WATER SUPPLY AND SANITATION STATUS IN EDUCATIONAL INSTITUTIONS AT TONGI OF GAZIPUR DISTRICT, BANGLADESH

A THESIS WORK BY

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PROJECT REPORT APPROVAL

It is hereby certified that the work presented in this thesis was carried out by the following final year students of session 2020-2021 under the direct supervision of Dr. Md. Rezaul Karim, Professor of Civil and Environmental Engineering (CEE), Dean of Faculty of Science and Technical Education, Islamic University of Technology, Gazipur, Dhaka.

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DECLARATION

It is hereby declared that this entitled “Water supply and sanitation status in educational institutions at Tongi of Gazipur district, Bangladesh” thesis/project report or any part of it has not been submitted elsewhere for the award of any Degree or Diploma (except for publication).

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DEDICATION

*WE WOULD LIKE TO DEDICATE THIS THESIS WORK TO OUR **PARENTS AND FAMILY**. WE WANT TO SHOW OUR GRATITUDE FOR THEIR CONTINUOUS SUPPORT THROUGHOUT OUR LIFE.*

WE ALSO WANT TO EXPRESS UTMOST RESPECT FOR OUR THESIS SUPERVISOR PROFESSOR DR. MD. REZAUL KARIM.

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Abstract

Water consumption is one of the most important aspects of our daily lives. In this research, 43 samples were collected from 43 educational institutions in the district of Tongi, Gazipur. The collection of samples has been divided into two distinct sections. One is dry season and the other is wet season. Then, all 43 samples from both seasons were analyzed for twelve physiochemical parameters and two bacteriological ones. The parameters consist of pH, DO, EC, TDS, TSS, TS, salinity, turbidity, Fe, Mn, color, As, E. coli, and feces contamination. We have conducted three analyses to comprehend the conditions. First is statistical analysis, then IWQI, and finally Pearson co relation analysis. The current sanitation conditions at the institute were then evaluated. The primary objective of the statistical analysis is to determine what proportion of test results exceed the WHO and ECR (1997) standard parameters. Importantly, one hundred percent of the samples exceeded the E. coli parameters. And approximately four percent of the data exceeded fecal contamination thresholds. Several other parameters have also exceeded the standard parameters, but these two are the most dangerous to human health. On the other hand, according to the IWQI results, nearly 35 percent of water is unfit for consumption during both seasons. In addition, the pearson co-relation analysis enabled us to comprehend the co-relationships between the water parameters for both seasons. The dry season has greater co-relationships than the wet season. And finally, we comprehend the current sanitation conditions of the institutions. Our sanitations have been divided into four categories. Following a study of sanitation ,we've realized that a large number of industries with a large population are contaminating both surface and ground water. Consistent consumption is harmful to human health and the environment. Therefore, we have endeavored to assess the current state of potable water in Tongi, Gazipur region institutions. Proper management and investigation of groundwater quality aids in supplying institutions in Gazipur with potable water of high quality.

Chapter One: Introduction

1.1 Background and Present scenario of the proposed topic

Today, water is a finite resource, especially in developing nations. Globally, 663 million individuals lack access to clean water (Ramutsindela & Mickler, 2019). Access to potable water has been deemed the most crucial element for human survival. Due to the consumption of contaminated water, millions of people suffer from diarrhea, cholera, typhoid, and parasites each year. Bangladesh has significantly relied on groundwater as a source of potable water (WHO/UNICEF, 2018).

Gazipur is a significant metropolis in Bangladesh that is rich in industries. It has a total area of 1741.53 square kilometers. Gazipur (town) has 31 Mahallas and 9 Wards. The municipality is 49.32 km2 in size. The city has a population of 123,531, with males comprising 52.52 percent and females 47.48 percent; the population density is 2,505 per square kilometer. The environment is degrading day by day due to the population explosion. Water is not only essential for imbibing, but also for a variety of other activities. Industrialization and urbanization may contribute significantly to the poor quality of water through the indiscriminate disposal of solid waste, industrial effluents, and other toxic wastes, which are the most significant environmental threats to human existence (Islam, Tusher, Mustafa, and Mahmud, 2013). Chemical contaminants pose a significant risk to public health that may have immediate repercussions (Akter et al., 2016). Therefore, the inhabitants of this region face an unsanitary situation.

Sanitation refers to the practice of healthy and hygienic conditions, such as safe and reliable water supply and appropriate refuse disposal (Ahmed, 2000). In developing nations, diseases caused by hazardous potable water and inadequate sanitation pose a significant burden. It is estimated that 88% of diarrheal diseases are caused by a lack of secure water and sanitation. Institutions of higher education serve communities with a high prevalence of maladies related to hazardous water supply and sanitation facilities, as well as malnutrition and other underlying health issues (WHO, 2004).

The development, education, and security of children depend on their access to pure water, knowledge of hygiene, and a sanitary environment (UNICEF, 2012). There is a high prevalence of water and sanitation-related diseases in many countries, causing many people, particularly children, to become ailing or even die (UNICEF, 1998). Children who suffer from persistent water-related illness are at a disadvantage in school, as poor health reduces cognitive potential directly and indirectly through absenteeism, attention deficits, and early withdrawal (UNDP, 2006). Moreover, the lack of adequate and separate sanitation facilities for boys and girls at school discourages girls from attending school full-time, which negatively impacts their academic performance and perpetuates gender inequality. Bangladesh faces numerous challenges relating to water, sanitation, and hygiene due to its concentrated population and susceptibility to inundation. High concentrations of naturally occurring arsenic contaminate superficial groundwater, placing an estimated 35 million people at risk for chronic arsenic toxicity, which can cause cancer and impair cognitive development in children (Kinniburgh and Smedley, 2001). Frequent and recurrent natural disasters, such as floods and cyclones, also provoke outbreaks of waterborne diseases, decimate existing sanitation facilities, and compromise safe water supplies, thereby exacerbating preexisting health problems (WHO, 2007). If water- and sanitation-related diseases are to be eradicated, it is necessary to improve hygiene practices. For the majority of hygiene behaviors, adequate water and sanitation facilities are required to enable people to transform their intention to change into actual change (UNICEF, 1998). There are approximately 78,000 primary schools (almost every village has at least one) and approximately 20 million students enrolled.

Therefore, analyzing, judging, and resolving water-related issues have become a pressing concern. It is not only detrimental to human health, but also to our ecosystem and environment.

1.2 Objectives of the study

The objective of our study is to find some goals. And they are:

- This study evaluates the safety of potable water in 43 schools in Tongi, Gazipur, Bangladesh. Its purpose is to evaluate potential quality and safety concerns regarding the water ingested by students and personnel in these institutions.

- And another purpose of this study is to investigate the water supply, sanitation, and hygiene conditions in the designated schools, as these factors have a direct bearing on the health of thousands of students. It will evaluate the availability and quality of water sources, sanitation facilities, and sanitary practices in schools. The findings will shed light on potential dangers and enhancement opportunities to guarantee a healthy school environment for students.

1.3 Significance of the Study

This study is especially significant for Tongi, as it is an industrial area with numerous industries in close proximity to the investigated institutions. In addition, some institutions obtain their water supply from the industrial zone. This study will therefore provide valuable insights into whether the water supply in these institutions is contaminated and assess the potential impact on the health of students and faculty. By assessing the safety and purity of the water supply, the study can identify any potential contamination issues caused by industrial activities. It will assist in determining the extent to which industrial activities may be affecting the water supply and assessing the health dangers associated with such contamination. Understanding the potential contamination and its effects on health is essential for implementing the necessary measures to mitigate risks and ensure that these institutions have access to safe potable water. The findings of the study will contribute to informed decision-making and the development of strategies to resolve water quality concerns in the industrial area of Tongi, thereby protecting the health and well-being of the school community.

Again, Studies frequently place a greater emphasis on evaluating potable water quality and supply, while comparatively less emphasis is placed on sanitation and hygiene practices. To ensure a comprehensive approach to public health, it is essential to address all three aspects: potable water, sanitation, and hygiene. This study seeks to replace the void by emphasizing on sanitation and hygiene conditions in addition to the purity and supply of potable water. By investigating the overall water, sanitation, and hygiene (WASH) situation in the schools, the study acknowledges the interconnectedness of these factors and their collective impact on the students' health and well-being. The inclusion of sanitation and hygiene assessment allows for a more comprehensive comprehension of school conditions, identifying potential contamination sources and improvement areas. By addressing all three components, the study can provide comprehensive recommendations for enhancing WASH practices, thereby promoting a healthier and safer environment for students and faculty.

And finally, Given the COVID-19 pandemic, the current sanitation situation, hygiene practices, and the impact on water supply and sanitation systems in schools must be evaluated. It is essential to comprehend how students uphold health codes, the existing solid waste management procedures, and any alterations or obstacles brought on by the pandemic. This study seeks to replace the void by conducting a thorough analysis of the current state of affairs. It will assess the availability and functionality of restrooms, handwashing stations, and refuse management systems in the institutions. In addition, the study will evaluate students' and staff's adherence to health codes, such as mask-wearing and social distance practices. In addition, the study will investigate the potential effects of the COVID-19 pandemic on the school's water supply and sanitation systems. It will investigate any interruptions in water supply, alterations in water quality due to altered utilization patterns or maintenance issues, and the overall resilience of the sanitation infrastructure in the face of the pandemic. The study can shed light on the obstacles schools face in sustaining sanitation and hygiene practices during the COVID-19 pandemic by illuminating the current situation. The findings will assist in the identification of areas for improvement, the development of strategies to mitigate risks, and the implementation of measures to ensure the health and safety of the school community in relation to water supply, sanitation, and hygiene.

Chapter two: Literature review

2.1 Previous study

According to Water Supply and Sanitation Facilities in Primary School's of Gaibandha District in Bangladesh, this study aims to assess the current condition of water supply and sanitation facilities at primary schools in Gaibandha Sadar, Bangladesh. For this objective, 49 elementary institutions were selected. The study revealed that approximately 86% of schools used narrow tube wells for their water supply and sanitation. About 18% of schools lacked or had inoperative sanitation facilities. Sixty-nine and fifty-five percent of schools have distinct lavatory facilities for girls and teachers, but only one school has separate toilet facilities for male and female instructors. The availability of water, detergent, and hand cleansing facilities in the girls' and boys' restrooms is average, whereas the instructors' restroom is satisfactory. The majority of schools (69%) have an active drainage system at the water point, while 41% have refuse baskets in all classrooms. In this regard, effective management and monitoring of existing facilities are necessary to enhance the water supply and sanitation situation in Bangladesh's primary schools. (Islam et al., 2015)

In Water supply and sanitation status in educational institutions at Mirzapur of Tangail district, Bangladesh, During the months of January and February 2014, a study was conducted to evaluate the quality of potable water provision and sanitation in educational institutions in the district of Tangail's Mirzapurpourashava. Water samples were collected from the tube wells of 15 distinct educational institutions, and a questionnaire survey of 150 respondents was conducted based on a reconnaissance survey to determine the potable water quality and sanitation status of 15 selected educational institutions. The ranges for pH, EC, TDS, DO, hardness, and Fe were 7.23 to 7.95, 264 to 542 S/cm, 136 to 273 mg/l, 1.90 to 4.30 mg/l, 120 to 298 mg/l, and 0 to 10 mg/l, respectively. Except for DO, all observed water quality parameters were within the standard limits for Bangladesh, whereas Fe concentrations in three primary schools exceeded the standard value for potable water quality in Bangladesh, which is between 0.3 and 1.0 mg/l. The survey results revealed that shallow tube wells and Tara pump tube wells were primarily used for water supply in these educational institutions, with the majority of tube wells having a depth between 140 and

180 feet (47% of tube wells), 100 to 140 feet (23% of tube wells), and 180 to 220 feet (remaining 30%). 40% of the restrooms lacked soap and/or toilet paper, while 60% of the restrooms contained these amenities. The study found that the existing water supply and sanitation facilities were inadequate, and the primary educational institutions were in the worst condition. In three institutions, the distance between the latrine and the potable water source was less than 10 meters, indicating the potential for ground water contamination. (Latif et al., 2017)

In the study of Factors influencing sanitation and hygiene practices among students in a public university in Bangladesh, Introduction In educational contexts, improved hygiene and sanitation practices are effective for preventing infections, controlling the spread of pathogens, and promoting health. In recent decades, Bangladesh has made remarkable strides in advancing higher education. To expand the nation's higher education infrastructure, over a hundred universities were established. During their studies, hundreds of thousands of graduate students spend time in university settings. On the other hand, little is known about the sanitation and hygiene practices of university students. This research seeks to identify and comprehend the factors that influence university students' sanitation and hygiene practices. Methods This research was conducted at Shahjalal University of Science and Technology, a public university located in a divisional city of Bangladesh. We adopted an exploratory qualitative study design in accordance with the Integrated Behavioral Model for Water, Sanitation, and Hygiene (IBM-WASH). We designed and tested semi-structured interview protocols containing sanitation and hygiene-related behavior, access, and practice-related questions prior to their implementation. We conducted seventeen in-depth interviews (IDIs), four focus group discussions (FGDs, [6–8 participants per FGD]), and seven key informant interviews (KIIs) with students and university personnel, respectively. Data analysis utilized thematic analysis. To ensure data validity, triangulation of methods and participants was performed. Results Despite having adequate awareness and knowledge, the students' sanitation and hygiene practices were shockingly poor. A multitude of interrelated factors influenced sanitation and hygiene practices, as well as each other. Individual factors (gender, awareness, perception, and sense of health benefits), contextual factors (lack of cleanliness and maintenance, and the supply of sanitary products), socio-behavioural factors (norms, peer influence), and university infrastructure factors (shortage of female toilets, lack of monitoring and supervision of cleaning activities) emerged as the determinants of the sanitation and hygiene behavior of university students. Conclusion The findings of this study indicate that, despite the rapid expansion of on-campus university education, sanitary practices in public universities are remarkably inadequate due to a variety of dynamic and interconnected factors located at various (individual, contextual, socio-phycological) levels. To advance improved sanitation and hygiene practices among university students, multi-level interventions including regular supply of WASH-related materials and agents, promoting low-cost WASH interventions, improving quality cleaning services, close monitoring of cleaning activities, promoting good hygiene behavior at the individual level, and introducing gender-sensitive WASH infrastructure and construction may be beneficial. (Kabir et al., 2021)

According to Sustainability of a water, sanitation and hygiene education project in rural Bangladesh: a 5-year follow-up, The International Centre for Diarrhoeal Disease Research, Bangladesh, oversaw a WSH (water supply, sanitation, and hygiene) education intervention initiative from 1983 to 1987. About 800 households in the intervention area received handpumps, pit latrines, and sanitation education. The control group did not receive any interventions, but they did have access to the typical public and private WSH facilities. After 1987, there was no external support to maintain these provisions. The 1992 cross-sectional follow-up survey included approximately 500 randomly selected households from the intervention and control areas. In 1992, 82% of the pumps were still in good working condition, and 94% of these pumps were in good working condition in 1987. In 1992, 64% of latrines were functional, compared to 93% at the end of 1987. In 1992, approximately 84% of adults in the former intervention area utilized sanitary latrines, compared to only 7% in the control area. However, knowledge regarding disease transmission was limited and comparable in both regions. People stated that they utilized the WSH facilities to better their circumstances. In 1992, the prevalence of diarrhoeal diseases in the control population was roughly double that of the intervention population. (B. A. Hoque et al., 1996)

In the study of Water supply, sanitation and hygiene education : report of a health impact study in Mirzapur, Bangladesh, The primary objective of water supply and sanitation programs is to enhance the community's health. This not only reduces human distress but also allows for economic gains. The Mirzapur study is significant because it validates a fundamental premise upon which much water and sanitation policy is based: that advancements in water supply and sanitation have a positive effect on community health.

It is especially noteworthy that the impact was demonstrated in rural Bangladesh, despite the fact that the majority of households are within a few minutes' walk of a polluted alternative water source, but individual connections are not an affordable level of water supply service. An integrated bundle of handpumps, latrines, and sanitation education resulted in extremely significant health benefits. It is unclear, however, to what extent these benefits could have been realized by these three components separately or at lower levels of provision. The initiative demonstrated the viability and operational benefits of an integrated approach that combines water distribution, sanitation, and hygiene education. The sanitation education component contributed to the adoption and use of the handpumps and latrines, and its messages could not have been implemented without them. (*Water Supply, Sanitation and Hygiene Education : Report of a Health Impact Study in Mirzapur, Bangladesh :: IRC*, n.d.)

