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# 1. INTRODUCTION

## 1.1 General Introduction

Water crises are rising at such an alarming rate that it doesn't need introduction. As a millennium development goal, the United Nation has drawn the attention of the world towards the drinking water problem, data showed 748 million people had no access to improved drinking water, at international level (United Nation Organization, 2015)

A planet without water is a planet without life. Water is a precious natural resource and basic need of life. As we all are aware that water is the basic necessity for all living creatures which makes water a precious natural resource. Ahead of World Water Day (March 22) on 18$^{th}$ March, 2021 the UN Water called a high-level meeting to expedite the action and doubling efforts on SDG 6 by 2030. The Sustainable Development Goal (SDG) 6 on "Water and Sanitation" in SDG report 2020 showed 2.2 billion population of the world deprived of safely managed drinking water, including 785 million lacking basic drinking water and this number will go further year by year.

At national level, India is following directions of the UN and rapidly underwent various policy frameworks to speed-up the action and efforts for sustainable drinking water. The Ministry of Drinking Water and Sanitation, now named, ministry of Jal Shakti, took water crises very seriously and declared it a National Movement (28-09-2019) for water conservation. An alarming water crisis is deafening but still not realized and there is a need to put obligatory responsibility on stakeholders. "India's water future is in danger if the current trend in its use continues" (Piyus et al. 2011). "At macro level, India is in a water- stressed state" and Gap between demand and supply of water in India is worsening (Anju et al. 2011). According to world resource group estimates, if the present pattern of demand remains unchanged then by 2030 only 50 per cent of demand will be met (WRG 2009). Availability of safe drinking water is a serious concern at local, national and international level as it has many uses and water for drinking is a must and inevitable for living. So, providing drinking water is not only imperative but also recognized as the right to life in article 21 of our constitution. There is increasing demand for water due to increasing temperature, increasing population, pollution in the water due to industrial effluents, slow rate of water recharge, inefficient use of water and other economic, social and political aspects. Therefore, it poses concerns for policy makers. Managing

limited availability of water in general, multiple use of water and drinking water in particular further pose challenges.

Intensive ground water extraction on one hand and increasing pollutants on the other has made the situation worse in many states like Andhra Pradesh, Gujarat, Maharashtra, Karnataka and Tamil Nadu (Asit et al., 2017). Further, mismanagement of available water resources makes drinking water a scarce resource. NASA report, 2009 placed the Indus basin at second most overstressed aquifer globally. Government is actively taking many initiatives to improve availability of drinking water despite natural, geographical, demographical, social, technological, institutional, infrastructural and other hurdles.

In view of the above problems, Gujarat state is also facing the heat of water crises in general and Vadodara in particular, as Vadodara is not an exception to it. Gujarat state has limited water resources and is divided in four regions, i) South and central Gujarat ii) North Gujarat iii.) Saurashtra iv) Kachchh. It has 185 river basins and 95 per cent of the total yearly rainfall was received between the months of June to September (Gujarat state water policy 2014). Gujarat had 50000 mcm of water resources, 76 percent was surface water and 24 percent was groundwater. Water used for irrigation, domestic and industrial purposes accounts for 88 percent, 10 percent and 2 percent respectively (Gujarat state water policy, 2014). “The current trend of increase in water supply from all users will outstrip available supplies significantly by the year 2025” (Gujarat state water policy, 2014). It is time to integrate the efforts of stakeholders to address the drinking water problem of present and future generations. It is important to understand the role of every stakeholder and obligatory duties have to be assigned to tackle the problem of drinking water. To increase the efficiency in management and usage of drinking water, every stakeholder needs to participate, suggest, accept, and be accountable and liable for it. In the next section of introduction, we will see the various parameters and risk associated with it (UN meeting, 2021).

### 1.1.1 Global Concern on Drinking Water

These are the highlights covered on drinking water concern at global level, from the various reports, conferences and meetings. World health assembly has passed various resolution pertaining to safe drinking water, sanitation facilities, health and hygiene in a chronology, WHA

35.17 (1982), WHA 39.20 (1986), WHA42.25 (1989), WHA 44.28 (1991), WHA 45.31 (1992), WHA 51.28 (1998), and WHA 63.23 (2010) & resolution WHA 70.7 (2017).

Another important international body, the United Nations General Assembly addressed human rights to water and sanitation in resolution 64/292 (2010). resolution 72/178 (2017) UN human Rights council resolution 39/8 (2018) also loudly addressed the human rights to safe drinking water and sanitation subject matter at international level.

### 1.1.2 India- Water Woes

Water borne diseases cause approximately USD 600 million a year in India. This is true for drought and flood affected areas, whereas already one third of India's population experienced it in a couple of previous years.

