carried out along with the staff of GWSSB recently. The calculation of water demand at each headwork is carried out using the population census data of Year 2011 against the actual water supplied for two months of January (chart 4.1) and February (chart 4.2). These charts are clearly indicating that at many headworks the gap between the water supplied and actual water demand

lies even in the mid of winter season. In the RRWSS situated near the front end of supply projects it is noticed that villages mostly receiving the water even higher than the actual demands. The reason for this may be due to availability of good quality water against the deep sources of underground local sources, users like to withdraw more water from the bulk water supply based RRWSS water. On the contrary, it is noticed that till the bulk water supply projects are under progress and substantial works need to be commissioned in next few years, the tail end head works are not able to get the sufficient water as per the actual demand, therefore, such RRWSS performance is seriously affected.

4.4 Acceptable Water Quality

It is common knowledge that the management of water resources dates back to 5th Century B.C. when, 'Treatise on Air, Water and Place' became part of the Hippocratic Corpus. Yet it is wonder that humanity realized only in 19th Century A.D. that water is one of the important determinants of health and disease. Even in this computer era of phenomenal scientific and technological developments, it is rather disconcerting that there are still constraints in achieving water quality assurance especially in the rural areas of developing countries like India and others.

Based on the stipulations of the World Health Organization and US Public Health Services, Bureau of Indian Standards in their IS:10500-1991 'Specifications for Drinking Water' have exhaustively stipulated limits for water supply and monitoring authorities for adoption and certification to ensure clean and hygienically safe water for human consumption.

When the theoretical knowledge of treatment remains intact universally, in the practical implementation the system suffers widely due to inherent defects, lack of systematic approach and co-ordination.

Common defects include lack of frequent monitoring of raw water quality especially turbidity, poor maintenance of clarifier, ineffective desludging, irregular filter backwashing and algae removal without parallel standby system for continuous treatment. The ritualistic lackadaisical approach in dosing coagulant chemicals results in deterioration of water quality in addition to mud ball formation in filters resulting in ineffective filtration, growth of micro organisms, deterioration of filtered water clarity even compared to raw water; Haphazard chlorination causes either super chlorination and consumer aversion or in-adequate chlorination, lack of contact time resulting in ineffective disinfection. Recontamination of treated water is the worst in that the treatment cost becomes anfractuous and also leads to incidence of waterborne diseases.

Invariably the distance between treatment works and supply area is too long as in Regional Rural Water Supply Schemes and hence the water from the main is stored in service reservoirs and distributed. In such cases there is every possibility of dissipation of chlorine in the mains and hence secondary chlorination to impart a residual of at least 0.1-0.2 mg/lit at consumers' tap after 30 minutes contact time is essential.

As water is distributed in network of pipes, the quality may suffer also due to

1. Corrosion of pipes
2. Flushing which dislodges foreign matter
3. Ingress of dirt and living organisms through leaks
4. Cross connections and contamination
5. Water hammer and surge
6. Growth of organisms including bacteria, algae, schizomycetes, worms and insects
7. Solution of metals with which the water comes in contact

The deterioration may be subtle, discouraging and more difficult to correct than undesirable characteristics of water.

Therefore, it is well known that selection of sources, treatment and maintenance of water supply infrastructure is not possible without the monitoring and evaluation on water quality.

Water quality at source, after treatment & disinfection practices employed at various stages of water distribution network is studied. Grab sampling is done with the help of field staff and water quality is checked for various parameters in all selected schemes. Users' data survey carried out also taken into consideration while summarizing the various facts. Figure 4.6 shows the water quality satisfaction in selected RRWSS during the users' data survey. It is clear from the response of users' that in most schemes, water received through regional scheme meet the satisfactory water quality.