In the study of Water sanitation and hygiene status in the neighbourhood of Bangladeshi Islamic schools and mosques, Faith-based interventions to enhance water, sanitation, and hygiene have been underutilized and offers promise to influence community behavior. Prior to implementing a faith-based WASH intervention, we surveyed the surrounding households of eight Islamic schools and mosques in Bangladesh. We randomly selected 192 mosque-attending families and conducted interviews with their adult female members. Nearly all households used enhanced water sources and restrooms at baseline. However, the restrooms were filthy. After the pit/septic tank was emptied, feces were disposed of into the environment. Children younger than three years of age defecate and dispose of their waste primarily in the open air, which should be improved through behavior modification recommendations. Very little hand cleansing agent was present in the hand washing area. The Islamic faith-based intervention should be devised and implemented to promote hand cleansing, safe sanitation practices, and safe food handling. Safely dispose of infant excrement. (Alam, 2017)

According to the study of Water, Sanitation and Hygiene (WASH) in Schools in Low-Income Countries: A Review of Evidence of Impact, Many institutions in low-income countries lack access to adequate water facilities, sanitation, and sanitary education. The purpose of this systematic literature review was to identify and assess the impact of water, sanitation, and hygiene (WASH) interventions in schools in low-income countries. From

March to June 2018, published peer-reviewed literature was systematically screened using PubMed, Embase, Web of Science, the Cochrane Library, Science Direct, and Google Scholar. There were no restrictions on the publication date. 38 peer-reviewed articles that fulfilled the inclusion criteria were identified. The papers were grouped according to four categories of reported outcomes: (i) reduction of diarrhoeal disease and other hygiene-related diseases in school students; (ii) improved WASH knowledge, attitudes, and hygiene behaviours among students; (iii) reduced disease burden and improved hygiene behaviours in students' households and communities; and (iv) increased student enrollment and attendance. Also examined were the typically unmeasured and unreported 'output' and/or 'exposure' of program fidelity and adherence. Several studies provide evidence of positive disease-related outcomes among students, whereas other evaluations did not find statistically significant differences in health or indicated that outcomes depend on the nature and context of interventions. Thirteen studies provide evidence of changes in WASH-related knowledge, attitudes, and behaviors, such as soap-washing hand hygiene. It is necessary to conduct additional research to determine whether and how school-based WASH interventions can enhance hygiene practices and community health. Inconsistent evidence suggests that school-based WASH programs can reduce student absences. Ensuring access to safe and sufficient water and sanitation and promoting hygiene in schools has the potential to improve health and education and contribute to inclusion and equity, but delivering school-based WASH interventions does not guarantee positive outcomes. While additional rigorous research will be beneficial, political will and interventions with high program fidelity will also be essential. (Alam, 2017)

In the study of Drinking water, sanitation, and hygiene (WASH) situation in primary schools of Pakistan: the impact of WASH-related interventions and policy on children school performance, The Sustainable Development Goals of the United Nations include the objective of ensuring universal access to water, sanitation, and hygiene (WASH); however, very few studies have evaluated comprehensive school WASH service in Pakistan. The purpose of this study was to identify WASH services in Pakistani primary schools and to assess the relationship between recent WASH interventions and policies and academic performance. A representative cross-sectional investigation was conducted in Pakistan's Sindh province's primary institutions. Observations and interviews were conducted to determine the WASH conditions of the institutions. The primary exposures of interest were the implementation of previous WASH interventions and the National WASH policy in schools, as well as the WASH coverage. Among the outcomes of concern were WASH conditions and academic performance. The structural equation modeling

(SEM) with bootstrap resampling technique was used to characterize the relationship between WASH exposures and school performance. We gathered information from 425 institutions. The coverage of basic water, sanitation, and hygiene (WASH) facilities in Sindh's primary schools continues to be low based on WHO WASH service ladder criteria. Inconsistencies were also discovered in all three domains of WASH facilities (availability, accessibility, and functionality). The school performance was significantly correlated (P 0.001) with the presence of WASH interventions and/or WASH policies, whereas the presence of WASH policies and/or recent WASH interventions at the school was not correlated with the overall water quality. Our evaluation revealed several WASH deficiencies, including excessive levels of heavy metal and feces contamination. To enhance educational outcomes, it is recommended that primary schools adopt a national WASH policy and finance WASH interventions based on evidence. (J. Ahmed et al., 2022)

In the study of Drinking Water Quality and Options for the Primary Schools of a Salinity Affected Coastal Area of Bangladesh, In the littoral regions of Bangladesh, salinity intrusion precipitated a severe potable water crisis. The situation is notably dire for minors in school. However, there is limited information on water utilities in coastal institutions. Here, we evaluate the purity of potable water and provision infrastructures in the primary schools of a Bangladeshi coastal region severely afflicted by salinity. In Dacope Upazila of the Khulna district in Bangladesh, thirty-eight institutions were selected and investigated on purpose in order to meet the objective. Only harvested precipitation (63%), ponds (21%), and tube wells (16%) were identified as sources of potable water. The concentrations of DO, pH, NO3, SO4, and PO4 in the potable water met the quality standard. Total coliform counts, however, exceeded the national standard. The susceptibility of harvested rainwater and pond water to microbial contamination was greater than that of high-salinity tube wells. Despite the fact that 29% of schools have installed portable water filtration units, these are inaccessible to pupils. Students are susceptible to water-borne diseases as a result of their reported consumption of hazardous potable water. Principal obstacles to the provision of safe potable water in Bangladesh's coastal primary schools are a paucity of resources and inadequately designed infrastructure. (Hossain et al., 2021)

In the study of Water, sanitation and hygiene (WASH) in schools in Brazil pre-and peri-COVID-19 pandemic: Are schools making any progress?, Prior to the COVID-19 pandemic, a lack of data and research on water, sanitation, and hygiene (WASH) in Brazilian schools prevented an evaluation of how secure and healthy schools are to reopen. The objectives of this study were to assess the current state of WASH in Brazilian schools and to determine whether or not Brazilian schools have made any progress in providing WASH since the onset of the COVID-19 pandemic. From the 2020 and 2021 Brazilian National School Census (BNSC), data on WASH conditions in schools in Brazil were retrieved. For the first objective, the frequencies of 31 variables were calculated for the entire nation and regions, taking into account all 173,700 BNSC 2021 institutions. As indicators of an adequate WASH infrastructure in schools, five major variables were considered. The T-test and ANOVA were used to assess differences between these five variables based on locality, management model, and regions. To compare WASH in schools pre- and peri-COVID-19 pandemic, only schools present in both datasets (n = 170,422) were considered for the second objective. Before and during the pandemic, the frequencies of 31 variables were calculated for the entire country and its regions. When differences in variables between years were observed, paired t-tests were administered. Currently, the majority of schools in Brazil are equipped with restrooms (97%), potable water (95%), enhanced sanitation (78%), and solid refuse collection (70%). In all regions of the country, there were both improvements and declines in the WASH infrastructure of schools between 2020 and 2021. In terms of WASH infrastructure alone, schools in the South and Southeast regions of the United States are better prepared for a safe reopening. Nevertheless, public schools, rural schools, and schools in the North and Northeast have the greatest need for WASH interventions. Results indicate that little progress was made, and reforms are still required in Brazilian institutions. (Poague et al., 2022)

Using the Water Quality Index (WQI) and multivariate statistics to assess the water quality in the Maddhapara Granite Mining Industrial Area, Dinajpur, Bangladesh. The primary objective of this investigation is to evaluate the water's hydrochemical properties. Find the source of surface and subterranean water pollution in the Maddhapara Granite Mining Industrial Area. There are three clusters consisting of 31 samples. Cluster I (70.97%), Cluster II (22.58%), and Cluster-III (6.45%) accounted for the respective percentages of groups in the total water sample. According to the outcome of factor analysis, five factors explained 75.89% of the total variance. Strong loading components suggest that ion dissolution, the weathering of minerals, and human activities are the primary sources of pollution. The Water Quality Index analysis revealed that 96.77 percent of the water samples were of exceptional quality and 3.23 percent were of acceptable quality. Cluster I contained the highest quality water of the three clusters, followed by Cluster II and Cluster III. (Howladar, Al Numanbakth, and Faruque, 2017).

A cross-sectional analysis of the Water Quality Index for measuring potable water quality in rural Bangladesh. To improve public health, the research seeks to increase household awareness of the chemical composition of drinkable water. The Water Quality Index (WQI) is regarded as the most effective classification system for water. A number of water quality parameters are included in a four-equation rating water quality and determining its suitability for human consumption. 542 samples are collected from 293 households for analysis of the water quality index. 67% of the sample population had poor quality drinking water (WQI>100), while 33% had excellent quality drinking water (WQI100). In that region, the majority of people consume water of low quality. Higher concentrations of arsenic, manganese, and iron were discovered to be the cause of deteriorating water quality. Approximately fifty percent of households exceeded the Bangladeshi acceptable limit for reasonable manganese exposure. (Akter et al., 2016).

Using hydrochemical, multivariate statistical, and water quality index methods, the water quality and pollution sources of the Surma river in Bangladesh were evaluated. The purpose of this study is to evaluate 14 parameters of water quality, including turbidity, TS, TSS, TDS, hardness, iron, DO, BOD, COD, alkalinity, water pH, conductivity, chloride, and CO2. They discovered that improper management of drainage systems and solid refuse are the leading causes of water quality degradation in the Surma river. The majority of BOD, COD, Turbidity, TSS, and CO2 water samples exceeded the standard limit. Hierarchical cluster analysis, principal component analysis (PCA), and correlation matrix analysis are the most widely used statistical analyses for identifying the dominant components and sources that explain variations in water quality and their effects on water environments. According to the Water Quality Index (WQI) analysis, the majority of water samples are of low quality. In factor analysis, five factors explained 78.8 percent of the total variance. The environmental contaminants with the highest factor loading values are TDS, DO, BOD, COD, pH, and turbidity. Human refuse, sewage contamination, land discharge, organic contaminants, and agricultural practices have the greatest impact on river water quality, according to analyses and observations. (Howladar et al., 2021).

An assessment of the condition of groundwater for irrigation and consumption around brick kilns in three districts of Balochistan province, Pakistan, using the water quality index and multivariate statistical methods. The purpose of this survey is to assess the purity of subterranean water for consumption and irrigation in three Balochistan districts. The purity of groundwater was evaluated based on twenty-two physiochemical parameters using standard protocols. With few exceptions, the majority of the analyzed physicochemical parameters were found to exceed WHO's permissible limits. Using the water quality index (WQI), they determined that the water quality in the study area is substandard. The dominant cation and anion patterns are $Na^+ > Mg^{2+} > Ca^{2+} > K^+$ and $HCO_3^- > SO_4^{2-} > Cl^- >$ Fa, respectively. The correlation matrix reveals a substantial positive and negative correlation between sample parameters. Cluster analysis identifies distinct clusters based on homogeneity of parameters, whereas factor analysis predicts the pollutant source in groundwater. The results of these statistical methods for multivariate analysis also demonstrated the contribution of both natural and anthropogenic activities to the alteration of the hydrochemistry of the groundwater studied. (Khanoranga and Khalid, 2019).

Developing a new integrated water quality index (IWQI) model to assess the adequacy of water for human consumption. This study demonstrates how the Water Quality Index (WQI) can be determined with greater precision and fewer limitations. The conventional method considers either the permissible or preferable limit. Thus, considerable confusion persists, resulting in less precise results. There are numerous methods for evaluating Water quality indices, each with their own weaknesses and limitations. There is a need to develop a water quality index (WQI) that is flexible enough to represent the adequacy of potable water around the globe. Consequently, the Integrated Water Quality Index (IWQI) was devised, which considers both permissible and preferable limits. It is more precise because it has fewer limitations. Based on this concept, the IWQI has been divided into five categories: excellent (1), good (1–2), marginal (2–3), poor (3–5), and unsuitable (> 5) based on the concentration of cations (Ca, Mg, Na, and K), anions (Cl, SO_4, and NO_3), and other parameters (pH, TDS) in groundwater samples. The results indicate that 2% of the samples are superb for imbibing, 39% are good, 43% are marginal, 8% are poor, and 8% are unfit for consumption. The results are obtained at 20% below the maximum permissible level and can be adjusted per user need to alert water administrators of potential ingesting water-related health risks to humans. Due to industrial and agricultural input into the water aquifer system and ground water contamination, the water quality is deteriorating daily. Therefore, the IWQI method is more precise and objective than other methods. (Mukate et al., 2019).

Evaluation of the characteristics and quality index of potable water in Rajshahi, Bangladesh The purpose of this study is to analyze 116 ground water samples collected in Bangladesh's drought-prone Rajshahi City Corporation area before and after the monsoon seasons of 2014 and 2015. It is performed to evaluate the consumption suitability from a management standpoint. According to the Bangladesh Drinking Water Standards (2005), parameters such as pH, Ca^{2+}, Mg^{2+}, Cl, Fe(total), and Mn^{2+} exceed the desirable limit, but are within the permissible limit without adverse effect, with the exception of Mg^{2+} concentration, which accounts for 45 percent in the pre-monsoon period and renders groundwater unfit for human consumption. The groundwater contains more alkaline earth elements (Ca^{2+}+ Mg^{2+}) than alkaline earth elements (Na^{+}+K^{+}). Again, weak acids (HCO_3^-) outnumber strong acids (SO_4^{2-}) in areas where Ca^{2+} and HCO_3^- are dominant constituents and contribute to transient groundwater hardness. The aquifer's groundwater is of the (Ca^{2+}, Mg^{2+}, HCO_3^-) type. Cluster analysis identifies three categories of water: iron-type water (Type I), sodium-type water (Type II), and calcium-type water (Type III). The majority of the subterranean water in this region is of high quality. However, the passage of time and a growing population can have a negative impact on water quality. We must therefore implement mitigation measures and a long-term control strategy. (Rahaman et al., 2019).

Evaluation of groundwater quality using the Water Quality Index (WQI) and multivariate analysis: a case study of the Tefenni plain (Burdur, Turkey). This study investigated the purity of groundwater, its seasonal variations, and its suitability for consumption, irrigation, and industrial use. In the Tefenni plain, agricultural and domestic water use is primarily dependent on groundwater. Therefore, 56 samples were collected from wells, lakes, and sources for analysis. Based on the water quality index, they determined that during both arid and rainy seasons, 89.28% of groundwater samples are of outstanding quality. According to factor analysis, water-rock interaction and nonpoint pollution sources are the leading causes of groundwater contamination. Based on the water quality index, they determined that Ca–Mg–HCO_3, Mg–Ca–HCO_3, Na–CO_3–Cl, and Na–HCO_3–Cl are the predominant water types in the area under investigation. Analyses of the R mode factor and correlations were conducted to determine the chemical variation. According to R-mode factor analysis, the most important parameters are total dissolved 7 solids, Na, Cl, HCO3, and NH3. Again, Water condition Index (WQI) was used to determine the suitability for consumption and to investigate the condition of ground water. The variation between arid and rainy seasons was also investigated. (Varol and Davraz, 2014)

Chapter Three: Study Area

3.1 General

Choosing the optimal location for the research project's analysis is crucial. It will assist us in precisely receiving the results and solutions. Otherwise, the research will not be effective enough.

3.2 Study area

Our research project in Tongi, Gazipur, Bangladesh covers a total area of 32.07 km2 in its scope of investigation. inside this area are located all 43 MPO (Monthly Pay Order) educational establishments that are located inside the Tongi district of Gazipur. There are 19 elementary schools, 15 secondary schools, 5 colleges, and 4 madrassas included in this group of establishments.

Investigating the quality of the drinking water and sanitary facilities in the region under investigation should be the major emphasis of your research. You want to obtain a better grasp of the general circumstances and discover any areas that may need improvement by examining and assessing these elements. Your goal is to accomplish both of these goals.

We have employed ArcMap and Google Earth Pro in order to aid in seeing and charting the locations of these educational institutions. These tools provide you the ability to create a spatial context for your research by allowing you to spatially portray the distribution of the institutions that are located inside the study region. We have able to collect data and get insights on the state of the drinking water and sanitation issue at these educational establishments if you choose to carry out your research in this particular region of Gazipur. This research has the potential to contribute to the identification of possible problems, the development of focused solutions, and an overall improvement in the circumstances of the studied region.

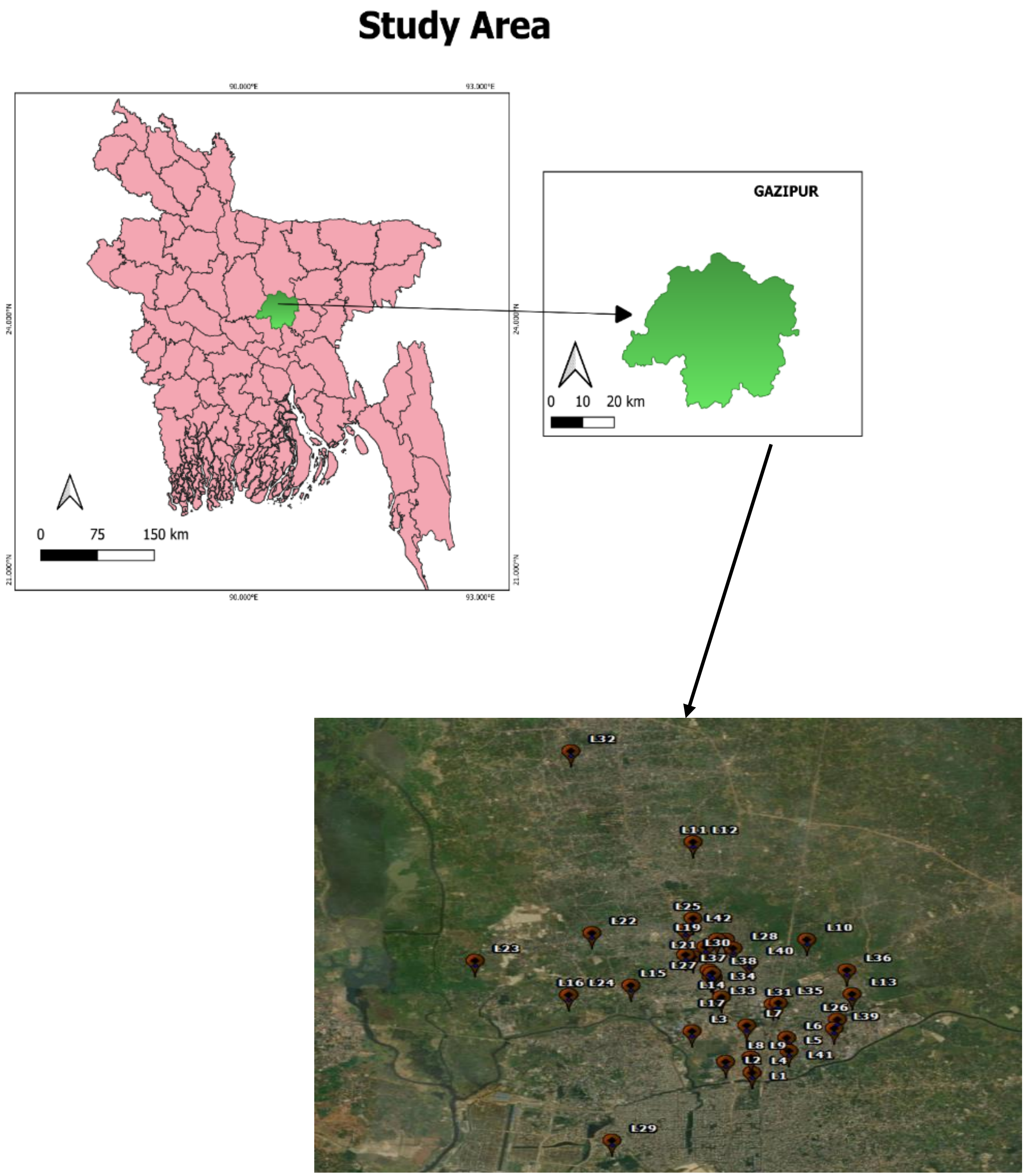

Figure 3.2 1: Study area

Chapter Four: Methodology

4.1 Secondary data collection

The process of collecting data included acquiring pertinent information from the Upazilla primary education office and the Upazilla secondary education office. This section describes the methods used to collect the required data for the study. There are 43 educational institutions in total. There are 19 primary schools, 15 secondary institutions, five colleges, and four madrassas. We required the assistance of the Upazilla primary education office and Upazilla secondary education office to obtain information such as the number of teachers and students.

In the beginning, formal permission was obtained from both the Upazilla primary education office and the Upazilla secondary education office. Ethical considerations, including data confidentiality and privacy, were addressed, along with the study's purpose and objectives. The officials granted permission to access the necessary data. The initial phase of data collection consisted of an exhaustive examination of official documents, reports, and records accessible at the Upazilla primary education office and Upazilla secondary education office. These records consisted of annual performance reports, student enrollment records, attendance registers, examination results, curriculum guidelines, and teacher assignment records. Also examined were primary and secondary education policies and guidelines pertinent to the Upazilla.