More than 60% of India's 718 districts are affected by extreme water depletion. Groundwater is extracted at such a fast rate that groundwater depletion becomes a challenge to us.

## 1.3 Drinking Water Parameters and Health Effect

As per the BIS, Indian Standard for Drinking Water - Specification IS 10500: 1991 (1991) had published the guideline for drinking water showing different parameters and the maximum permissible limits for each parameter’s values in mg/l and corresponding column shows the general health effect.

After the brief overview of the water parameters and its health risk, the next section explains the water governing authority in detail.

## 1.4 Water and Institutions

Water resource is one of the key resources, which is undervalued and underpriced. As the development is increasing it puts more pressure on the water resources. Rapid Industrial development increases the pollution in the water and causes contamination of water resources on one hand and on the other the agriculture sector puts the pressure on demand for water for irrigation purposes. To achieve sustainability in the water resource and attain the SDG-6, the Ministry of Jal Shakti undertakes all the matters related to water resources under its purview. The

ministry of Jal shakti is the main institution which has its subordinate departments and the Role which are explained in the following section.

Ministry of Jal Shakti came into the existence under the leadership of the Modi government in the year 2019 by merging two departments, department of drinking water and sanitation, and department of water resources, river development and ganga rejuvenation under the Jal Shakti

## 2. LITERATURE REVIEW

| | | |
|---|---|---|
| Suvechha Ghatani et al (2022) | Research study based on primary data of the Darjeeling city; 220 households were surveyed through scheduled questionnaire. The objectives of the study were to know the availability status of drinking water. | The study found 71 percentage of the sample relied on the municipal source for drinking water and they found it uncertain and unreliable, 20 percentage of the sample depends on natural spring water and 9 percentage of the population depends on private source for drinking water. Further the distribution of the drinking water availability and access influence by the social connections and land-lordship and lover income group had disadvantage compared to higher income group. |
| Mishra, (2021) | Primary school run by the government in Allapur village of Telangana highlighted the problem of drinking water | Problem of drinking water among the matters of concern. |
| Subhashree et al., (2020) | Swachh Bharat Swachh Vidhyalaya campaign study conducted in the selected 95 schools in Karnataka state of India from Mangalore. | The finding of the research showed that 96.8 percentage of the schools provides safe drinking water to promote students' health |
| A. Kumar et al., (2019) | Study based Arsenic contamination of ground water causing impaired memory and intelligence, a sample of 65 students and water sample collected from 3 handpumps, functional for one decade, of Simri Village, Buxar district of Bihar | Concluded that change in neuro-behavioral activity caused by arsenic poisoning of the selected sample. |

| | | |
|---|---|---|
| Deshmukh & Khanna, (2019) | Research study on Sangli district of Maharashtra, focused on water sanitation and facilities given by higher secondary schools. | It was identified that the facility provided by the government schools, for drinking water, were poor in terms of quality and the private schools were better. |
| S. Kumar et al., (2018) | The current study focuses on global energy data and the principles of operation of various desalination facilities. It also provides a comprehensive overview of the most recent published studies on a variety of solar-based desalination techniques | Rising urban population, there is a need to backup urbanization by providing drinking water and other factors, as the pollution and population increase the pressure on drinking water. |
| Chaudhry et al., (2017) | Prevalence of dental fluorosis among school students in the greater Noida, Uttar Pradesh. Total 1318 students were sample size | The result found that fluorosis was mainly associated with handpump water. |
| Khandare et al., (2017) | Research based on sample size of 824, case-control, school children living in fluoride affected hilly areas in the Doda district of Jammu and and Kashmir | Study found that students were more affected by dental fluorosis and kidney damage. |
| A. Verma et al., (2017) | Cross-sectional study conducted on fluorosis caused by ingestion of fluorosis via food and water among school children, affected by dental fluorosis in Kolar Taluk, Karnataka, India. Sample size of 1026 students was selected by a stratified sampling method. | Finding of the shows that still the water harvesting in the water scare region is unreliable, inefficient, and costly. |

## 3. STATEMENT OF PROBLEM / RESRARCH GAP

Major research work studies are confined to the contamination of drinking water and the issues of widening the gap of availability of drinking water. The researcher has not come across inductive study on the drinking water infrastructure of the schools and its economic aspects.

The proposed research would be a unique contribution in the field of operational and maintenance cost of hygiene factors for drinking water of the selected educational building of Vadodara city.

## 4. OBJECTIVE OF THE STUDY

**Primary Objective:**

- The primary objective of the proposed research study is to identify the hygiene factors of drinking water and operational and maintenance cost (O & M) hygiene factors in the selected educational buildings of Vadodara cities of Gujarat state.

**Secondary Objectives:**

- To identify the dependence of educational institute on municipal supply or private supply of drinking water.
- To identify the educational institute wanting hygiene factors.
- To compare the drinking water hygiene at public owned and private owned educational buildings.
- To identify the role of the private sector in supplying drinking water in the selected educational building.