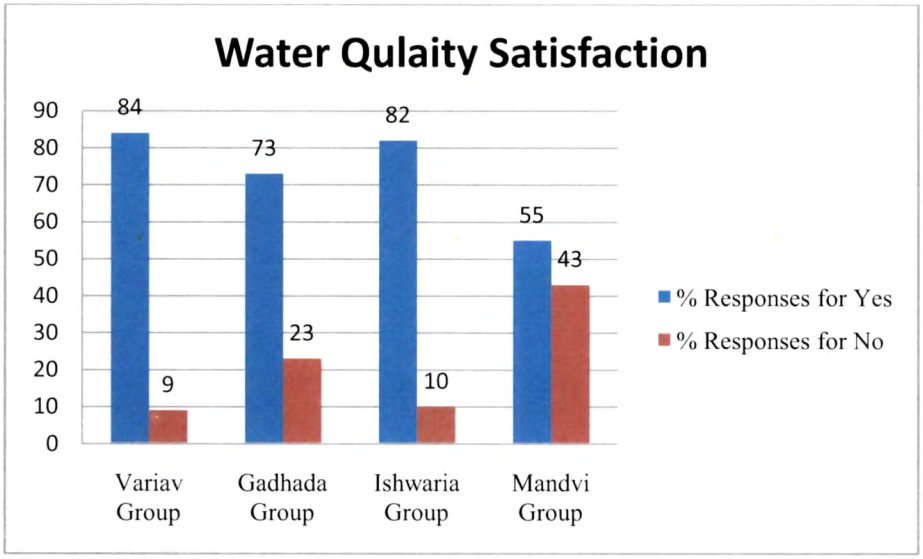


Figure 4.6 Users' Data Survey Results on Water Quality Satisfaction in Selected RRWSS

In users' data survey another important outcome received is that in all schemes most villagers' are aware about the chlorination. During the field visits, it is noticed that the Gram Panchayats and local NGOs' are

making good publicity for the awareness for water and sanitary hygiene. Figure 4.7 shows the results of Users' Data Survey on awareness of chlorination in selected RRWSS.

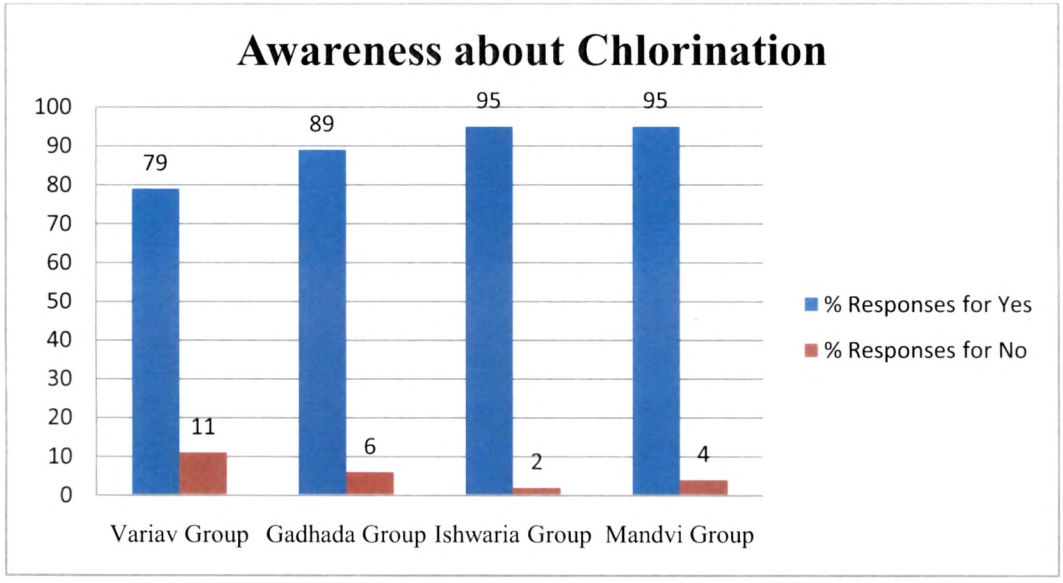


Figure 4.7 Users' Data Survey Results on Awareness of Chlorination in Selected RRWSS

In the study it is also tried to check the awareness of users regarding various treatment methods for the water which they consume. Therefore, in Users' Data Survey, information regarding the awareness regarding domestic methods of treatment such as boiling, filtration, use of chlorine tablets, bleaching powder, use of alum and commercial purifiers, etc. has been covered. Figure 4.8 is showing that the methods such as boiling, use of purification tablets and filtration are popular in most schemes. Further, the RRWSS Mandvi group scheme shows the less awareness for above methods compare to other schemes. This may be due to none or less presence of NGOs, WASMO and/or social organizations in the region active to create awareness in water quality.