In addition to document evaluation, semi-structured interviews with key personnel from both offices were conducted. The purpose of these interviews was to acquire insights and perspectives on primary and secondary education in the Upazilla. Education officers, administrators, and other personnel with extensive knowledge and experience of the education system were interviewed. To guarantee a variety of perspectives, a strategy of strategic sampling was implemented. Using a standardized data collection form, all information gleaned from the document review and interviews was meticulously recorded. The form included fields for capturing pertinent data such as pupil demographics, teacher qualifications, infrastructure facilities, educational policies, and obstacles confronted in primary and secondary education.

The recorded information was cross-checked and validated by comparing it with multiple sources, such as different documents or interviews, to ensure its accuracy. Through follow-up interviews or consultations with the relevant officials, inconsistencies or discrepancies were clarified.

Throughout the process of data acquisition, ethical considerations were of the utmost importance. Participants' anonymity and confidentiality were rigorously protected, and any potentially sensitive information was handled with care and kept strictly confidential.

4.2 Field investigation

For the purpose of this analysis, a method known as purposive sampling was used to pick the educational institutions to examine. The criterion for selection included aspects such as the kind of school (primary, secondary, or mixed, college, or madrasa), the number of students enrolled at the institution, its geographic distribution, and its representation of various educational zones within the scope of the research. This method guaranteed that a broad cross-section of institutions was represented in the sample.

Before beginning the physical inquiry, approval from the appropriate authorities, such as the individual school administrations and educational district offices, was requested. This was done in order to avoid any potential legal complications. The goal of the research, the processes for collecting data, and the ethical issues, including the confidentiality of the data and the anonymity of the participants, were all discussed. The administrations of the educational institutions provided their informed permission, and any and all possible issues or queries that were presented by the institutions were answered.

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We have been to each of the 43 educational institutions and carried out in-person inspections there. During these visits, a predetermined procedure was followed in order to collect the necessary data. We monitored the water supplies, classrooms, labs, restroom conditions, and other aspects of the facility's infrastructure, and we took notes and observations throughout. In addition, we talked with the school administrators, instructors, and students, utilizing standardized questionnaires to collect more information regarding the functioning of the institution as well as student experiences. The practice of conducting physical investigations provided a means for achieving an all-encompassing comprehension of the educational atmosphere present inside each school.

4.3 Questionnaire development

Before any data was collected for the study, the researchers took the time to brief the school administration on its objectives and purpose. It was brought to everyone's attention how important it is for schools to do water supply, sanitation, and hygiene facility assessments. It has been established that the school administration is prepared to take part in the research project since they have given their approval for it.

For the sole purpose of this research, a questionnaire for a survey was devised. The questionnaire had a total of 38 questions, all of which were centered on different elements of the water supply, sanitation, and hygiene facilities found in the schools. The purpose of these questions was to collect information in more depth on the availability and functionality of amenities inside the school grounds, such as water sources, toilets, handwashing stations, waste management systems, and general hygiene practices.

The survey questionnaire was given out at the school in conjunction with the head teacher or another member of staff selected for that purpose. We have given great consideration to each inquiry included in the questionnaire in order to provide replies that are accurate and comprehensive. When there was a need for further information or clarification, follow-up inquiries were directed toward the head teacher or a member of the staff. The replies were written down in the questionnaire that was given.

Ethical concerns were adhered to throughout the whole of the process of data collecting. The schools and their employees' right to privacy and confidentiality were protected at all times, and the material that was gathered was put to use only for the sake of study. Any information that may be considered sensitive or could be used to identify a person was treated with caution and was held in the strictest confidence.

4.4 Sample collection

These procedures are designed to ensure accurate and reliable sample analysis. Let's examine each phase in more detail:

Before sterilizing the sample vials, two or three droplets of a 3% sodium thiosulphate solution were added. The purpose of this phase is to neutralize the bactericidal effects of any chlorine present in the samples. Chlorine is commonly used as a disinfectant in water treatment, and its presence could potentially interfere with the analysis by preventing or killing bacterial growth.

The sample vials were sterilized to eradicate any potential contaminants that could compromise the results of the analysis. Sterilization eliminates any microorganisms or substances that could modify the water's composition. The addition of sodium thiosulfate solution prior to sterilization neutralizes chlorine and prevents it from interfering with the sterilization process.

After collection, the sampling vials were placed in a wicker receptacle containing ice for temperature control and preservation. This phase is essential for preventing bacterial proliferation in samples during transport to the laboratory. By maintaining a temperature range between 4 and 8 degrees Celsius, the development of bacteria and other microorganisms is delayed, reducing the risk of sample degradation and potential changes in water quality.

The samples were transported to the laboratory within two to four hours of their collection. This brief time period is crucial for minimizing any potential changes to the samples over time. Certain water parameters, such as dissolved oxygen levels, pH, and microbial populations, are susceptible to change if samples are not immediately analyzed. A timely analysis helps to ensure that results are accurate and representative.

Once in the laboratory, the preserved samples were stored at 4 degrees Celsius until analysis. This temperature of refrigeration aids in preserving the integrity of the samples by inhibiting bacterial growth and reducing the likelihood of chemical reactions. The accuracy and dependability of the results acquired are enhanced by storing samples at a controlled temperature until analysis.

Overall, these sampling procedures exhibit a thorough approach to sample collection, preservation, and analysis. The addition of sodium thiosulfate solution neutralizes chlorine, sterilization eliminates contaminants, temperature control minimizes bacterial growth, timely analysis reduces the likelihood of sample changes, and storage at 4°C preserves sample integrity. Using these standardized methodologies, the objective is to collect accurate and representative data on the quality of water and effluent.

4.5 Sample testing

Instrument And Chemicals that were needed for testing are given below:

Table 4.5 1: Instrument and chemicals

Quality Parameters	**Instruments Used**	**Chemical Required (if any)**
pH	pH Meter	-
Turbidity	Spectrophotometer	-
Color		-
Total Solid (TS)	Beaker Cylinder Filter Paper Balance	-
Total Dissolve Solid (TDS)		-
Total Suspended Solid (TSS)		-
Escherichia Coli (*E. coli)* Fecal contamination	Petri Dish Filter Paper	Endo Broth Powder Bacto Agar Rosolic Acid Sodium Hydroxide
Iron (Fe) Content Manganese Content	Nessler Tube Measuring Cylinder	Hydrochloric Acid Potassium Permanganate Solution Potassium Thiocyanate Solution Standard Iron Solution
Arsenic (Ar) Content	HACH Arsenic Test Kit	

Some of the method testing are described below:

pH:

• Following pH meter calibration, the H+-sensitive probe was cleansed with distilled water.

• A sample was poured into a clean vessel, the probe was submerged in the sample, and the readings were logged.

• The instrument was cleansed with distilled water after testing a single sample.

Color and Turbidity:

• The cell containing distilled water is placed in the sample compartment with transparent side facing the light source. The Lid of the cell was closed and 'AUTOZERO' key was pressed to calibrate the Spectrophotometer.

• Discarding the distilled water, sample containing cell was placed and the lid was closed.

• 'START' key was pressed to measure both Color and Turbidity in the same process.

Iron Content: Sample water was taken in a Nessler and 5ml diluted HCL was added with two drops of Potassium permanganate. Potassium thiocyanate is added to the solution which will turn brown if iron is present.

Arsenic Content: The HACH Arsenic Test strip is inserted in the cap so that the pad completely covers the openings and some sample was added in it. Reagent #1 and Reagent #2 is added to the sample and swirled continuously and after 20minutes, the strip was removed and immediately compared with the color chart to find the reading.

Total Solid, Total Dissolved Solid, Total Suspended Solid:

- A dry glass breaker was weighed initially and 100ml sample was taken in the beaker. The breaker was placed in oven under 103°C for 24hours.

- The beaker was cooled and the weight of beaker along with the solid was measured. The amount of Total Suspended is determined by subtracting the weight of clean beaker form step 1. TS(mg/l) can be calculated using the equation stated below-

$$\boldsymbol{TS(mg/l) = (mg\ of\ solid\ in\ the\ beaker \times 1000)/sample\ taken}$$

- A double layered filter paper is taken and weighed. Taking another 100ml sample in another beaker, it is to be filtered through the double layered filter paper and the filtrate is to be collected and kept in oven under 103°C for 24hours.

- After drying the filter paper with the solid has to be weighed and subtracting from the weight of filter paper we will obtain the value of TDS. TDS in mg/l is then calculated using the following equation-

$$\boldsymbol{TDS(mg/l) = (mg\ of\ solid\ in\ the\ beaker \times 1000)/\ sample\ taken}$$

- After calculating TS and TDS, TSS(mg/l) can be calculated using-

$$\boldsymbol{TSS(mg/l) = TS(mg/l) - TDS(mg/l)}$$

Fecal Coliform, Escherichia Coli:

M-ENDO Broth and MFC-AGAR medias are prepared to identify the TC, FC and E. coli respectively by membrane filtration:

- 48gm M Endo broth powder and 15.6gm Bacto Agar are dissolved separately in 1 liter distilled water. Mixed water was heated with constant shaking and it was poured in the Petri Dish to cool down. 43gm MFC Agar was dissolved in 1 liter distilled water and 10ml 1% solution Rosolic acid was added in 0.2N NaOH and the mixed water was heated in similar way to prepare the media.

- 10-15ml saline have been taken and small amount of sample was poured and filtered.

- The paper is then placed on the petri dish and is incubated for 24 hours at 37°C for TC, E. coli and 44°C for FC. After 24hours, the number of bacteria was counted and documented.

4.6 Data analysis

4.6.1 General

This chapter of the book will go through the precise, step-by-step methodology of the data analysis part that has been done. The whole procedure has been broken down into numerous stages:

- Statistical analysis
- Water Quality Indices using “Integrated Water Quality Index (IWQI)” method
- Pearson correlation matrix
- Sanitation

4.6.1 Statistical analysis

Statistical analysis is the process of accumulating and analyzing vast quantities of data in order to identify trends and develop insightful conclusions. We have done the mean and maximum and minimum from the whole data.

Mean:

The mean is one of the measures of central tendency in statistics, along with the mode and median. Mean is simply the average of the values in a specified set. It signifies the uniform distribution of values within a specified data set.

4.6.2 Integrated Water Quality Index (IWQI)

A complete and impartial water quality assessment for water resources based on physicochemical factors, the integrated water quality index correlates with current drinking water quality criteria (Mukate et al., 2019).

Integrated water quality index can be calculated in 5 steps. These steps are described in the following:

Step 1: Choosing the parameters

We have selected a total of eight physiochemical parameters. And they are pH, DO, TDS, color, Turbidity, Fe, As, Mn. These parameter were selected to evaluate drinking quality by using IWQI. The analysis was conducted using Bangladesh Drinking Water Standard (BDWS 2005) acceptable and desired limits.

Step 2: Desirable Limit (DL) and permitted limit established by Bangladesh Drinking Water

Range was calculated using the standard (BDWS 2005), which took into account their harm to the public's health.

Eq. 2.2.1 was used to calculate the range's values.

Range = Permissible Limit (PL) – Desirable Limit (DL)……. (2.2.1) (Mukate et al., 2019).

The calculated values of range of selected parameters along with DL, PL are represented in Table 1.

Table 4.6.2 1: Calculated values of ranges

Parameters	DL	PL	Range(PL-DL)
pH	6.5	8.5	2
DO	0	6	6
TDS	0	1000	1000
Color	0	15	15
Turbidity (NTU)	0	25	25
Fe	0.3	1	0.7
As	0	1	1
Mn	0	0.1	0.1

All values are expressed in mg/l except Turbidity (NTU) and pH on scale.

Step 3: Modified Permissible Limit computation

Modified permissible limit was calculated in Eq. 2.2.2 as difference between permissible limit and 15% deficit of the range calculated in Table 4 (Mukate et al., 2019).

Modified Permissible Limit (MPL) = Permissible Limit (15%Range) …… (2.2.2) (Mukate et al., 2019).

Table 4.6.2 2: Values of MPL

Parameters	Permissible Limit	Modified PL (MPL) (15% deficit to original)
pH	8.5	8.2
DO	6	5.1
TDS	1000	850
TS	1000	850
Color	15	12.75
Turbidity	25	21.25
Fe	1	0.895
As	1	0.85
Mn	0.1	0.085

Step 4: Calculation of Sub-indices (SI)

Any parameter concentration below or above DL and PL, respectively, significantly reduces water quality. Any parameter concentration between DL and PL is regarded as excellent for water quality. Therefore, the idea of integrated water quality is founded on the data depicted in Figure 1.

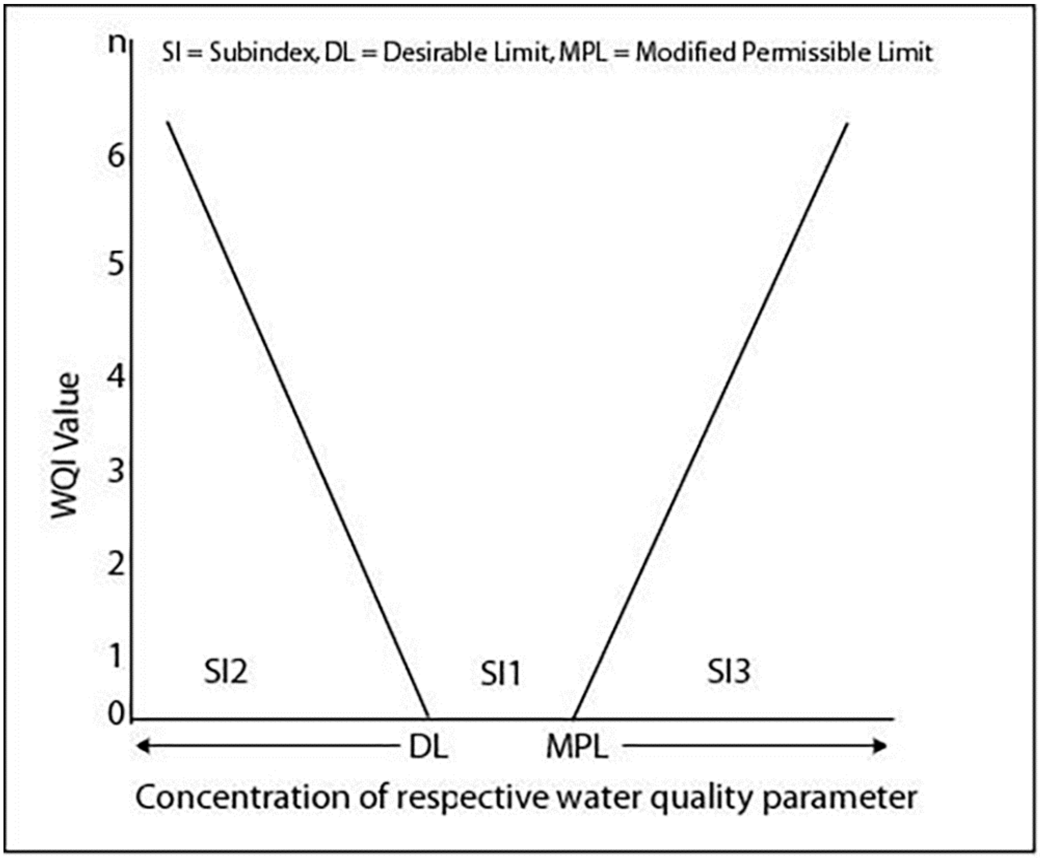

Figure 4.6.2 1:The conceptual Integrated Water Quality Index (IWQI) model (Mukate et al., 2019).

Now if monitored value of ith parameter, Vi is between DL and MPL i.e., DL ≤ Vi ≥ MPL then,

SI1 = 0 ……… (2.2.3)

Again When Vi ≤ DL

$SI2 = (DL - Vi)/DL$, …… (2.2.4)

Lastly When, Vi ≥ MPL

$SI3 = (Vi - MPL)/PL$, When, Vi ≥ MPL …… (2.2.5)

Where, SI = Sub-Index Value,

Vi = Monitored value of ith parameter

Step 5: Determination of IWQI

Final Integrated water quality index of ith sample can be calculated by summing up all sun-indices value acquired from Eq. 2.2.3 to 2.2.5. So,

$IWQIi = \sum SIij\ n\ j$=1 , Where $SIij$ = Sub-index of jth parameter of ith sample

Finally, Water quality can be evaluated through IWQI values according to Table

WQI Value	**Rating of Water Quality**	**Explanation**
< 1	Excellent	Excellent for Drinking
1-2	Good	Good for Drinking
2-3	Marginal	Acceptable for Domestic
3-5	Poor	Not Suitable for Drinking
>5	Unsuitable	Unsuitable for Drinking

Table 4.6.2 3: Categorization of water quality

4.6.3 Pearson’s Correlation Coefficient (r)

Pearson’s correlation is a statistical measure of linear correlation between two variables. Karl Pearson developed this correlation technique between variables. The correlation coefficient is donated by r.

If x, y are two variables, and both variables contain n pair of values, then Pearson’s correlation coefficient can be calculated by Eq 3.1

$$r = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \bar{x})^2 \sum_{i=1}^{n}(y_i - \bar{y})^2}} \quad \text{.................................. (3.1)}$$

Where, r values are ranged from -1 to 1. Here, +1 means strong positive correlation and -1 being strong negative correlation. Whereas 0 means no correlation between x and y.

4.6.4 Sanitation

The survey questionnaire responses and on-site observation records, were analyzed to assess the water supply and sanitary conditions in the schools. The responses from the survey questionnaire were analyzed using appropriate statistical techniques, such as, to identify trends, patterns, and discrepancies in the facilities provided. The on-site observation records were used to validate and complement the survey findings.

The on-site observation records were used to corroborate or supplement the survey findings, identify any discrepancies or inconsistencies, and provide additional insights into the quality and functionality of the facilities. For example, if the survey indicated that a school had functional toilets, the on-site observations could verify the cleanliness and accessibility of those facilities. Conversely, if the survey responses indicated a lack of handwashing stations, the on-site observations could confirm this information and provide specific details about the absence or inadequate provision of such facilities.

Chapter five: Result and Discussion

5.1 Statistical analysis

We have divided out data collection and test two season. One is considered as dry season. Which was conducted on in to the mid-September to the end of the November. And on the other hand our another season is considered as the wet season. Which was conducted on the mid of the March to the end of the April. Our statistic concerning the quality of drinking water of 43 educational institution. Our table represents the maximum, minimum, mean values of the respected data. Also it demonstrate the exceeding values of the WHO standards and ECR(1997) standards.