## 5. SCOPE OF THE STUDY

Scope of the proposed research study, in drinking water, dependence of people on state and private sector, hygiene factors, and operational and maintenance cost in drinking water.

For doing so (scope), the coverage of proposed research study is confined to the selected educational building of the Vadodara city of Gujarat state.

## 6. CONCEPTUAL FRAMEWORK

After the review of literature, the researcher identified that cost analysis is important for the drinking water availability in the educational institution of the selected schools in Vadodara city. The school survey is done to identify the major factors contributing towards the drinking water in schools. The factors are classified into fixed and variable cost and then further information on

cost is collected through various sources. These cost gives the idea or indication to fix the budget estimates for drinking water availability in schools.

## 7. RESEARCH METHODOLOGY.

The procedures implemented in conducting the research are presented as under:

a. Geographical Area of the Study The study was confined to selected educational building of Vadodara city in Gujarat
b. Time Span: research conducted during 2018- to 2022
c. Research Design The study cost analysis for drinking water availability in the selected schools of Vadodara city. Thus, the present study trails descriptive and analytical research design.
d. Methods of Data Collection: scheduled questionnaire, observation and feedbacks
e. Secondary Data: DOI reserve, Government Reports, and water ministry and concerned authorities' online sources are considered
f. Primary Data: (a) Responses on drinking water infrastructure of schools and (b) cost data collected from Packed drinking water suppliers of Vadodara city through market survey- online and offline.

Research Approach Sample survey method has been used in the present study. The Researcher has collected primary data through structured questionnaire, personal interview and observations.

### 7.1.1 Population:

(a) Population for the present study comprises of schools and

(b) Packaged drinking water supplier of Vadodara city in Gujarat.

### 7.1.2 Sample Unit

(a) The sample unit of the selected 80 schools of Vadodara city.

(b) 11 water suppliers.

### 7.1.3 Sample Method and Sample

(a) The sample unit of the selected 80 schools of Vadodara city.

(b) Purposive sampling method is used for collecting data on schools drinking water infrastructure and supplier of packaged drinking water.

### 7.1.4 Research Instrument

Selected schools and water supplier were approached using Scheduled questionnaire, field observation and feedbacks to collect data.

### 7.1.5 Statistical Tools Used for the Study

Descriptive statics are used to study the objectives of the research like measure of central tendency; mean, median mode is used for analysis, Pie charts, histogram chart, bar diagrams are also used in the analysis are used to analyze the cost.

## 8. SIGNIFICANCE OF THE STUDY

Research study helps in viewing the role of public and private in supplying drinking water and developing an efficient public-private partnership model. It helps in proposing adequate operational & maintenance costs for providing improved drinking water at educational buildings. This helps in achieving the goals of Millennium Development Goal at micro level. The policy frame can be made for those schools lacking proper drinking water. Outcome of the proposed study helps in framing the policy to improving the drinking water facilities. Further, it improves the health and wealth of youth.

This research proposes to assess the operational and maintenance cost of water Infrastructure. This study also proposes to identify the hygiene factors of drinking water in the selected educational buildings of Vadodara cities of Gujarat state.

## 9. LIMITATIONS OF THE STUDY

Every study is inadequate by certain factors. The present study, being a quantifiable one, is exposed to time constraints. Added, the results of the study cannot be generalized due to the small size of the sample. Thus, more research at a larger scale involving larger number of respondents is required to gain better understanding into the existing research field.

Major limitations of this study are: Proposed research is limited to the selected educational building of Vadodara city in Gujarat state; the size of the sample makes it narrow. Study is time

bound and has limited scope and doesn't give a macro view. It may not be suitable to make generalization of the findings. This is mainly because of its limited sample size and study area being limited only to one city in Gujarat. This study is based on primary data generated through scheduled questionnaire, and observation and collected from the respondent at different schools, water supplier as such, its findings depend on the accuracy of data.

The study is based on the response of the school authority and the supplier of Packaged drinking water of Vadodara city given the geographical resources, due to which generalization made may not be wholly true. The Researcher, being an outsider and external analyst, clearly has no access to the internal information. Therefore, it is hard to describe the inside view of schools and quality of water supply in the study.

## 10. RESEARCH FINDINGS

### 10.1 Analysis of Drinking Water Infrastructure in Schools

This is a schools data analysis. It is based on analysis of data collected from the respondents. In the present study 80 schools were surveyed to identify the major factors contributing towards drinking water infrastructure in selected schools of Vadodara city; however, for some of the questions and attributes within, the numbers of responses may vary.