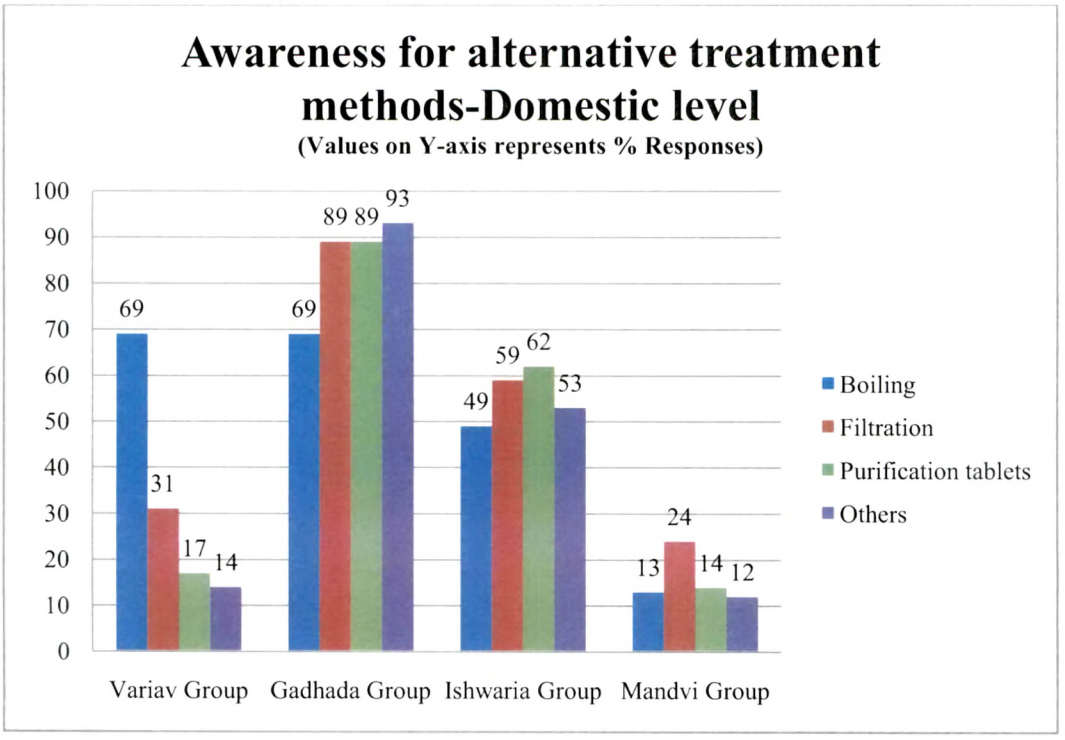


Figure 4.8 Users' Data Survey Results on Awareness for Alternative Treatment Methods Used on Domestic level

4.5 Service Performance Index (SPI)

Service performance is dependent of four indicators as discussed and is as listed below.

- Sustainability of Source
- Adequacy of Water to tail enders
- Water supply reliability
- Acceptable water quality

For the determination of overall service performance, the above indicators can be rated as excellent, medium to high, low to medium and poor. Further, to evaluate the overall service performance of any scheme, importance of all or some of the above indicators may be kept same or different depending on the necessity or importance of above indicators in

the scheme or site specific conditions. So, to evaluate the overall service performance, an Index value may be calculated as per Equation 4.1. Service Performance Index (SPI) can be expressed as

$$SPI = \frac{\sum_{i=1}^{4} Ii\, Wi}{Wmax \times \sum_{i=1}^{4} Ii} \times 10 \qquad \text{Equation 4.1}$$

$$SPI = \frac{I1\,W1+I2W2+I3W3+I4W4}{Wmax\,(I1+I2+I3+I4)} \times 100 \qquad \text{Equation 4.2}$$

Where, W= Weights assigned to each of the indicators based on their ratings; and I= Importance factor for each of the indicators based on their impact on overall service performance and its interrelation to other indicators.

SPI varies from 0 to 100, 100 being the maximum index value with all factor rated as excellent. 0 is the minimum index value that a service can have when all the factors have a 'poor' rating. In general, higher is the index value; better is the service performance of the scheme.

In order to define performance of a service based on the ratings as an Index (numerical value), four ratings may be assigned as weights (0 to 1). The selection of weights for above ratings requires skillful observations which may vary from field conditions. For a present study of Gujarat state, the selected value of weights is as per Table 4.6 (Excellent Performance, W = 1.0, Medium to High Performance, W= 0.65, Low to Medium Performance, W= 0.35, Poor Performance, W = 0.0).

Importance factor (I) attached with Sustainability of source, Adequacy of water to tail enders, Water supply reliability and Acceptable water quality can be same for all or different, as per the user's judgment. The value of the importance factor may differ as per the site specific conditions such as RRWSS lying in the water rich area or water scarce area (i.e importance of water to villagers for drinking in presence/absence of water available from an alternative source).