In the dry season, according to the provided table, the pH values of the water samples range from 7.12 to 8.38, with a mean of 7.7. The WHO standard for pH in water is between 6.5 and 8.5, and all of the measurements are within this range. None of the samples exceeds the WHO's recommended limit. The absence of a WHO or BD standard for EC makes it difficult to determine whether the values exceed any particular thresholds. The EC values of the water samples range between 241 and 429, with a mean of 306,35. The mean DO value of 5.3 is within the WHO-recommended range of 4.0 to 6.0. Nonetheless, approximately 41.86 percent of the samples exceed the WHO standard, indicating that a substantial proportion of the water samples may have lower dissolved oxygen levels than recommended. The average TDS value of 166.11 mg/l lies within the WHO standard range of 0-500 mg/l, indicating that the level of dissolved solids in the water samples is acceptable. The data lacks a WHO or BD standard for TSS, making it challenging to determine if the values exceed any particular thresholds. The mean TS concentration of 168.77 mg/l lies within the WHO standard range of 0-500 mg/l, indicating that the total solids concentration of the water samples is acceptable. Since the data does not include a WHO or BD salinity standard, it is challenging to ascertain whether the values exceed any thresholds. The mean color value of 6.05 PtCo exceeds the WHO's minimum requirement of 15 PtCo. Approximately 9.3 percent of the samples exceed the WHO standard, indicating a higher level of color intensity than is recommended. The mean turbidity of 1.37 NTU is lower than the WHO standard of 5 NTU. Approximately 6.98% of the samples exceed the WHO standard, indicating that a small proportion of the samples may contain higher turbidity levels. The average iron concentration meets the WHO standard of 0.3 mg/l. However, approximately 32.56% of the samples exceed the WHO standard, indicating that a significant portion of the water samples contain a higher iron concentration. The average fecal value of 0.16 N/100 ml is in compliance with the WHO standard of 0 N/100 ml. Nonetheless, 4.65 percent of the samples exceed the WHO standard, indicating the presence of fecal coliform bacteria in a minor proportion of the samples. The mean E.coli concentration of 38.49 N/100 ml is greater than the WHO threshold of 0 N/100 ml. All of the samples (one hundred percent) exceed the WHO standard, indicating a significant presence of E. coli bacteria in the water samples. All of the samples have an arsenic concentration of 0 mg/l, which meets the WHO standard of 0 mg/l. The average manganese concentration of 0.36 mg/l exceeds the WHO limit of 0.5 mg/l. Approximately 32.56% of the samples exceed the WHO standard, indicating that a significant portion of the water samples contain a higher manganese concentration.

	Unit	N	Minimum	Maximum	Mean	WHO Standard	Percentage of exceeding value (WHO)	BD standards (ECR 1997)	Percentage of exceeding value (ECR 1997)
pH	-	43	7.12	8.38	7.66	6.5-8.5	0	6.5-8.5	0
EC	µS/cm	43	241	429	306.35	-	-	-	-
DO	mg/l	43	2.56	8.52	5.3	4.0-6.0	41.86	0-6	27.9
TDS	mg/l	43	124.9	210	166.11	0-500	0	0-1000	0
TSS	mg/l	43	0	6	0.44	-	-	-	-
TS	mg/l	43	121	212	168.77	0-500	0	0-1000	0
Salinity	%	43	0.11	0.36	0.17	-	-	-	-
Color	PtCo	43	0	69	6.05	15	9.3	0-15	9.3
Turbidity	NTU	43	0.12	11.7	1.37	5	6.98	0-10	6.98
Fe	mg/l	43	0.05	0.93	0.3	0.3	32.56	0.3-1	62.79
Fecal	N/100 ml	43	0	4	0.16	0	4.65	0	4.65
E.coli	N/100 ml	43	5	287	38.49	0	100	0	100
As	mg/l	43	0	0	0	0	0	0	0
Mn	mg/l	43	0.03	0.83	0.36	0.5	32.56	0-0.1	86.04

Table 5.1 1: Statistical analysis of Dry season

On the other hand we can find out on the table that in wet season, The pH range of the water samples is 7.08 to 7.98, with an average of 7.468. The WHO standard for pH in water is between 6.5 and 8.5, and all of the measurements are within this range. None of the samples exceeds the WHO's recommended limit. The concentrations of dissolved oxygen in the water samples range from 5.77 to 7.83 mg/l, with an average of 6.759 mg/l. 4.0-6.0 mg/l is the WHO standard for dissolved oxygen. Intriguingly, 81.39 percent of the samples exceed the WHO standard for dissolved oxygen, indicating relatively high concentrations. Electrical conductivity is measured in microsiemens per centimeter per liter (S/cm). However, neither the WHO standard nor the percentage of exceeding values for this parameter are provided in the table. Therefore, it cannot be determined to what extent the observed values exceed the standards. The range of total dissolved solids is 135.3 to 270 mg/l, with a mean of 194.484 mg/l. 0-500 mg/l is the WHO standard for total dissolved solids in water. None of the samples exceeds the WHO's recommended limit. The range of total suspended solids in the water samples is 0 to 5 mg/l, with a mean value of 0.4219 mg/l. Unfortunately, the table does not include the WHO standard or the proportion of exceeded values for this parameter, so it is impossible to determine the extent of exceeded values. The range of total solids in the water samples is between 135.3 and 272 mg/l, with a mean of 194.903 mg/l. Similar to TSS, neither the WHO standard nor the percentage of exceeding values are provided for this parameter in the table. The salinity levels of the water samples range between 0.12% and 0.289%, with an average of 0.188%. The table does not include the WHO standard or the percentage of salinity values that exceed the standard, so the extent of salinity values that exceed the standard cannot be determined. The color of the water samples ranges from 0 to 76 PtCo, with a mean of 6.814 PtCo. The WHO color standard for water is 15 PtCo. Approximately 16.27% of the samples surpass the WHO color standard. The turbidity levels of the water samples range from 0.17 to 11.5 NTU on average, with a mean of 1.209 NTU. The WHO turbidity standard is 5 NTU. Approximately 4.65% of the samples exceed the WHO turbidity standard. Iron concentrations in the water samples range from 0.08 to 1.12 mg/l on average, with a mean of 0.317 mg/l. The WHO iron water standard is 0.3 mg/l. Approximately 34.88 percent of the samples exceed the WHO iron standard. The feces concentrations in the water samples range from 0 to 3 N/100 ml, with an average of 0.116 N/100 ml. 0 N/100 ml is the WHO standard for fecal microorganisms in water. Approximately 4.65% of the samples exceed the WHO's fecal bacteria standard. The range of E.coli concentrations in the water samples is from 2 to 394 N/100 ml, with a mean concentration of 43.395 N/100 ml. The WHO water standard for E. coli microorganisms is 0 N/100 ml. Each sample exceeds the WHO limit for E. coli bacteria. The table indicates there are no observations for arsenic, so there is no value to report as exceeding. The range of manganese concentrations in the water samples is 0.04 to 0.87 mg/l, with an average of 0.375 mg/l. The WHO water manganese standard is 0.5 mg/l. Approximately 27.9 percent of the samples exceed the WHO manganese standard. This values are reflected in the table of data provided.

	Unit	N	Minimum	Maximum	Mean	WHO Standard	Percentage of exceeding value (WHO)	BD standards (ECR 1997)	Percentage of exceeding value (ECR 1997)
pH	-	43	7.08	7.98	7.468	6.5-8.5	0	6.5-8.5	0
DO	mg/l	43	5.77	7.83	6.759	4.0-6.0	81.39	0-6	81.39
EC	µS/cm	43	233	593	387.512	-	-	-	-
TDS	mg/l	43	135.3	270	194.484	0-500	0	0-1000	0
TSS	mg/l	43	0	5	0.419	-	-	-	-
TS	mg/l	43	135.3	272	194.903	0-500	0	0-1000	0
Salinity	%	43	0.12	0.289	0.188	-	-	-	-
Color	PtCo	43	0	76	6.814	15	16.27	0-15	16.27
Turbidity	NTU	43	0.17	11.5	1.209	5	4.65	0-10	4.65
Fe	mg/l	43	0.08	1.12	0.317	0.3	34.88	0.3-1	65.11
Fecal	N/100 ml	43	0	3	0.116	0	4.65	0	4.65
E.coli	N/100 ml	43	2	394	43.395	0	100	0	100
As	mg/l	43	0	0	0	0	0	0.05	0
Mn	mg/l	43	0.04	0.87	0.375	0.5	27.9	0-0.1	81.39

Table 5.1 2:Statistical analysis of Wet season

In comparison of dry season and wet season, Dissolve oxygen has exceeded in wet season than the dry season. In dry season it was 41.86% and in wet season in came to 81.39% according to the WHO standard. Almost double. And according to ECR(1997) the value of dry season was 27.90% and it exceeded to 81.39%.

And the other noticeable mater was E.coli has exceeded hundred percent for both of the season and for both of the standards. And on the other hand for fecal it has exceeded 4.65% for both of the season for both of the standards. But on the other side all the other parameters has exceeded wasn’t that much of noticeable comparing both of the seasons.

5.2 Integrated Water Quality Index

The Integrated Water Quality Index (IWQI) is an instrument for evaluating the overall water quality by combining multiple water quality parameters into a single index value. It provides a comprehensive and holistic method for assessing water quality and facilitates comparisons across multiple locations and time periods. Multiple water quality parameters are considered by the IWQI, which provides a more comprehensive assessment of water quality than analyzing individual parameters separately. It captures the combined effects of various pollutants and environmental factors on water quality by integrating multiple parameters.

During the dry season, the data represents the values of the Integrated Water Quality Index (IWQI) and the corresponding comments for various educational institutions and schools. The IWQI ranges from 0.02 to 9.11, and the remarks categorize the water quality as either Excellent, Good, Marginal, Poor, or Unsuitable. In general, schools with IWQI values below 2 are categorized as Good or Excellent, whereas IWQI values above 6 indicate Unsuitable water quality. Some schools have water quality that falls between Marginal and Poor. According to the data, approximately 23% of educational institutions, or 10 out of 44 schools, have Good or Excellent water quality. Approximately 41% (18/44) of the institutions have Marginal or Poor water quality. The remaining 36% (16 of 44) have Unsuitable water quality. Our current data provides an evaluation of water quality in the corresponding regions and can be used to identify schools or locations with prospective water quality issues

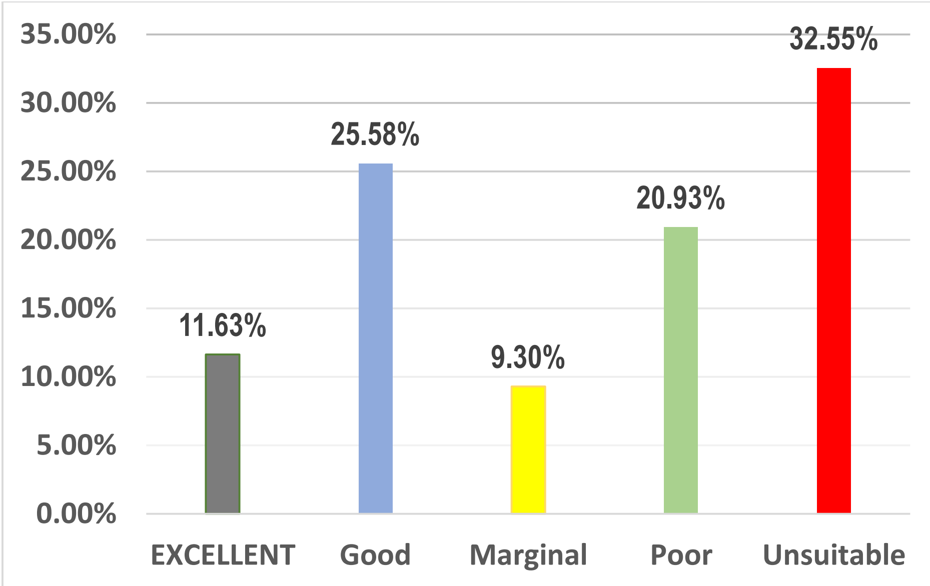

Figure 5.2 1: IWQI representation of dry season

In wet season, their corresponding IWQI (Integrated Water Quality Index) values, and the associated remarks categorizing the water quality. Among the schools mentioned, approximately 20% have Excellent water quality (4 out of 20), while around 18% are classified as Good (6 out of 34). Approximately 27% of the schools (10 out of 37) have Marginal water quality, and roughly 35% (14 out of 40) are categorized as Poor. The remaining 20% (8 out of 40) fall into the Unsuitable water quality category. These IWQI values and remarks provide an assessment of the water quality status in the respective educational institutions, indicating areas where water quality improvements may be needed.

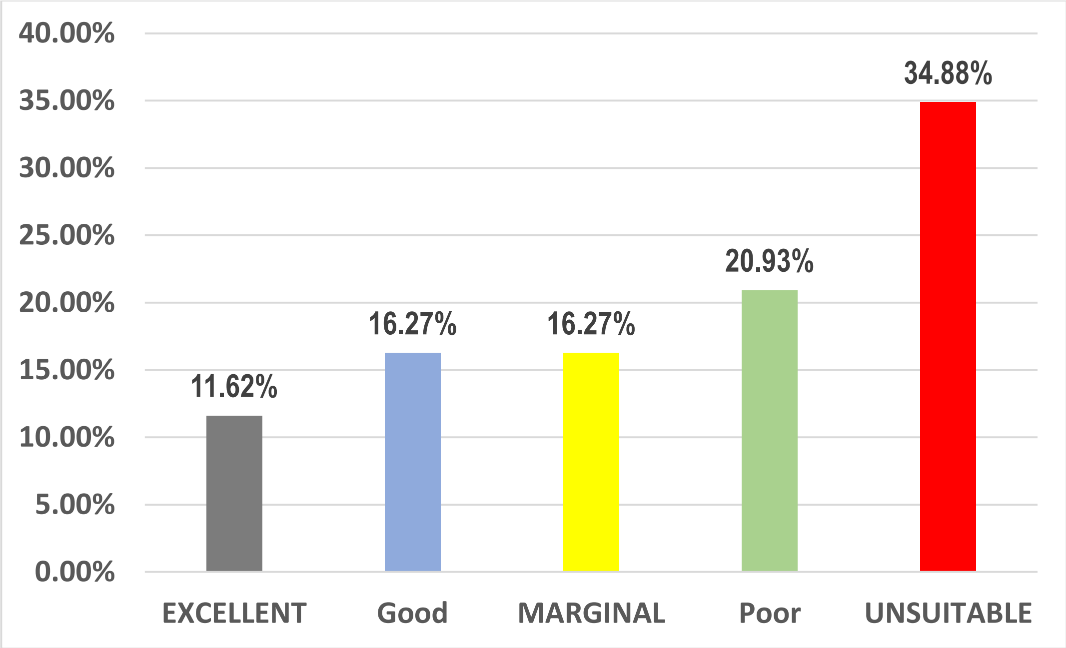

Figure 5.2 2: IWQI representation of wet season

Compared to both seasons, the superior water quality remains unchanged. However, the proportion of high-quality water is greater during the dry season compared to the rainy season. However, during the rainy season the quality of marginal water is higher than during the dry season. The subpar water quality, however, remains the most conspicuous aspect. In addition, the proportion of unsuitable water has marginally increased during the rainy season.

5.3 Principle Component Analysis (PCA)

Principal Component Analysis (PCA) is a dimensionality reduction technique used to transform high-dimensional data into a lower-dimensional representation. It identifies the directions along which the data varies the most, called principal components. These components are orthogonal and capture the maximum variance in the data. PCA involves standardizing the data, computing the covariance matrix, calculating eigenvectors and eigenvalues, selecting the principal components, and transforming the data. It is used for data visualization, noise reduction, feature extraction, and data compression. However, it assumes linear relationships between variables and may not perform well in nonlinear scenarios.

The origin of solutes and the process that produced the observed water compositions may be revealed by using correlation analysis to identify correlations between the physicochemical properties of water samples (Hamzaoui-Azaza et al., 2010). The parameters' positive and negative correlation are shown using Pearson correlation. If the number is 0, then there is no connection between the parameters, while a correlation coefficient of 1 or close to 1 denotes high correlation. According to Manish et al. (2006), parameters with r values between 0.5 and 0.7 exhibit moderate correlation, whereas those with r values more than 0.7 are deemed highly linked. A significance threshold of less than.05 (p.05) is required. A parameter's positive correlation suggests that as one parameter rises, another parameter rises along with it. When there is a negative correlation, it implies that the features are not homogeneous and that when one parameter value increases, another parameter value decreases (Howladar et al., 2021).

For this analysis we have selected all the physiochemical parameters. There is in total eleven parameters. And they are pH, EC, DO, TDS, TSS, TS, Salinity, Color, Turbidity, Fe and Mn. As we have selected two seasons for our data collection we have done our analysis part in that procedure.

In the dry season, we observe the following correlations between parameters:

1. TDS (Total Dissolved Solids) and TS (Total Solids): They have a strong correlation of 0.85, indicating a significant relationship between the amount of dissolved solids and total solids present.
2. TDS and salinity: There is a moderate correlation of 0.54, suggesting a moderate relationship between the level of dissolved solids and salinity.
3. TSS (Total Suspended Solids) and turbidity: They show a strong correlation of 0.70, indicating a substantial relationship between the amount of suspended solids and turbidity.
4. Color and turbidity: They are strongly correlated with a coefficient of 0.77, indicating a significant association between water color and turbidity.

The analysis result are shown in the below figure.

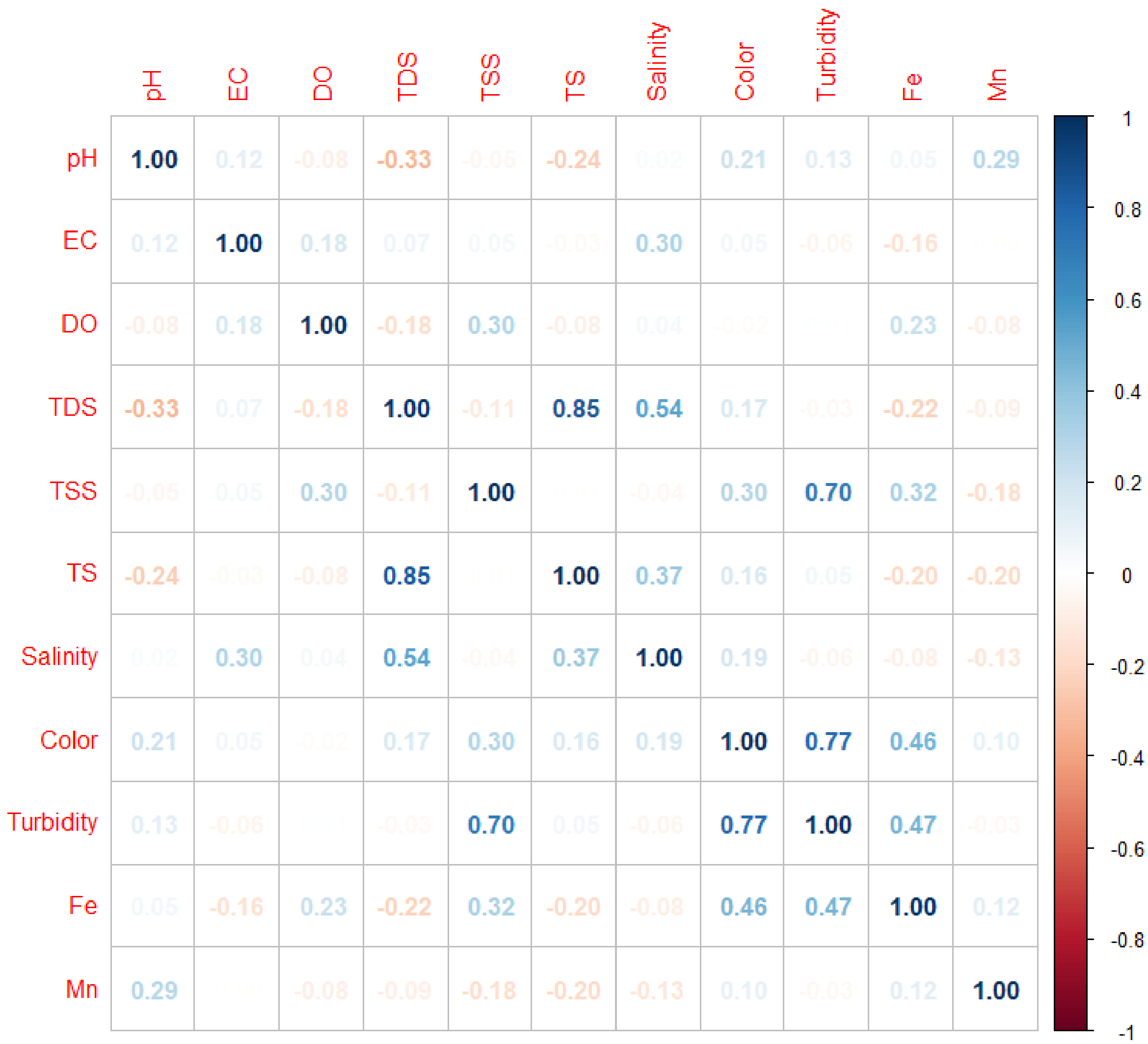

Figure 5.3 1:principle component analysis of Dry season.