#### 10.1.1 General Information

The data collection of the schools gives the general information of the selected schools of the Vadodara city. The brief data analysis of the general information is discussed below:

**Type of School**

| Type of School | | | | |
|---|---|---|---|---|
| | Frequency | Percent | Valid Percent | Cumulative Percent |
| Private | 38 | 47.5 | 47.5 | 47.5 |
| Government Funded | 42 | 52.5 | 52.5 | 100.0 |
| Total | 80 | 100.0 | 100.0 | |

The data collected from the selected schools of the Vadodara city are classified into two categories i.e., Private and Government funded schools. Data of 47.5% private schools and 52.5% government funded schools are covered under the survey.

**Timing of the Schools**

| Timing of the school | | | | | |
|---|---|---|---|---|---|
| | | Frequency | Percent | Valid Percent | Cumulative Percent |
| | Afternoon | 22 | 27.5 | 27.5 | 27.5 |
| | Morning | 58 | 72.5 | 72.5 | 100.0 |
| | Total | 80 | 100.0 | 100.0 | |

The data collected of the of the selected schools are analyzed on the basis of timing of the selected schools showed that 27.5 % of the schools are functioning in the afternoon timing and the 72 % of the selected schools were operating in the morning timing.

**Mid-day meal**

| Mid-day meal facility at school | | | | | |
|---|---|---|---|---|---|
| | | Frequency | Percent | Valid Percent | Cumulative Percent |
| | No | 49 | 61.3 | 61.3 | 61.3 |
| | Yes | 31 | 38.8 | 38.8 | 100.0 |
| | Total | 80 | 100.0 | 100.0 | |

The data collected on the mid-day meal facility in the schools were collected from the selected schools. The data analysis showed that 61.3% of the schools selected were showing that mid-day meal program is not functional or applicable in the selected school and 38.8 % of the selected schools were providing mid-meals in the school.

**The Student, Teacher, Non-Teaching Staff and Housekeeping staff**

| Descriptive Statistics | | | | | |
|---|---|---|---|---|---|
| | N | Minimum | Maximum | Mean | Std. Deviation |
| Total number of students studying in the school | 80 | 20 | 3500 | 584.74 | 690.716 |
| Total number of teaching staff in the school | 80 | 2 | 150 | 23.09 | 29.308 |
| Total number of non-teaching staff in the school | 80 | 0 | 50 | 7.25 | 11.056 |
| Total number staff kept for housekeeping work in the school | 80 | 0 | 100 | 6.73 | 13.384 |

The data collected on the total number of the students in the selected schools were analyzed and showed the minimum number of the student's strength of the selected schools was 20 and the maximum number of the selected schools showed the 3500 students. The average number of the students showed 584.74 in every school with high Standard deviation 690.716.

Total teaching staff of the selected schools showed an average 23.09 teachers in every school with 29.308 standard deviation, with minimum 2 teachers and maximum 150 teachers in the school.

Total number of numbers of non-teaching staff showed the zero (0), means the there are some school with no non-teaching staff, and maximum number of showed 50 numbers of
Non-teaching staff, with standard deviation of 11.056.

Another important analysis on data collected on number of housekeeping showed that zero (0) in some schools and 100 in some school. The average number of the housekeeping of the selected schools showed 6.73 labours are required for cleaning with standard deviation of 13.384.

### 10.2. Fixed Factors

Study finds out the various types of factors involved in providing drinking water in the educational institutions, particularly in the Vadodara city, schools were surveyed using

scheduled questionnaire and observation through taking picture of the drinking water facility available in the school. Scheduled questionnaire covers the major factors forming as a part of drinking water infrastructure, the factors are classified as fixed and variable. The classifications of the factors are done on the basis of the time period i.e., short time period, within one year and long time period, more than one year. The following are the dimension covered for classification of factors, **fixed Factors i.e., Drinking water Tank, Taps, Purifier, Water cooler, Hand Pump, Water Motor and Variable Factors i.e., Labor, Purifier Filter, Electricity, Bleaching powder (cleaning purpose)**

The following question were asked from the concerned authority to collect the data on the various dimension of drinking water infrastructure of the selected schools to know the fixed and variable factors forming as a part of drinking water infrastructure. The study undertaken to find the major fixed factor for providing the drinking water in the schools are as follows:

**10.2.1 Drinking water Tank** – Analysis of Size and Type of water tanks available in selected schools. The data on the size and type of the water tank is collected under the following questions.

***The type of drinking water tank***

| Type of drinking water tank | | | | | |
|---|---|---|---|---|---|
| | | Frequency | Percent | Valid Percent | Cumulative Percent |
| | A- concreat water tank | 43 | 53.8 | 53.8 | 53.8 |
| | A &B | 3 | 3.8 | 3.8 | 57.5 |
| | B- plastic water tank | 32 | 40.0 | 40.0 | 97.5 |
| | E- other type | 2 | 2.5 | 2.5 | 100.0 |
| | Total | 80 | 100.0 | 100.0 | |

It is found that the majority of the selected schools are using types A category of water tank, more than 50% of the schools are using type A tanks followed by type B using 40% and only few schools are seen with type A and B totaling to only 3. Only 2.5 % of the school used other type of tanks.