Table 4.6 Showing Ratings and Weights Assigned for the Various PI's for the Evaluation of Service Performance of an RRWSS

Service Performance Indicator	Rating	Description	Weight Assigned
Sustainability of Source	Excellent Performance	Perennial surface water, Sustainable ground water source with continuous water recharge	W_1= 1.0
	Medium to High Performance	Perennial surface water source with limited availability, ground water source with seasonal recharge	W_1= 0.65
	Low to Medium Performance	Non perennial surface water source, Non sustainable ground water sources with seasonal recharge	W_1= 0.35
	Poor Performance	Non sustainable ground water sources with unknown recharge	W_1= 0.0
Adequacy of Water to tail enders	Excellent Performance	Available water through supply during non monsoon periods > 70 lpcd	W_2= 1.0
	Medium to High Performance	Available water through supply during non monsoon periods between 40- 70 lpcd	W_2= 0.65
	Low to Medium Performance	Available water through supply during late summer periods < 40 lpcd but for other periods between 40-70 lpcd	W_2= 0.35
	Poor Performance	Available water through supply during most periods of year < 40 lpcd	W_2= 0.0
Water supply reliability	Excellent Performance	Water supplied during non monsoon periods >27 days/month	W_3= 1.0
	Medium to High Performance	Water supplied during non monsoon periods between 20-27 days/month	W_3= 0.65
	Low to Medium Performance	Water supplied during non monsoon periods <20 days/month but in other periods > 20 days/month	W_3= 0.35
	Poor Performance	Water supplied during whole year is < 20 days/month	W_3= 0.0
Acceptable water quality	Excellent Performance	Source water meets potable water quality criteria with least/conventional water treatment throughout year	W_4= 1.0
	Medium to High Performance	Source water may turn up to non potable category during summer, but adequate treatment facilities available	W_4= 0.65
	Low to Medium Performance	Source water become non potable category during summer and no treatment facilities/ alternate sources	W_4= 0.35
	Poor Performance	Source water become non potable category during most period of year except during monsoon period & no treatment facilities/ alternate sources	W_4= 0.0

Further, from the study it is also revealed that the 'Sustainability of source', 'Adequacy of water to tail enders' and 'Water supply reliability' are also mutually related and rely partially on each other. Therefore, to evaluate the overall SPI, the selection of importance factor for each PI needs to be carefully selected. In a present study of the Gujarat state for various RRWSS under study area the value of the weights and importance factor selected are as per Table 4.7.

Following assumptions are also made for calculating the overall SPI for above schemes are as under:

1. Service Performance Indicators such as 'Sustainability of source' and 'Acceptable water quality' are much more important at planning stage of any RRWSS, whereas the 'Adequate water supply to tail enders' & 'Water supply reliability' are more important at the operating stage of any RRWSS. By keeping this in central focus, while calculating SPI for four schemes under study the importance factor for later two PI's are doubled.
2. Weights given for the 'Sustainability of source' indicator is assigned as 0.65 for the Gadhada, Ishwaria & Mandvi RRWSS by keeping in mind that though the RRWSS's are relying on sustainable surface water of river Narmada but indirectly on pumping and on other operations of Narmada water supply pipe networks.
3. The ratings for the overall SPI value is interpreted as:

Value of SPI	**Performance Rating**
>80	Excellent Performance
>55-80	Medium to High Performance
>35-55	Low to Medium Performance
0- 35	Poor Performance

Table 4.7 Showing Service Performance Index value for various RRWSS under study area

Name of the RRWSS	Weight (W) & Importance Factor (I)	Service Performance Indicator				Overall SPI value	Performance Rating
		Sustainable water source	Adequate water to tail enders	Water supply reliability	Acceptable water quality		
Variav Group, Surat	W	1.0	0.65	1.0	1.0	88.33	Excellent Performance
	I	1.0	2.0	2.0	1.0		
Gadhada Group, Bhavnagar	W	0.65	0.65	0.65	1.0	60.83	Medium to High Performance
	I	1.0	2.0	2.0	1.0		
Ishwaria Group, Amreli	W	0.65	0.35	0.65	1.0	50.83	Low to Medium Performance
	I	1.0	2.0	2.0	1.0		
Mandvi Group, Kachchh	W	0.65	0.0	0.35	1.0	50.83	Low to Medium Performance
	I	1.0	2.0	2.0	1.0		