In to the wet season we have got some co relations between the parameters. In the wet season, we observe the following correlations between parameters:

1. EC (Electrical Conductivity) and TDS: They have a moderate correlation of 0.56, suggesting a moderate relationship between electrical conductivity and the amount of dissolved solids.

2. TDS and TS: They exhibit a strong correlation of 1, indicating a perfect relationship between the amount of dissolved solids and total solids.

3. EC and TS: They have a moderate correlation of 0.56, suggesting a moderate relationship between electrical conductivity and total solids.

4. Color and turbidity: They are strongly correlated with a coefficient of 0.76, indicating a significant association between water color and turbidity.

The analysis result of wet season are shown in the below figure.

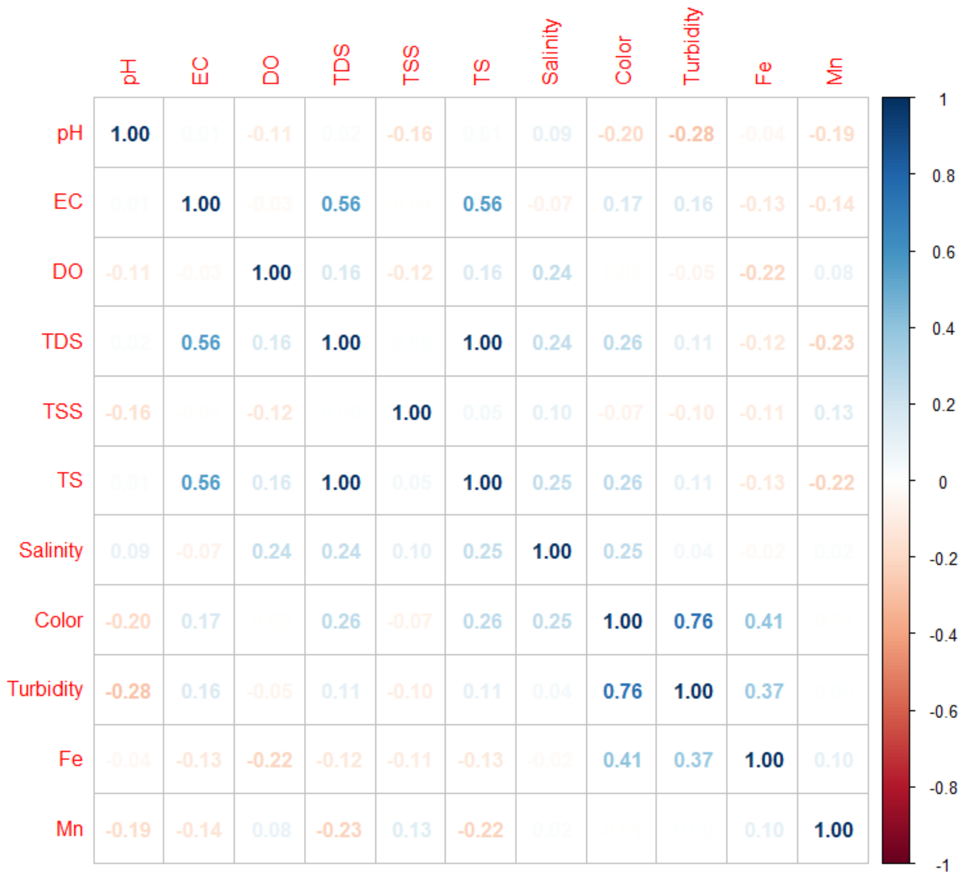

Figure 5.3 2:principle component analysis of Wet season.

Comparing the correlations between the dry and wet seasons, we can see that the correlation patterns differ to some extent. While the correlations between TDS and TS, as well as between color and turbidity, remain strong in both seasons, the other correlations vary. The correlation between TDS and salinity is stronger in the dry season (0.54) compared to the wet season. Similarly, the correlation between TSS and turbidity is stronger in the dry season (0.70) compared to the wet. Additionally, the wet season introduces a correlation between EC and TDS (0.56) and EC and TS (0.56), but in to the dry season there were no co relation between them.

5.4 Sanitation Assessment

For the assessment of sanitation we have done our surveys and we have built some questionnaire for the assessment. We have categorized in four section. And the sections are:

- Drinking Water
- Water Treatment Facilities
- Hygiene
- Solid Waste Management

5.4.1 Drinking water

In survey we have found that, deep tube wells are often used to deliver drinking water. Drilling into the earth is required to get groundwater, which is often seen as a dependable and hygienic supply of water. To give a steady supply of water for drinking, deep tube wells are often employed.

Again It is typical practice to utilize a submersible pump to retrieve water from deep tube wells. Water may be pumped from great depths using submersible pumps, which are intended to be immersed in water. They effectively and dependably draw water from subterranean sources, guaranteeing a steady supply for drinking water.

The school's water supply system uses piped water that is linked to an above tank. Using a series of pipes, this system enables the distribution of water across the school's grounds. Students and employees have easy access to drinking water since the water is kept in an above tank and then piped through the building to different taps and outlets.

The most typical source of drinking water is tap water. Water that is delivered to different taps or faucets through a system of pipes is referred to as tap water. It suggests that the piped water supply system, which provides safe and accessible access to drinking water from taps, meets the drinking water demands in the context of the survey.

And lastly water is always accessible throughout school hours. It implies that the water supply system is built to provide a constant flow of water throughout the school day, enabling both children and staff to get drinking water whenever necessary. This makes sure that the school community always has access to and is able to get drinking water when they are on the property.

According to the survey result shown in the figure of Depth of submersible pump, 81% of respondents said their submersible pump was deeper than 500 feet, while 19% said it was deeper than 2000 feet. These answers imply that deep groundwater sources exist since the submersible pumps in the survey context are deployed at significant depths. The precise depths may change based on the region and water table levels, but these findings demonstrate how submersible pumps can be used to reach water at considerable depths.

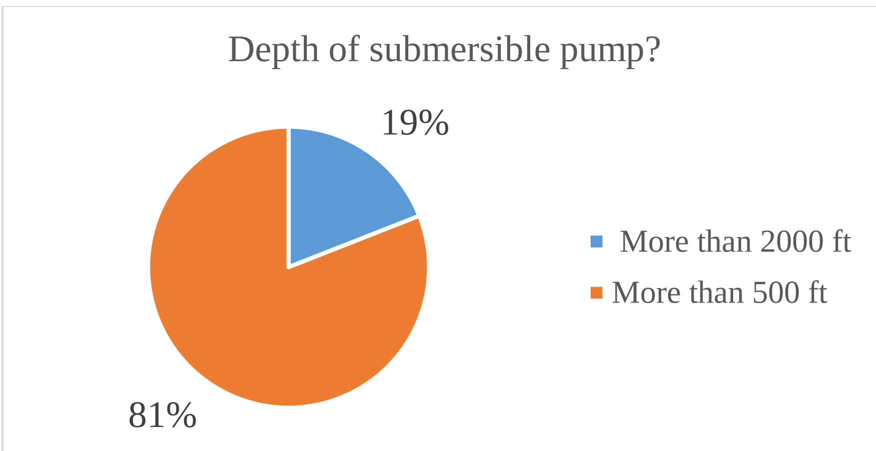

Figure 5.4.1 1: Survey result of depth of submersible pump

According to the survey result shown in the figure of “Is the distance between toilet and drinking water source less than 10M” (Hoque et al., 2015), 60% of participants said "Yes" when asked whether there is fewer than 10 meters between the toilet and the source of drinking water. However, 40% of respondents said "No." These replies show that there is a variable distribution in the distance between the drinking water source and the toilets.

To reduce the chance of contamination, it's crucial to have a safe distance between toilets and sources of drinking water. In order to reduce the risk of microbiological or chemical contamination of the water supply, it is ideal to have enough space between these regions. Although the majority of responders (60%) said the distance was less than 10 meters, the considerable minority (40%) who said it was more than that raises questions about the potential for contamination.

To ascertain the causes of the observed distances and to identify any possible steps that must be implemented to guarantee the safety and hygienic of the drinking water supply in connection to lavatory facilities, more examination and analysis would be required. To reduce the danger of contamination and guarantee the supply of clean drinking water for the context evaluated, it may be prudent to review and adopt suitable solutions, such as adequate plumbing and sanitation practices.

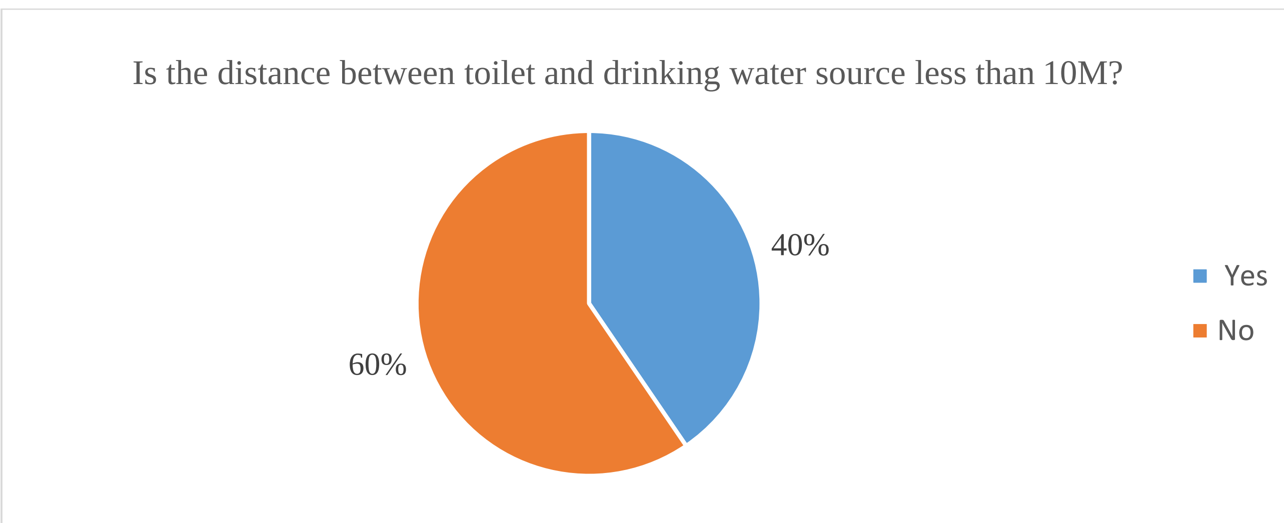

Figure 5.4.1 2:Survey result of the distance between toilet and drinking water source

5.4.2 Water Treatment Facilities

In water treatment facility survey we actually focused on the filtration system. When asked whether the school had a filtration system for the pupils, just 19% of respondents said "Yes," according to the Filtration system in the school survey findings, while 81% said "No." This suggests that most of the schools that were studied do not have a special filtering system set up for student usage.The safety and quality of the drinking water given to pupils may be impacted by schools lacking filtering systems. Systems for filtering water are essential for assuring its safety for consumption by eliminating impurities, pollutants, and potentially hazardous compounds. Students may be more likely to be exposed to waterborne pollutants without such systems. The following shows the graphical presentation of school filtration system.

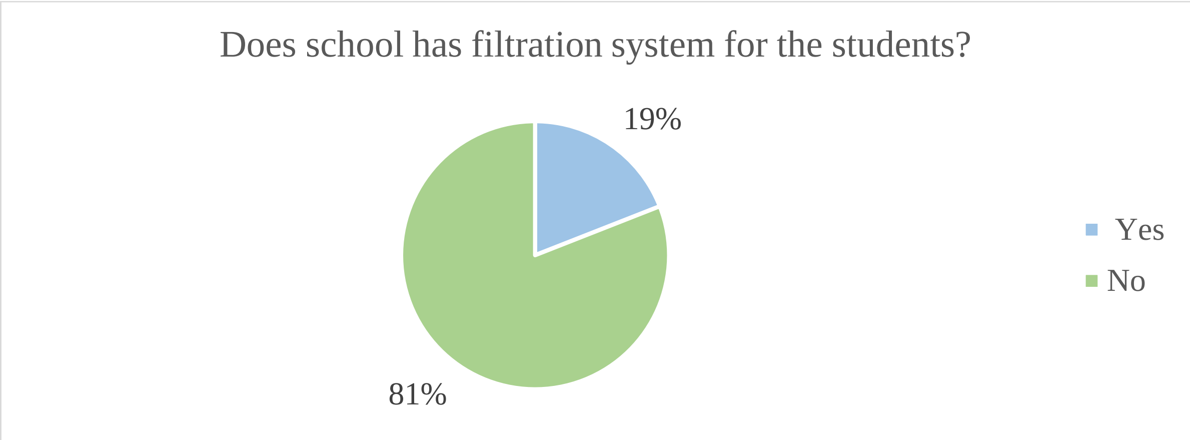

Figure 5.4.2 1:Filtration system in the school survey

According to the result of types of filter, When questioned about the kinds of filters available for the school's water treatment, 77% of respondents said they had "none." This suggests that a significant portion of the assessed schools do not presently have any kind of filtering system in place. The safety and purity of the drinking water given to pupils are questioned as a result of the absence of filtering equipment.

Without a filtering system, the water provided to pupils can be contaminated with pollutants and other elements that might be dangerous. Different pollutants, such as sediments, chemicals, bacteria, or even heavy metals, might be considered as contaminants. Drinking water that hasn't been properly filtered and treated may be harmful to students' health and wellbeing.However, 23% of respondents said they used a mechanical filter. A simple filtering technique that may help remove silt and bigger particles from water is a mechanical filter. Although mechanical filters provide some filtering, it's crucial to remember that they may not be able to remove all of the potential toxins from water.

More sophisticated filtering methods, such as activated carbon filters, ultraviolet (UV) disinfection, or reverse osmosis (RO) systems, are often advised for thorough water treatment. Numerous pollutants, including chemicals, germs, viruses, and other dangerous items, may be successfully eliminated using these cutting-edge filtering techniques.The quality and security of drinking water in schools may be greatly enhanced by the use of cutting-edge filtration technology. Insuring that kids have access to clean, safe drinking water helps to lower the risk of water-borne illnesses and to improve their general wellbeing.

The study findings demonstrate, in conclusion, the need for schools to prioritise the installation of efficient water filtration systems. The majority of the schools examined did not have filtration systems, which highlights how critical it is to solve this problem so that kids have access to clean, filtered water that satisfies the highest requirements for drinking water. The following shows the graphical presentation of types of filter.

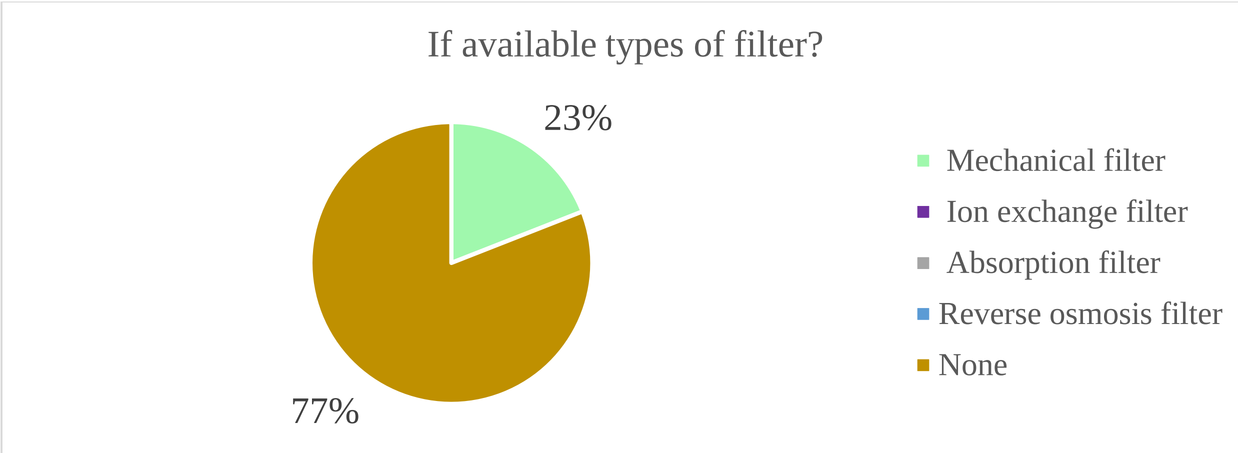

Figure 5.4.2 2:Types of filter in the school survey

5.4.3 Hygiene

In this survey we focused on the hygiene facilities of the schools. The study reveals that restrooms are present in all of the assessed schools. This shows that there are restrooms of some kind available for staff and students to use at all schools.