**The Size of drinking water tank**

| Size of drinking water tank | | | | |
|---|---|---|---|---|
| Capacity (litres) | Frequency | Percent | Valid Percent | Cumulative Percent |
| 700 | 1 | 1.3 | 1.3 | 1.3 |
| 1000 | 18 | 22.5 | 22.5 | 23.8 |
| 1500 | 2 | 2.5 | 2.5 | 26.3 |
| 2000 | 15 | 18.8 | 18.8 | 45.0 |
| 2500 | 4 | 5.0 | 5.0 | 50.0 |
| 3000 | 1 | 1.3 | 1.3 | 51.3 |
| 5000 | 18 | 22.5 | 22.5 | 73.8 |
| 6000 | 1 | 1.3 | 1.3 | 75.0 |
| 10000 | 17 | 21.3 | 21.3 | 96.3 |
| 15000 | 1 | 1.3 | 1.3 | 97.5 |
| 20000 | 2 | 2.5 | 2.5 | 100.0 |
| Total | 80 | 100.0 | 100.0 | |

It is found that 22.5 % of the schools have 1000 liters & 5000 liters size water tanks followed 21.3 % use 10000 liters water tank. 18.8% of the schools use 2000ltrs of water tank to meet the daily requirements. Others, 700, 1500, 2500, 3000, 6000, 15000 and 20000 capacities of the water tank forming only 15.9%.

**10.2.2 Taps**- Data is collected on the different types water tapes used for drinking water in the selected schools.

**Types of water tapes are used**

| Types of water tapes are used | | | | |
|---|---|---|---|---|
| | Frequency | Percent | Valid Percent | Cumulative Percent |

| | | | | | |
|---|---|---|---|---|---|
| | A-Semi-Automatic | 18 | 22.5 | 22.5 | 22.5 |
| | A And D | 3 | 3.8 | 3.8 | 26.3 |
| | B- Automatic | 1 | 1.3 | 1.3 | 27.5 |
| | B And C | 1 | 1.3 | 1.3 | 28.8 |
| | C-Push Taps | 7 | 8.8 | 8.8 | 37.5 |
| | D-Leaver On-Off | 23 | 28.8 | 28.8 | 66.3 |
| | E- On-Off Button | 12 | 15.0 | 15.0 | 81.3 |
| | F- Manual Rotation (Clock-Wise & Anti-Clock) | 15 | 18.8 | 18.8 | 100.0 |
| | Total | 80 | 100.0 | 100.0 | |

It is found that 28.8% of the school uses Leaver on off type of taps, 22.5 % of the schools uses Semi- Automatic Push taps, 18.8% manual rotation taps, 15% uses leaver type on/off taps, 8.8 % uses Push taps, and it is found that one of the selected schools is using automatic taps. A & D types of are used only 3.8% and B & C are only 1.3 %.

**10.2.3 Purifier**- data on schools using different types of water purifier is collected are analyzed.

**Type of water purifier system is used by the institute**

| Type of water purifier system is used by the institute | | | | | |
|---|---|---|---|---|---|
| | | Frequency | Percent | Valid Percent | Cumulative Percent |
| | RO Water Purifier System | 50 | 62.5 | 62.5 | 62.5 |
| | Water Cooler | 2 | 2.5 | 2.5 | 65.0 |
| | Water Cooler with RO System | 11 | 13.8 | 13.8 | 78.8 |
| | Non | 16 | 20.0 | 20.0 | 98.8 |
| | Others | 1 | 1.3 | 1.3 | 100.0 |

| | | | | | |
|---|---|---|---|---|---|
| | Total | 80 | 100.0 | 100.0 | |

It is found that 62.5 % of the schools using RO water purifier system, followed by 13.8% using water cooler with RO system and 20. % of the selected schools are not using Water purifier system. Only 2.5% of the selected schools are showing only water coolers.