The survey's findings indicated that all of the schools have septic tank facilities for their toilet systems. In places without access to a centralized sewage system, septic tanks are often utilized. They provide a technique for handling and getting rid of human waste locally. The presence of septic tank infrastructure suggests that the examined schools had their own sanitation systems in place to treat and manage toilet effluent. Septic tanks function by letting the liquid effluent run out and be absorbed into the earth while allowing the solid waste to settle at the bottom. This procedure aids in the natural treatment and degradation of garbage. Septic tank systems may be excellent at controlling wastewater, but to avoid problems like overflow or groundwater pollution, they need routine maintenance, appropriate operation, and periodic emptying. To guarantee the operation and cleanliness of septic tank systems, it is crucial for schools to have appropriate maintenance standards in place. Overall, the survey's findings indicate that septic tank systems are the schools' preferred technique for handling toilet waste. To guarantee adequate sanitation and avoid any possible health and environmental issues related to septic tank operation, it is essential for schools to routinely inspect and repair these systems.

According to the report, there are separate restrooms for male and female pupils at every school. This shows that the schools value offering gender-specific facilities that protect both male and female students' privacy and cleanliness. However, just 17% of the schools provide special restrooms for kids with physical disabilities, while 83% do not. This shows that many schools do not have special facilities to meet the requirements of kids with physical disabilities. It draws attention to a possible area for development with regard to accessibility and inclusion in the educational setting. Following figure shows the visual representation.

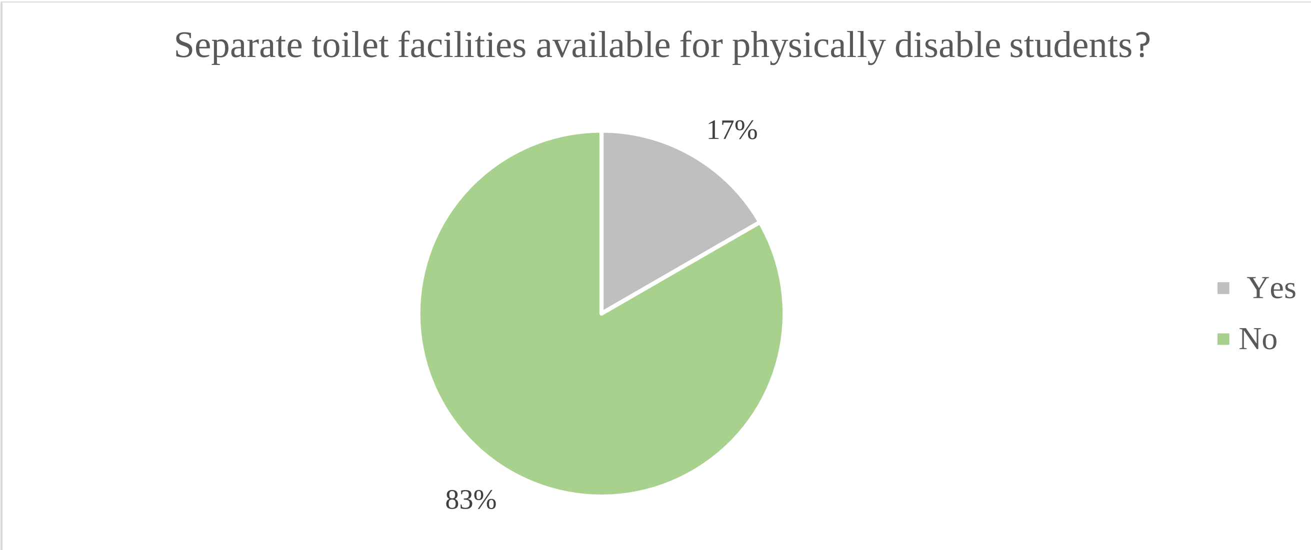

Figure 5.4.3 1:Separate toilet facilities available for physically disable students

There are separate restrooms for instructors in every school that participated in the poll. This demonstrates the understanding of the significance of providing specialized sanitary facilities for the teaching personnel. The poll reveals that 79% of schools with teacher restrooms have separate facilities for male and female instructors, whereas 21% do not. This suggests that the majority of schools prioritize providing their teaching staff with gender-specific facilities to ensure privacy and convenience. The pie chart is given in below figure.

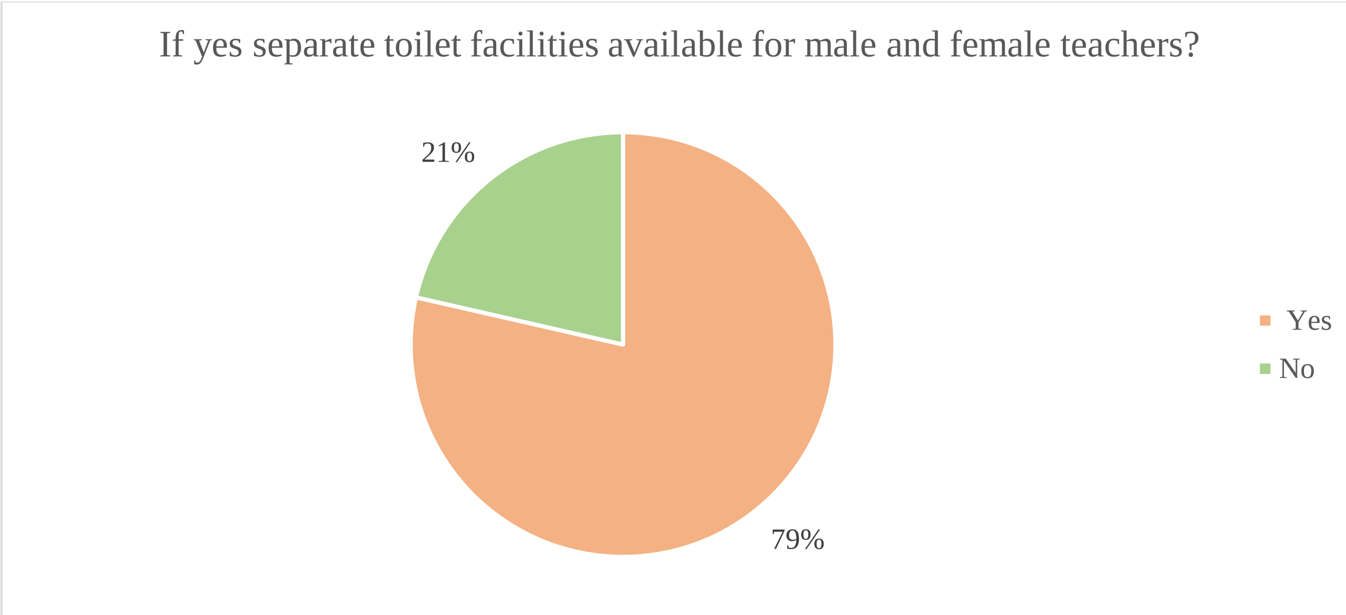

Figure 5.4.3 2:Separate toilet facilities availability for male and female teachers

According to the report, all schools have handwashing stations in the restrooms. This is fantastic news since handwashing is crucial to preserving cleanliness and halting the spread of illnesses. All schools said they had sinks with soap and running water for students to wash their hands. This is an excellent discovery since maintaining good hygiene and limiting the spread of infections depend on thorough handwashing with soap and water. Students and staff will always have access to soap, which is essential for good hand hygiene. By removing dirt, germs, and other impurities from hands, soap helps to lower the risk of illness and improve general health. It is essential for guaranteeing the efficacy of handwashing that schools have a stable source of flowing water, which is shown by having a pipe water supply for handwashing. Using running water makes handwashing more thorough and sanitary by helping to rinse off soap and impurities from hands. By providing handwashing stations with soap and pipe water, the assessed schools demonstrate their commitment to hygiene standards and their efforts to encourage staff and children to wash their hands properly. This is especially crucial in a school environment where many people congregate, raising the risk of disease transmission. It's important to remember that keeping up with efficient handwashing habits requires maintaining a consistent supply of soap and making sure the pipe water infrastructure is operating properly. Schools should have procedures in place to maintain the operation and cleanliness of pipe water sources, as well as to routinely inspect and restock soap dispensers. Overall, the survey's findings show that the assessed schools have made progress by offering handwashing facilities that include soap and piped water. Schools help to promote excellent hand hygiene habits, which are important for the wellbeing and health of students and staff, by providing access to these vital tools. Handwashing stations were scattered throughout the assessed schools, according to the survey replies. Most schools reported having handwashing stations outside the restrooms, however some also had them inside. A few schools claimed to provide sinks for handwashing both inside and outside the lavatory.

In most schools, having handwashing stations outside the restrooms may have some benefits. By placing handwashing stations outside the lavatory, you can guarantee that people can use them without going inside. This partition keeps the handwashing space clean and sanitary and away from the possibly contaminated lavatory area. On the other hand, installing a handwashing station within the lavatory may make it convenient and simple for people to wash their hands right away after using the lavatory. It makes sure that hand washing may be done right away, lowering the chance of cross-contamination. Offering flexibility and convenience, handwashing facilities are located both inside and outside the lavatory. People are given the option to choose a place based on their requirements and preferences. In all circumstances, it's crucial to check that the handwashing stations are simple to find, kept up and well equipped with soap and water. The effectiveness and hygienic upkeep of the handwashing facilities depend on regular monitoring, supply restocking, and cleaning and maintenance. The survey's findings show that schools, no matter where they are located, understand how important it is to provide facilities for handwashing. The availability of handwashing stations demonstrates a dedication to encouraging good hygiene habits and reducing the spread of infections within the school setting. Overall, the placement of handwashing stations should strike a balance between practicality, cleanliness, and maintaining a designated space for hand hygiene. Schools support the development of good hand hygiene practices among students and staff by providing easily accessible and well-maintained handwashing facilities, encouraging a healthier and more sanitary school environment. The figure is given below.

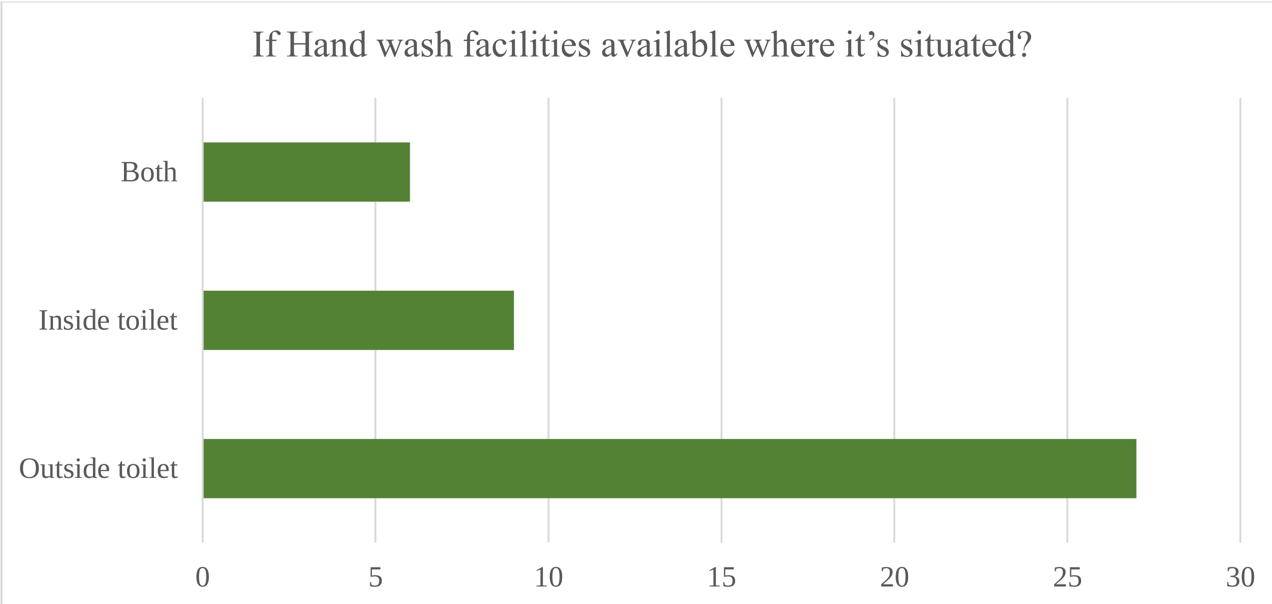

Figure 5.4.3 3:Hand wash facilities availability where it's situated

Based on the survey responses, the condition of the toilets varied among the surveyed schools. The majority of schools rated their toilet conditions as moderate, while a few reported excellent, poor, good, or fair conditions. A moderate rating suggests that the surveyed schools' toilets may have some areas for improvement in terms of cleanliness, maintenance, or overall functionality. It indicates that there might be aspects that require attention to ensure a more satisfactory and hygienic toilet environment for students and staff. Maintaining clean and well-maintained toilets is crucial for promoting good sanitation and hygiene practices within the school. Regular cleaning, proper waste management, and routine maintenance of toilet fixtures are essential to ensure a safe and healthy environment for users. Schools should prioritize addressing any identified issues in their toilet facilities, such as addressing plumbing problems, ensuring proper ventilation, and improving cleanliness. Regular inspections and scheduled maintenance can help identify and resolve any underlying issues that may affect the condition of the toilets. In addition, schools can implement measures to promote hygiene etiquette among students, such as providing hygiene education, installing hand hygiene reminders, and encouraging responsible use of toilet facilities. Overall, the survey results highlight the importance of regularly assessing and improving the condition of toilets in schools to provide students and staff with a comfortable, clean, and safe environment. By addressing any shortcomings and maintaining proper cleanliness and functionality, schools can enhance the overall hygiene standards and contribute to the well-being and health of their community. The figure is given below.

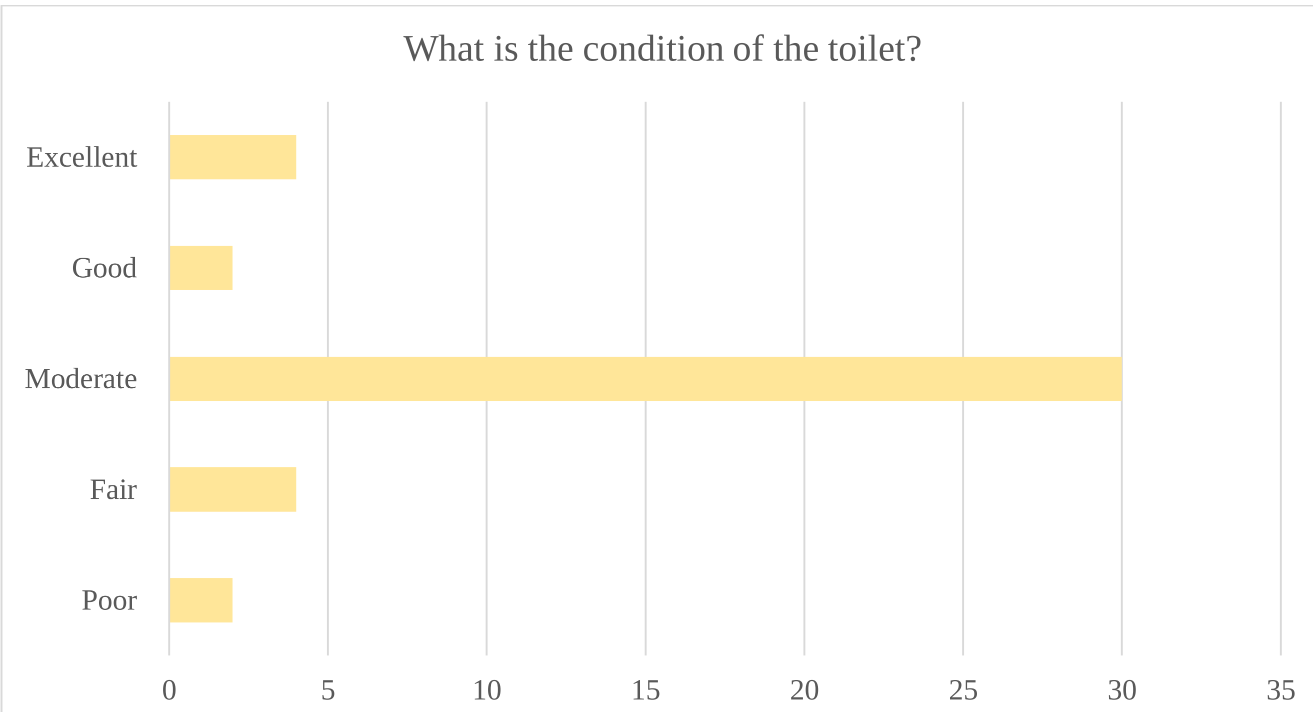

Figure 5.4.3 4:Toilet condition of the schools

5.4.4 Solid Waste Management

In order to effectively handle, dispose of, and reduce trash produced on school grounds, solid waste management in schools must be implemented. Waste segregation, recycling programmes, composting organic waste, waste minimization, awareness-raising, education, and cooperation with relevant stakeholders are some of the key areas of concentration. Schools support environmental conservation, resource conservation, and sustainability by encouraging behaviors including waste segregation, recycling, composting, and waste reduction. Additionally, promoting responsible behavior and instilling a feeling of environmental stewardship via education and improving student understanding of effective waste management. The school's trash management initiatives are further improved via partnerships with neighborhood authorities and organizations. In the end, adopting thorough solid waste management procedures in schools results in a cleaner, healthier environment and fosters responsible waste management behaviors in both students and staff members.

According to the survey report, there are garbage cans accessible at every school. This is a good finding since having dedicated bins promotes appropriate garbage disposal and keeps the school's grounds clean. According to the survey report, plastic garbage cans are used at every school. Due to its longevity, simplicity of cleaning, and capacity to hold a variety of garbage, plastic bins are often utilized. However, it's crucial that schools have distinct containers for recyclable and non-recyclable material to guarantee effective waste segregation.

According to the results of the survey, none of the institutions have a budget specifically designated for organic refuse management. This indicates an area for potential development, as a dedicated budget can support waste management initiatives such as recycling programmes, refuse reduction campaigns, and infrastructure maintenance. All schools, according to the survey, use manual sweepers for desludging, indicating that refuse receptacles and disposal areas are cleaned manually. It is essential for schools to provide the personnel involved in this duty with appropriate training and protective apparatus to ensure their safety and uphold sanitation standards.

According to the survey, the prevalence of desludging differs between institutions. The preponderance of institutions, 56%, reported annual desludging. 42% of schools de-sludge every two years, while 1% reported de-sludging based on overflow pipe conditions and another 1% via disinfection.

Desludging is the process of cleansing and disposing refuse receptacles and disposal areas to prevent waste accumulation, odors, and the proliferation of vermin and disease-causing organisms. The frequency of desludging is contingent on a number of variables, including the rate of refuse production, the capacity of the receptacle, and sanitation considerations. Desludging once a year is a common practice in many schools and is appropriate when waste generation is relatively low and receptacle capacity can accommodate refuse for an extended period. This frequency enables for regular maintenance and assures the school's sanitation and hygiene.

Desludging every two years may be appropriate in schools with minimal waste generation or when the waste disposal system is capable of handling waste for an extended period of time. During this time, it is essential to closely monitor the trash cans to prevent overflow and maintain sanitation. In certain instances, desludging based on excess pipe conditions or bleaching may be utilized. When using an overflow conduit, desludging occurs when refuse reaches a predetermined level, triggering an automatic disposal mechanism. In contrast, bleaching entails the use of chemical disinfectants to manage debris under specific conditions. Notably, the frequency of desludging should be determined based on each school's waste management requirements and the capacity of its waste disposal system. Monitoring waste receptacles and disposal areas on a regular basis is essential for preventing sanitary issues, ensuring hygiene, and sustaining a clean environment.

The frequency of desludging varies among the schools surveyed, with the majority electing for annual desludging. To ensure proper waste management and sanitation, the selected frequency must correspond with the waste generation rate and receptacle capacity. Regular monitoring and evaluation of the waste disposal system are necessary for determining the optimal desludging schedule for each school. The visual presentation is given below.

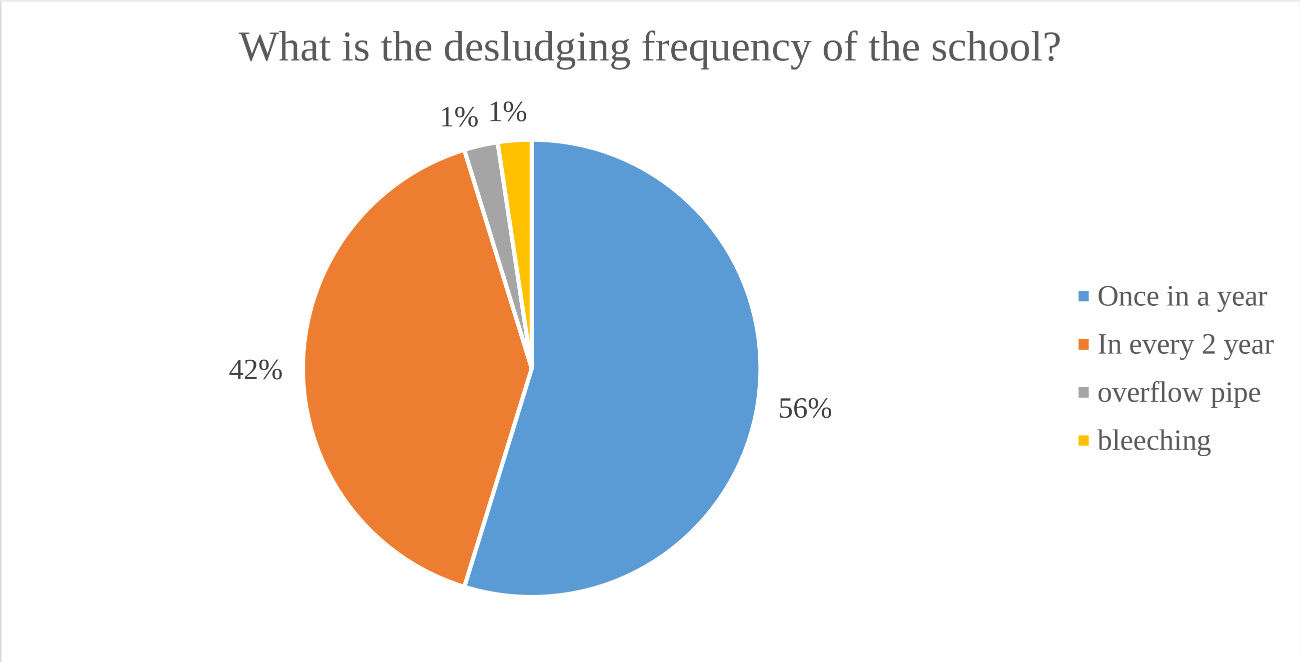

Figure 5.4.4 1:Desludging frequency of the school

According to the results of the survey, there are three options for solid refuse disposal on or near school grounds, Twelve percent of schools dispose of solid refuse by tossing it on a designated landfill located on or near school grounds. This method may entail establishing a designated area for refuse accumulation and subsequent disposal. This finding indicates that a sizeable percentage of schools conceal their solid refuse on or near the school grounds (25%). To bury trash, one must excavate holes or excavations and place the trash within them. This method seeks to naturally contain and decompose debris over time.

Burning on or near school grounds (63%): According to the survey, the majority of schools dispose of solid refuse by burning it on or near school grounds. This practice involves setting refuse materials on fire, typically in designated areas or ditches. The objective is to reduce waste volume through combustion. It is crucial to note, however, that burning trash can discharge hazardous air pollutants and is generally regarded as an environmentally hostile practice. It is essential to evaluate the repercussions of these disposal methods and investigate more sustainable options. Environment, air quality, and public health can be adversely affected by dumping, concealing, and burning detritus.

Consider implementing more eco-friendly waste management practices, such as waste segregation, recycling, and decomposition, in schools. refuse segregation is the process of segregating various categories of refuse in order to facilitate recycling or appropriate disposal. To promote the reprocessing of materials such as paper, plastic, and glass, recycling programmes can be implemented. Composting organic waste can help produce nutrient-dense soil amendments. In addition, schools should work with waste management authorities to ensure appropriate refuse collection and disposal. This may entail coordinating waste collection schedules or utilizing community waste management services. A portion of the schools surveyed dispose of solid refuse by dumping it on a landfill, concealing it, or burning it on or near school grounds, according to the survey results. These practices may have negative environmental and health effects. In collaboration with waste management authorities, schools should investigate more sustainable waste management practices, such as refuse segregation, recycling, and decomposition. Schools can contribute to a greener, healthier environment by implementing eco-friendly disposal practices. The summarization is presented on figure given below.

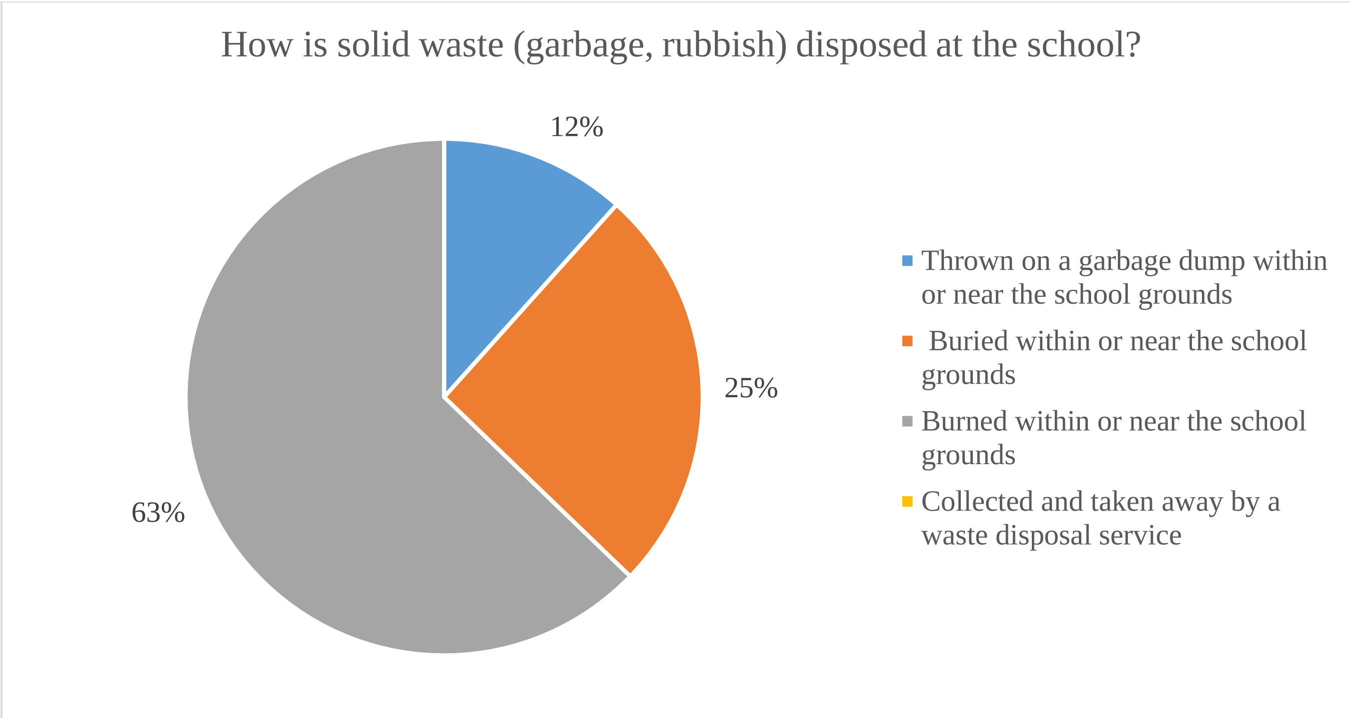

Figure 5.4.4 2: Solid waste disposal system

According to the survey results, the disposal or collection of solid refuse differs between institutions. The distribution was reported as follows: 50% at least once per day, between twice per week and once per week: 29%, Less often than once per week: 21%.

The frequency of waste disposal or collection is essential for sustaining school sanitation and hygiene and preventing refuse accumulation. At least daily waste disposal demonstrates a proactive approach to refuse management in schools. This frequency ensures regular waste removal, preventing refuse accumulation, foul odors, and the attraction of vermin. It contributes to the maintenance of a clean and sanitary environment for students, instructors, and staff.

Schools that dispose of waste between once every two days and once per week also demonstrate a satisfactory level of waste management. Although the frequency is slightly reduced, it is still sufficient to prevent refuse accumulation and maintain a respectable level of hygiene. Schools that dispose of waste less frequently than once per week may struggle to effectively manage waste. There is a greater chance of refuse overflow, odor issues, and increased vermin activity if there is a prolonged time between collections. This frequency may not be sufficient to maintain a consistently clean and sanitary environment. To enhance solid waste management, schools with less frequent refuse disposal should consider increasing waste collection frequency. This may entail contacting waste management authorities or implementing internal protocols for more frequent waste removal. By doing so, schools can assure a healthier and clearer environment for all.

Notably, waste disposal frequency should be determined based on each school's waste generation rate, waste capacity, and unique requirements. Monitoring refuse receptacles and waste accumulation areas on a regular basis is essential for determining the appropriate disposal frequency and making necessary adjustments. In summary, the survey results disclose a range of solid waste disposal or collection frequencies in the institutions surveyed. Schools that dispose of refuse less frequently may find it difficult to maintain sanitation and hygienic conditions. To maintain a consistently clean and hygienic environment for students and staff, schools should evaluate their waste generation rates and consider increasing disposal frequency. The summarization is presented on figure given below.

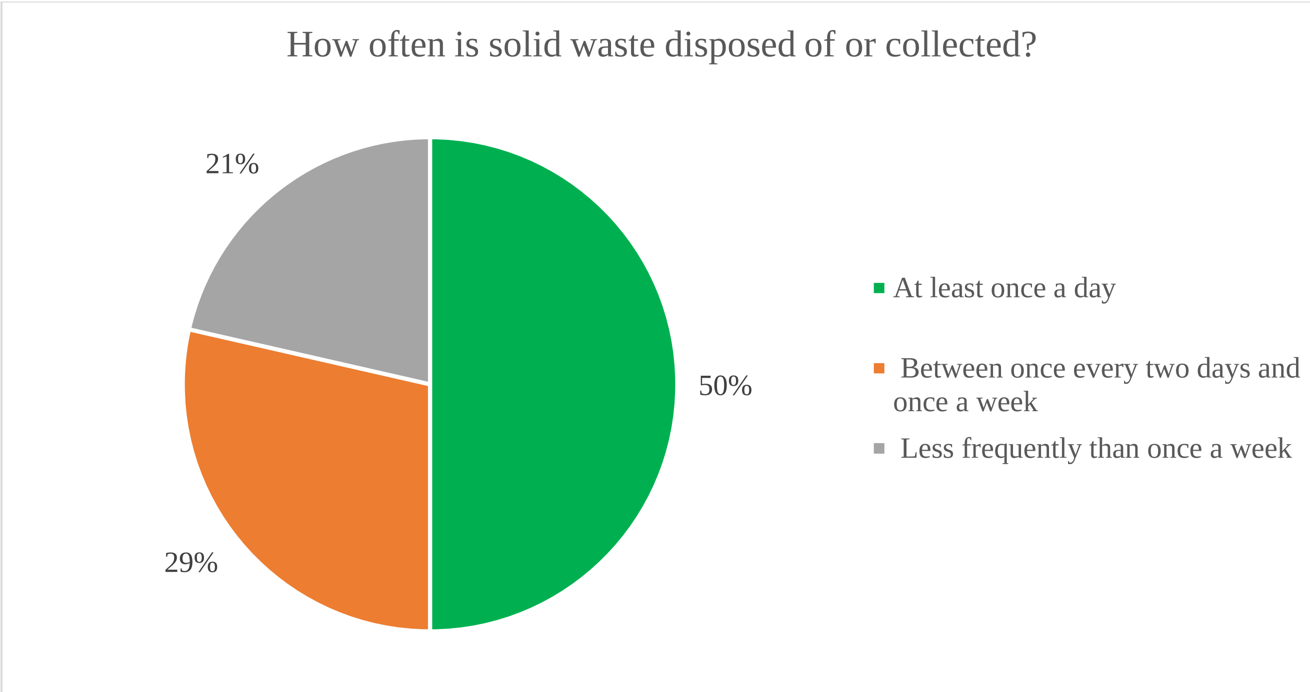

Figure 5.4.4 3: Timetable of solid waste disposal system.

According to the results of the survey, institutions' responsibilities for refuse collection vary. The distribution was reported as follows: School administration: 33 institutions and City administration: ten institutions.

The entity responsible for solid waste collection plays a crucial role in ensuring efficient waste management and disposal practices on school grounds. In schools where waste collection is the responsibility of the school administration, an internal refuse management system is indicated. The school administration is responsible for collecting and disposing of solid refuse generated on school grounds. This strategy grants schools greater control over waste management processes and guarantees direct oversight of waste processing.

In schools where the city corporation is responsible for waste collection, it implies that the local municipality or governing body is providing waste management services. Frequently, refuse collection from various institutions, including schools, falls under the purview of municipal waste management systems. This can assure compliance with refuse disposal regulations and provide a standardized approach to waste management. For the institutions where "other" entities are responsible for refuse collection, additional clarification is required to identify the precise entities involved in waste management. It may consist of private waste management companies, non-profit organizations, and other local stakeholders responsible for waste collection services.

Schools should establish explicit communication and coordination with the responsible entity to ensure effective waste management. This involves establishing regular waste collection schedules, providing suitable waste containers, and ensuring that proper waste segregation practices are adhered to. Collaboration with the responsible entity can facilitate the streamlining of waste management procedures and ensure that waste is handled and disposed of in a responsible and sustainable manner. In summation, the survey results indicate that the collection of solid refuse varies among the institutions surveyed. Some institutions have their own refuse collection authorities, while others rely on city corporations or other entities. Regardless of the responsible entity, effective waste management practices require close coordination and communication. By collaborating, schools can create a cleaner and healthier environment on their campuses.

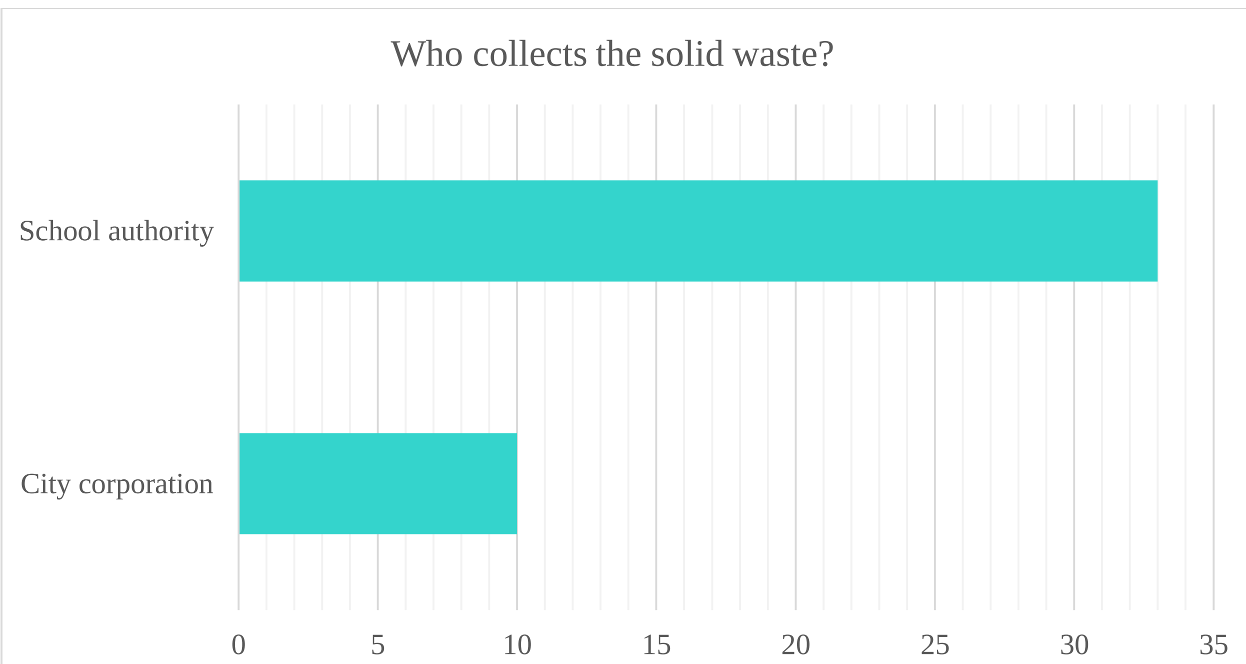

Figure 5.4.4 4:Solid waste collector.

5.5 Health risk

Exceeding the standard limits for E. coli and fecal contamination can have serious consequences for the health of students. E.coli (Escherichia coli) is a common variety of bacterium found in the intestines of humans and animals. Certain strains of E. coli can cause severe gastrointestinal ailments, including diarrhea, abdominal cramping, and vomiting, whereas most strains are innocuous. Fecal contamination is the prevalence of human or animal excrement in the environment, which may contain a variety of pathogens and hazardous microorganisms. When E.coli and fecal contamination levels exceed the standard values established by organizations such as the World Health Organization (WHO) and the Environmental Criteria and Assessment Office for Europe (ECR), it indicates an increased risk of exposure to pathogenic microorganisms.

During the moist season, E.coli counts are observed to be greater than during the dry season. This is attributable to several factors. During the arid season, a lack of water creates favorable conditions for bacterial multiplication. The lack of water reduces the dilution and purging of contaminants, allowing E. coli and other bacteria to proliferate more swiftly. Additionally, favorable temperature conditions during the arid season contribute to the development of microbes. In contrast, the wet season is characterized by increased precipitation, which increases water volume and surface area for microbial growth. This creates favorable conditions for bacterial multiplication, resulting in a greater number of microorganisms, including E. coli. Rainfall discharge can transport bacterial pollutants from a variety of sources, such as dumpsites, human refuse, and heating systems, contaminating various water sources. These contaminated water sources with elevated levels of E. coli pose a greater risk of pathogen transmission. This increased microbial contamination during the rainy season can result in more severe health issues, such as waterborne diseases and gastrointestinal infections. To address this problem, it is essential to improve water quality and reduce contamination during the rainy season. Preventing the spread of pathogens requires measures such as proper refuse management, enhanced sanitation infrastructure, and the promotion of awareness and hygiene practices. Regular monitoring of water sources, particularly during the rainy season, is essential for promptly identifying and addressing contamination issues. By adopting proactive measures to reduce E. coli levels and prevent pathogen transmission, risks to public health can be reduced, resulting in a healthier environment for the affected population.