**Number of water purifier in use**

| Number of water purifier in use | | | | | |
|---|---|---|---|---|---|
| | | Frequency | Percent | Valid Percent | Cumulative Percent |
| | 0 | 16 | 20.0 | 20.0 | 20.0 |
| | 1 | 46 | 57.5 | 57.5 | 77.5 |
| | 2 | 6 | 7.5 | 7.5 | 85.0 |
| | 3 | 6 | 7.5 | 7.5 | 92.5 |
| | 4 | 1 | 1.3 | 1.3 | 93.8 |
| | 5 | 2 | 2.5 | 2.5 | 96.3 |
| | 7 | 1 | 1.3 | 1.3 | 97.5 |
| | 10 | 2 | 2.5 | 2.5 | 100.0 |
| | Total | 80 | 100.0 | 100.0 | |

It is found that 57.5% of the schools uses 1 units of RO purifier, 7.5 % of the selected schools uses 2 units and 3 units of purifiers, and 1.3% of the selected schools uses 4 units and 7 units of the RO purifiers, flowed by 2.5 % of the selected schools using 5 units and 10 units of RO purifier.

**10.2.4 Water Cooler-** the data collected from the schools on water coolers for providing drinking water.

**School use water cooler attach to RO system**

| School use water cooler attach to RO system | | | | | |
|---|---|---|---|---|---|
| | | Frequency | Percent | Valid Percent | Cumulative Percent |
| | No | 19 | 23.8 | 23.8 | 23.8 |
| | Yes | 61 | 76.3 | 76.3 | 100.0 |
| | Total | 80 | 100.0 | 100.0 | |

The data showed that total 19 selected schools doesn't use RO system in the schools forming 23.8 % whereas the 76.3 % of the selected schools found using RO systems in the selected school.

**10.2.5 Hand Pump-** during the data collection hand pump is also seen as important factor for drinking water source. The data collected on the handpumps in the selected schools for meeting their daily requirement other sources than VMC water supply sources are collected

**The other source of daily water requirement**

| The other source of daily water requirement | | | | | |
|---|---|---|---|---|---|
| | | Frequency | Percent | Valid Percent | Cumulative Percent |
| | Ground Water | 19 | 23.8 | 23.8 | 23.8 |
| | Lake Water | 1 | 1.3 | 1.3 | 25.0 |
| | Well Water | 2 | 2.5 | 2.5 | 27.5 |
| | Hand Pump | 1 | 1.3 | 1.3 | 28.8 |
| | Other Surface Water | 57 | 71.3 | 71.3 | 100.0 |
| | Total | 80 | 100.0 | 100.0 | |

It is found that hand pumps are also used for daily requirement of the drinking water supply but it only contribute 1.3% and the major source of other than VMC tap supply source is 71.3 % comes from others (Water Tankers). Handpumps are not forming significant part of water infrastructure in the city within the VMC.

**10.2.6 Water Motor-** for the supply of drinking water from ground source to water tank or one storage to other storage, data on motor reaved that all the schools are using water motor for ensuring water availability for drinking and other use.

| CATEGORY | *Frequency* |
|---|---|
| Yes | 80 |
| No | 0 |

**10.3 Variable Factors**

**10.3.1 Labor-** labor is variable factor among the drinking water infrastructure and is needed mainly for the purpose of cleaning and keeping water infrastructure updated.

**Clean of the drinking water tank**

| **Clean of the drinking water tank** | | | | | |
|---|---|---|---|---|---|
| | | Frequency | Percent | Valid Percent | Cumulative Percent |
| | Once In A Week | 2 | 2.5 | 2.5 | 2.5 |
| | 4 Days A Week | 1 | 1.3 | 1.3 | 3.8 |
| | Once A Two Month | 7 | 8.8 | 8.8 | 12.5 |
| | Once A Three Month | 17 | 21.3 | 21.3 | 33.8 |
| | Once A Year | 6 | 7.5 | 7.5 | 41.3 |
| | Half-yearly | 47 | 58.8 | 58.8 | 100.0 |
| | Total | 80 | 100.0 | 100.0 | |

It is found that 58.8% of the selected schools used half-yearly cleaning, once a three-month cleaning is done by 21.3 % of the selected schools, 7.5 % schools clean water tank yearly, 8.8 % of the selected schools cleans water tanks once in two months and 2.5 % of the selected schools uses once a week cleaning of the water tank. Only 1.3% of the selected schools cleans 4 times a week.

**Labors are used to clean the tank.**

| Descriptive Statistics | | | | | |
|---|---|---|---|---|---|
| | N | Minimum | Maximum | Mean | Std. Deviation |
| how many labours are used to clean the tank? | 80 | 1 | 12 | 3.89 | 2.490 |

The data on number of labors used to clean showed the average of 3.89 labors to clean the water tank and the majority of the schools uses 4 labors to clean water tank.

**10.3.2 Purifier Filter-** the filters are the variable factors which changes with in the year many times depending upon the usage of the RO. Filters are changed monthly or quarterly or half yearly depends on its usage. The data collected on the filters are collected from the capacity of the RO storage.