During the research period, several environmental conditions in the institutions were observed that shed light on the contamination of water sources. First, there were insufficient dumpsites for appropriate refuse dispersal in the vicinity of the institutions. Consequently, streams were frequently used as alternative refuse dumps. In addition, it was observed that some institution residents engaged in unhygienic behavior. For example, restrooms and drains were located in close proximity to potable water sources. Consequently, contaminants from these unsanitary sources would enter the water bodies, contributing to the contamination of water sources. These observations emphasize the significance of addressing proper waste management practices and promoting hygiene consciousness in institutions. Establishing adequate waste disposal systems, ensuring proper toilet and drainage infrastructure, and educating residents on the importance of maintaining hygienic practices can aid in mitigating water pollution and protecting the health of students and surrounding communities.

Escherichia coli, also known as E. coli, is a member of the coliforms, a group of common bacteria found in the digestive tracts of humans and animals. There are only a few strains of this organism that can cause significant illness in humans, so it is typically not cause for concern. One of these strains causes traveler's diarrhea, while the other, E. coli O157:H7, contaminates meat and verdant greens. This strain (O157:H7) is capable of causing severe hemorrhagic diarrhea and potentially fatal, long-term complications. E.coli serves as an indicator for the potential presence of other, more dangerous microorganisms, such as Cryptosporidium, Giardia, Shigella, and norovirus. Some potential sources of fecal contamination are agricultural runoff, wildlife that uses the water as its natural habitat, discharge from areas contaminated with pet manure, wastewater treatment facilities, and on-site septic systems. These organisms may be carried into waterways, rivers, streams, lakes, or ground water by heavy precipitation. If this water is used as potable water without treatment or with insufficient treatment, it may cause illness. Infections of the digestive tract, epidermis, ear, respiratory system, eyes, nervous system, and wounds can result from contact with contaminated water. Stomach cramping, diarrhea, nausea, vomiting, and a low-grade fever are the most frequently reported symptoms. When the permissible level of E. coli is exceeded in recreational water, beaches, reservoirs, lakes, and swimming and fishing areas are closed. The Safe potable Water Act has established reduced limits for the levels of microorganisms in potable water from public water systems. If this level is reached or exceeded, consumers should boil water used for cooking, consuming, making infant formula, and tooth cleansing. However, a significant portion of the US population utilizes groundwater that is not regulated by the Safe Drinking Water Act because it is sourced from private wells [1]. Although private wells are not regulated by the EPA, their website provides resources for monitoring and maintaining them.

The presence of feces or fecal pathogens in water sources is referred to as aecal water contamination. It is a consequence of both anthropogenic and zoogenic sources of contamination. The discharge of industrial, municipal, and domestic effluent into water bodies is one of the human-made sources of feces-contaminated water. Wastewater from industries such as food processing, agriculture, and manufacturing may contain a variety of contaminants, including feces. Municipal effluent consists of sewage and other domestic and urban waste materials that may contain feces and pathogens. Domestic wastewater refers to the effluent produced by households. The sources of zoogenic contamination are animal-related activities. These include animal refuse from livestock husbandry, agricultural effluent from grazing fields, and contamination from wildlife. Animal waste, such as manure, may contain feces and pathogens that can infiltrate water bodies via discharge during precipitation or irrigation. Additionally, nonpoint/diffuse pollution sources contribute to feces-contaminated water. These sources include urban stormwater discharge, which can transport contaminants, such as feces, from streets, roofs, and other surfaces. Agricultural effluent from fertilized and pesticide-sprayed fields can also contribute to contamination. Overall, faecal water contamination is caused by both point sources (direct discharge of effluent) and nonpoint/diffuse sources (runoff from various activities). To address faecal water contamination, it is essential to implement proper wastewater treatment, establish effective stormwater management systems, promote responsible agricultural practices, and increase public awareness of the significance of proper waste disposal and hygiene practices. These measures can help reduce the presence of feces and pathogens in water sources, thereby safeguarding the health of both humans and the environment. (Paruch et al., 2019b)

Diseases caused by contaminated potable water pose a significant threat to public health. Drinking water contaminated with feces containing pathogenic microorganisms poses the greatest threat to human health. These pathogens can cause cholera, diarrheal maladies, dysentery, and enteric fevers, among others. The burden of water-related maladies varies by context, with the greatest impact observed in low-income settings, where diarrhea remains the primary cause of infant mortality. Epidemiological evidence from intervention studies and outbreak investigations suggests that the quality of potable water plays a significant role in the transmission of fecal-oral diseases. Due to a paucity of blinded studies, the precise magnitude of this effect has been the subject of debate. It is difficult to assess the impact of potable water quality on fecal-oral transmission due to the complexity and interconnectedness of the pathways involved. These paths can vary considerably based on the specific context and conditions. To effectively address this issue, it is necessary to implement measures that enhance the quality of potable water and prevent fecal contamination. These measures may include instituting robust water treatment processes, ensuring proper sanitation and waste management, promoting hygiene education and behavior modification, and establishing appropriate regulatory frameworks for water quality standards. By addressing these factors and working to ensure secure potable water sources, the risks associated with waterborne diseases can be mitigated, resulting in enhanced public health outcomes and a decrease in the prevalence of water-related ailments. (*Water-related Disease Outbreaks Surveillance*, 1978)

Immediate action is required to address this issue in order to enhance sanitation and water quality. Implementing stringent water treatment processes, assuring proper effluent management, promoting hygiene practices such as handwashing, and conducting regular monitoring and testing of water and food sources may be required. In addition, educating students about proper hygiene practices and the significance of clean water and food can aid in preventing the spread of infections and reducing their negative health effects.

5.6 Limitations

During the course of the investigation, it was discovered that the availability and accessibility of data varied between the Upazilla primary education office and the Upazilla secondary education office. This disparity in data may be the result of administrative restrictions or limitations within the respective offices. As a consequence, certain data points may have been absent or insufficient, which may have affected the overall analysis and interpretation of the findings. These limitations were acknowledged and made endeavors to resolve them appropriately. We presumably employed a variety of strategies to mitigate the impact of missing or insufficient data. These strategies may have included cross-referencing available data from multiple sources, undertaking exhaustive data validation procedures, and, when necessary, making reasonable assumptions or estimates. Despite the acknowledged limitations, we proceeded with the analysis and interpretation of the available data, taking into account the context and the potential consequences of the absent or insufficient information. Within the given constraints, they most likely utilized appropriate statistical techniques and methodologies to derive meaningful insights and draw valid conclusions. To ensure transparency and provide a comprehensive comprehension of the data and its potential ramifications, it is crucial to recognize and acknowledge these limitations. By resolving these limitations and being transparent about them, the researchers can provide a more accurate depiction of the reliability and validity of the study's findings.

The limitations of the physical investigation methodology utilized in the study should be acknowledged. Limiting the investigation to a specific number of institutions within the selected area was a significant limitation. This limited purview raises questions about the generalizability of the findings to a larger population or to other geographic locations. The results may not accurately reflect the situation in other institutions or regions, thereby limiting their applicability. Observation and self-reporting were used to acquire the data, which represents a further significant limitation. Both of these techniques are susceptible to biases and measurement errors. Observation can be impacted by the observer's interpretation or subjective judgments, resulting in inconsistencies or errors in data collection. Self-reporting relies on the respondents' ability and willingness to provide accurate information, which can be affected by recall bias or social desirability bias. To compensate for these limitations, researchers frequently employ rigorous sampling techniques to ensure a representative sample and standard protocols for data acquisition to minimize biases. To improve the validity and dependability of the findings, they may also employ multiple data acquisition methods or triangulation of data from various sources.It is essential to recognize these limitations when interpreting the study's findings. When extrapolating the results to other settings or populations, caution should be exercised. The findings should be interpreted within the context and population under investigation. Future research could attempt to surmount these limitations by increasing the sample size, incorporating more diverse geographic locations, employing more robust data collection techniques, and instituting quality control measures to increase the reliability of the findings.

And finally, Due to the far-flung locations and divergent orientations of the institutions, transportation posed a significant challenge for the research. Traffic congestion made collecting samples and transporting them to the laboratory a time-consuming and chaotic task. The geographical dispersion of the institutions necessitated extensive travel, resulting in increased sample collection time and effort. The transportation difficulties were exacerbated by the need to navigate multiple directions and the possibility of confronting heavy traffic. The presence of traffic congestion impeded the free flow of us and specimens, resulting in delays and disruptions. These delays may compromise the freshness and integrity of the samples, thereby affecting the precision of the research results. We have instituted strategies to optimize the collection and conveyance process in response to these transportation issues. This may involve meticulous route planning and scheduling to minimize travel time and avoid rush hour. Additionally, alternative modes of transportation, such as motorcycles and bicycles, could have been considered for more efficient navigation through congested regions. Transporting samples without compromising their quality would have necessitated the use of efficient packaging and preservation techniques, including the use of appropriate containers and temperature control. Despite the difficulties presented by transportation issues, we acknowledged these constraints and likely attempted to mitigate their impact on the research. By addressing transportation constraints, researchers can improve the overall efficacy and dependability of data collection and mitigate any potential negative effects resulting from transportation issues.

Chapter six: Conclusions and Recommendations

This chapter provides a summary of the findings of the study conducted on the water supply, sanitation, and sanitary conditions of the institutions in question. It emphasizes the study's efficacy in resolving water-related concerns by highlighting crucial findings and conclusions. The chapter also discusses the potential benefits of the study for stakeholders, including guiding interventions and enhancing the schools' overall environment. Possible enhancements to the study are briefly mentioned, such as expanding the scope or conducting longitudinal research. In addition, recommendations for additional actions are presented, including the implementation of water treatment technologies, the improvement of infrastructure, the promotion of sanitation education, and the improvement of refuse management practices. The chapter provides an overall summary of the study's outcomes, efficacy, benefits, potential enhancements, and suggestions.

6.1 Conclusion

This investigation analyzed the current state of potable water in Gazipur's densely populated industrial district. Due to the possibility of contamination from industries and a large population, the study assessed the purity and safety of both surface water and groundwater sources. The study analyzed the prevalence of contaminants in potable water, including microorganisms and compounds, through exhaustive sampling and laboratory analysis. The study's findings will raise awareness about the hazards associated with water consumption and provide a foundation for implementing measures to enhance water quality management and safeguard human health in Gazipur. We have collected the data samples from the institutions located different places. We have collected the samples into two phases. One is dry season and another one is wet season. And we did the physico-chemical and bacteriological test. Then analyzed it with three different method. One of them is statistical analysis, other one is IWQI analysis and lastly Pearson correlation analysis. And lastly the present sanitation condition is analyzed. In statistical analysis we have showed the parameters that has exceeded the standard parameters. And the most noticing scenario is that E.coli has exceeded hundred percent for both of the season and Fecal contamination has exceed both of the season but for some of the institute. And on the IWQI analysis, we have selected all the physio chemical parameters. And the result we have got is almost 35 percent of the water is unsuitable for drinking for both of the season.

Using Pearson correlation analysis, the intensity and direction of the linear relationship between various parameters is determined. Positive and negative correlations were discovered within clusters of variables in this study, indicating direct or inverse relationships between variables. This analysis enables us to comprehend how various parameters interact within particular zones. By identifying influential parameters within these zones, it informs targeted interventions and water quality management strategies. Overall, Pearson correlation analysis sheds light on the interdependencies between parameters and informs effective measures to improve water quality.

The district of Gazipur contains numerous industries. It has a significant effect on water quality. It is detrimental to both groundwater and surface water. Strong loadings of components (>0.75) indicate that industrial effluent is the primary source of chemical contamination. It is a chemical contamination is occurring as a result of industrial effluent. It is directly degrading the character of the water.

6.2 Recommendations

A comprehensive analysis of the potable water of institutions in the Gazipur region reveals the precise impact of industries, a large population, water processing, and water use. This issue can be mitigated by adopting some effective measures. Such as:

- Implementing rigorous water treatment processes: The establishment of effective water treatment systems can help eliminate or reduce pathogens, including E.coli, from the water supply. Processes such as filtration, disinfection (e.g., chlorination), and sedimentation can be employed to ensure safe and clean drinking water.

- Ensuring proper sewage management: Proper management of sewage systems, including adequate wastewater treatment facilities and maintenance of sewage infrastructure, is essential to prevent contamination of water sources. This includes appropriate disposal and treatment of human waste to minimize the risk of fecal contamination.

- Promoting hygiene practices: Educating students about the importance of hygiene practices, such as regular handwashing with soap and water, can significantly reduce the spread of infections. Promoting proper hygiene etiquette in schools and providing access to clean water and sanitation facilities are crucial aspects of preventing contamination and maintaining good health.

- Conducting regular monitoring and testing: Regular monitoring and testing of water and food sources are necessary to identify and address contamination issues promptly. This includes routine water quality assessments and microbiological testing to ensure that the standards for safe drinking water are met.

- Educating students about hygiene habits: Providing students with knowledge about proper hygiene habits, such as safe food handling, water hygiene, and sanitation practices, is essential. This can be achieved through educational programs and awareness campaigns aimed at improving hygiene behaviors and fostering a culture of cleanliness.

By implementing these measures, institutions can help prevent the spread of infections, reduce the impact of fecal contamination on student health, and create a healthier environment conducive to learning and well-being.

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Appendix

Appendix A: IWQI values for dry season

Name	IWQI VALUE	Remarks
Siraj Uddin Sarker Vidyaniketan & College	1.65	Good
Ashraf Textile Mills High School	8.97	Unsuitable
Olympia Textile Mills High School	3.37	Poor
Nishat Jute Mills High School	5.77	Unsuitable
shaheed smrity government primary school	1.3	Good
shaheed smrity High school	1.45	Good
Arichpur government primary school	1.75	Good
Amzad Ali Sarker Pilot Girl's High School	3.78	Poor
Amzad Ali Sarker Pilot Girl's College	3.56	Poor
Banomala government primary school	1.18	Good
Silmoon government primary school	7.16	Unsuitable
Silmoon government High School	7.98	Unsuitable
Morkun government primary school	1.84	Good
Kaderia Textile Mills High School	1.94	Good
Hazi pear Ali government primary school	0.82	EXCELLENT
Dewra government primary school	3.36	Poor
Auchpara government primary school	4.15	Poor
Mojida Government High School	1.99	Good
TDH government primary school	1.01	Good
Rowshan Earshad government primary school	3.22	Poor
Gazipura government primary school	9.11	Unsuitable
Sataish government high School	0.7	EXCELLENT
Sataish government primary School	1.775	Good
Gutia government primary school	2.82	Marginal
Dewra government primary school	5.53	Unsuitable
Nowagani government primary school	2.073	Marginal
Pagar government primary school	0.092	EXCELLENT
Auchpara government primary school	3.11	Poor
Dottapara government primary school	2.53	Marginal

Hazi Sayed Shah government primary school	4.94	Poor
Mamdi Mollah High School	8.97	Unsuitable
Noagao Am,A Majid Miah High school	5.94	Unsuitable
Sharifpur Ziash Khan High School	1.32	Good
Tongi Pilot Girl’s School	6.64	Unsuitable
Tongi Pilot Girls' College	5.23	Unsuitable
Mudafa Hazi Sayed Ali High School	7.98	Unsuitable
Shilmun Abdul Hakim Master High School	8.2	Unsuitable
Safiuddin Sarkar Academy and College	0.4	EXCELLENT
Tongi Govt. College	5.47	Unsuitable
Tongi Asraful Ulum Alim Madrasa	5.611	Unsuitable
Tongi Islamia Alim Madrasa	2.3	Marginal
Miraspara Hamidia Dakhil Madrasa	0.02	EXCELLENT
Tamirul Millat Kamil Madrasah	3.347	Poor

Appendix B: IWQI values for wet season

Name	IWQI VALUE	Remarks
Siraj Uddin Sarker Vidyaniketan & College	2.06	MARGINAL
Ashraf Textile Mills High School	9.48	UNSUITABLE
Olympia Textile Mills High School	2.91	MARGINAL
Nishat Jute Mills High School	5.75	UNSUITABLE
shaheed smrity government primary school	1.46	Good
shaheed smrity High school	1.48	Good
Arichpur government primary school	3.75	Poor
Amzad Ali Sarker Pilot Girl's High School	4.077647	Poor
Amzad Ali Sarker Pilot Girl's College	3.27	Poor
Banomala government primary school	0.71	EXCELLENT
Silmoon government primary school	7.25	UNSUITABLE
Silmoon government High School	7.8	UNSUITABLE
Morkun government primary school	2.58	MARGINAL
Kaderia Textile Mills High School	2.9567	MARGINAL
Hazi pear Ali government primary school	1.273	Good
Dewra government primary school	3.767	Poor
Auchpara government primary school	3.895	Poor
Mojida Government High School	2.24	MARGINAL
TDH government primary school	1.745	Good
Rowshan Earshad government primary school	3.585	Poor
Gazipura government primary school	8.763	UNSUITABLE
Sataish government high School	0.665	EXCELLENT
Sataish government primary School	1.953	Good
Gutia government primary school	3.114	Poor
Dewra government primary school	5.927	UNSUITABLE
Nowagani government primary school	2.104	MARGINAL
Pagar government primary school	0.176	EXCELLENT
Auchpara government primary school	3.702	Poor
Dottapara government primary school	2.998	MARGINAL
Hazi Sayed Shah government primary school	5.314	UNSUITABLE
Mamdi Mollah High School	7.196	UNSUITABLE
Noagao Am,A Majid Miah High school	6.516	UNSUITABLE
Sharifpur Ziash Khan High School	1.186	Good
Tongi Pilot Girl’s School	7.804	UNSUITABLE
Tongi Pilot Girls' College	5.826	UNSUITABLE

Mudafa Hazi Sayed Ali High School	8.684	UNSUITABLE
Shilmun Abdul Hakim Master High School	8.981	UNSUITABLE
Safiuddin Sarkar Academy and College	1.063	Good
Tongi Govt. College	6.358	UNSUITABLE
Tongi Asraful Ulum Alim Madrasa	6.851	UNSUITABLE
Tongi Islamia Alim Madrasa	0.845	EXCELLENT
Miraspara Hamidia Dakhil Madrasa	0.535	EXCELLENT
Tamirul Millat Kamil Madrasah	3.227	Poor