**The storage capacity of RO**

| The storage capacity of RO | | | | | |
|---|---|---|---|---|---|
| | | Frequency | Percent | Valid Percent | Cumulative Percent |
| | 50 | 42 | 52.5 | 52.5 | 52.5 |
| | 100 | 7 | 8.8 | 8.8 | 61.3 |
| | 150 | 1 | 1.3 | 1.3 | 62.5 |
| | 200 | 4 | 5.0 | 5.0 | 67.5 |
| | 250 | 5 | 6.3 | 6.3 | 73.8 |
| | N/A | 21 | 26.3 | 26.3 | 100.0 |
| | Total | 80 | 100.0 | 100.0 | |

The data on RO filters found that small RO capacity filters with capacity of 50ltrs and 100ltrs used by the schools are 61.3% altogether and the rest are only forming 12.6% using large capacity storage filter.

**10.3.3 Electricity –** the use of electricity forms important part of the drinking water infrastructure, in the absence of electricity the water infrastructure in in active. The usage of the electricity details was collected on the electricity.

**Average number of hours electricity is used to fill drinking water tank (per day)**

| Descriptive Statistics | | | | | |
|---|---|---|---|---|---|
| | N | Minimum | Maximum (minutes) | Mean | Std. Deviation |
| what is the average number of hours electricity is used to fill drinking water tank (per day )? | 80 | 0 | 120 | 37.81 | 17.697 |

The data on electricity used for getting drinking water tank filled showed the average of 37.81 minute with 17.697 standard deviation.

**10.3.4 Bleaching powder (cleaning purpose)-** It was found that majority of the schools uses bleaching powder to clean the water tanks, it is also found that no standard cleaning material is used for cleaning the water tank. It was found that water tank is cleaned with normal water, detergents, bleaching powder are the major cleaning material.

**10.4 Analysis of packaged drinking water supplier**

Under this chapter the researcher estimated the cost of drinking water from the private sector and tries to highlight the role of private sector in supplying the packaged drinking water.

**10.4.1 Total Cost of Packaged drinking water to schools**

| Quantity | | D | Charges D1 | Charges D2 | Charges D3 |
|---|---|---|---|---|---|
| | Price | 24.09 | 118.18 | 163.64 | 231.82 |
| | | | | | |
| | Total/ Day | 120.45 | 238.63 | 284.09 | 352.27 |
| | | | | | |
| 5 | Total/ 265 | 31919.25 | 63236.95 | 75283.85 | 93351.55 |
| | Price | 23.91 | 118.18 | 163.64 | 231.82 |
| | | | | | |
| | Total/ Day | 239.1 | 357.28 | 402.74 | 470.92 |
| 10 | | | | | |
| | Total/ 265 | 63361.5 | 94679.2 | 106726.1 | 124793.8 |
| | Price | 23.64 | 36.36 | 104.55 | 222.73 |
| | | | | | |
| | Total/ Day | 472.8 | 509.16 | 577.35 | 695.53 |
| 20 | | | | | |
| | Total/ 265 | 125292 | 134927.4 | 152997.75 | 184315.45 |
| | Price | 22.64 | 0 | 0 | 0 |
| | | | | | |
| | Total/ Day | 905.6 | 905.6 | 905.6 | 905.6 |
| 40 | | | | | |
| | Total/ 265 | 239984 | 239984 | 239984 | 239984 |
| | Price | 21.91 | 0 | 0 | 0 |
| | | | | | |
| | Total/ Day | 1752.8 | 1752.8 | 1752.8 | 1752.8 |
| 80 | | | | | |
| | Total/ 265 | 464492 | 464492 | 464492 | 464492 |
| | Price | 21.82 | 0 | 0 | 0 |
| | | | | | |
| | Total/ Day | 2182 | 2182 | 2182 | 2182 |
| | | | | | |
| 100 | Total/ 265 | 578230 | 578230 | 578230 | 578230 |

**D; charges without delivery cost**

**D1; delivery within 3km**

**D2; delivery within 10 km**

**D3; delivery within 20 km**

The total cost of the school for providing packaged drinking water to the students is calculated on the yearly basis keeping the daily requirement as 5 units of packaged drinking water containing 20 liters each, RO drinking water, estimated for 265 effective working days are as follows

| D | D1 | D2 | D3 |
|---|---|---|---|
| 31919.25 | 63236.95 | 75283.85 | 93351.55 |

The total cost of the school for providing packaged drinking water to the students is calculated on the yearly basis keeping the daily requirement as 10 units of packaged drinking water containing 20 liters each, RO drinking water, estimated for 265 effective working days are as follows

| D | D1 | D2 | D3 |
|---|---|---|---|
| 63361.5 | 94679.2 | 106726.1 | 124793.8 |

The total cost of the school for providing packaged drinking water to the students is calculated on the yearly basis keeping the daily requirement as 20 units of packaged drinking water containing 20 liters each, RO drinking water, estimated for 265 effective working days are as follows

| D | D1 | D2 | D3 |
|---|---|---|---|
| 125292 | 134927.4 | 152997.75 | 184315.45 |

The total cost of the school for providing packaged drinking water to the students is calculated on the yearly basis keeping the daily requirement as 40 units of packaged drinking water containing 20 liters each, RO drinking water, estimated for 265 effective working days are as follows

| D | D1 | D2 | D3 |
|---|---|---|---|
| 239984 | 239984 | 239984 | 239984 |

The total cost of the school for providing packaged drinking water to the students is calculated on the yearly basis keeping the daily requirement as 80 units of packaged drinking water

containing 20 liters each, RO drinking water, estimated for 265 effective working days are as follows

| D | D1 | D2 | D3 |
|---|---|---|---|
| 464492 | 464492 | 464492 | 464492 |

The total cost of the school for providing packaged drinking water to the students is calculated on the yearly basis keeping the daily requirement as 100 units of packaged drinking water containing 20 liters each, RO drinking water, estimated for 265 effective working days are as follows

| D | D1 | D2 | D3 |
|---|---|---|---|
| 578230 | 578230 | 578230 | 578230 |

## 11. RESULTS

### 11.1 Primary Objective:

- (a)The primary objective of the proposed research study is to identify the hygiene factors of drinking water and operational and (b) maintenance cost (O & M) hygiene factors in the selected educational buildings of Vadodara city of Gujarat state.
- (a) It is found that hygiene factors of the drinking water are directly and indirectly dependent of the major factors contributing towards drinking water infrastructure
- (b) Maintenance cost of the as follows; -

### 11.2 Cost of fixed and variable factors

After the identification of the fixed Factors i.e., Drinking water Tank, Taps, Purifier, Water cooler, Hand Pump, Water Motor and Variable Factors i.e., Labor, Purifier Filter, Electricity, Bleaching powder (cleaning purpose). The cost estimate is obtained from the selected published sources, experts, contractors and retail stores are consulted for getting the current price of the materials. Minimum and maximum cost price range are considered for wider coverage

**11.3 Secondary Objectives:**

- To identify the dependence of educational institute on municipal supply or private supply of drinking water
- Mostly schools are dependent on the municipal source for primary requirement of drinking water but they also fulfil some the requirement from other sources.
- To identify the educational institute wanting hygiene factors
- All the selected schools want budget grants for maintaining schools drinking water infrastructure forming a important part of hygiene factors
- To compare the drinking water hygiene at public owned and private owned educational buildings.
- It is found that drinking water facilities are better in private schools in comparison to government schools.
- To identify the role of the private sector in supplying drinking water in the selected educational building.
- The private sector role is important in supplying drinking water is the following parameters –
    i. Quality assurance
    ii. Assured supply
    iii. Management expertise
    iv. No O&M cost on school management

**11.3 RECOMMENDATION**

- The research found that there is major Two types of cost Involved in supplying drinking water 1) Fixed cost & 2) Variable cost. These costs are further classified into Recurring (variable) and Non Recuring (fixed) cost as per time-based classification. These costs are classified into Capital expenditure and Revenue expenditure. Accordingly, budget has to be allocated to schools.
- Capital expenditure is significantly greater than revenue expenditure, but the value, output and functionality of the drinking water availability is completely dependent on the revenue expenditure. (eg. Water tank with inadequate cleanliness may result in non-use of water

tank). So timely allocation of the revenue expenditure is more important and needed on time.

## 13. CHAPTER SCHEME

### CHAPTER 1: INTRODUCTION

This chapter covers the introduction of water at international and national level, its health hazards, departments and institutions, policies and programs related to drinking water.

### CHAPTER 2: REVIEW OF LITERATURE

The review of literature covers the international, national literature related to the subject matters. It highlights the object of the various studies carried in the related areas, research methodology used and their finding, suggestions, recommendation, and conclusions.

### CHAPTER 3: RESEARCH METHODOLOGY

This chapter covers the detail of various methods and tools used for achieving the objective of the research. It also covers the objectives, significance and rational, and the limitation of the study.

### CHAPTER 4: STUDY ON DRINKING WATER INFRASTRUCTURE OF SCHOOLS

This chapter discusses findings from the survey of Drinking Water Infrastructure of Schools. This chapter also details the cost analysis of the drinking water on the basis of the major factors contributing towards drinking water infrastructure.

### CHAPTER 5: ANALYSIS OF PACKAGED DRINKING WATER SUPPLIER

This chapter discusses findings from the survey of packaged drinking water supplier. This chapter details the cost analysis of the drinking water from the packaged drinking water suppliers.

### CHAPTER 7: Suggestions, Conclusion and Recommendations

This chapter discusses findings from the field survey. These are based on the analysis of data collected during the field survey.

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