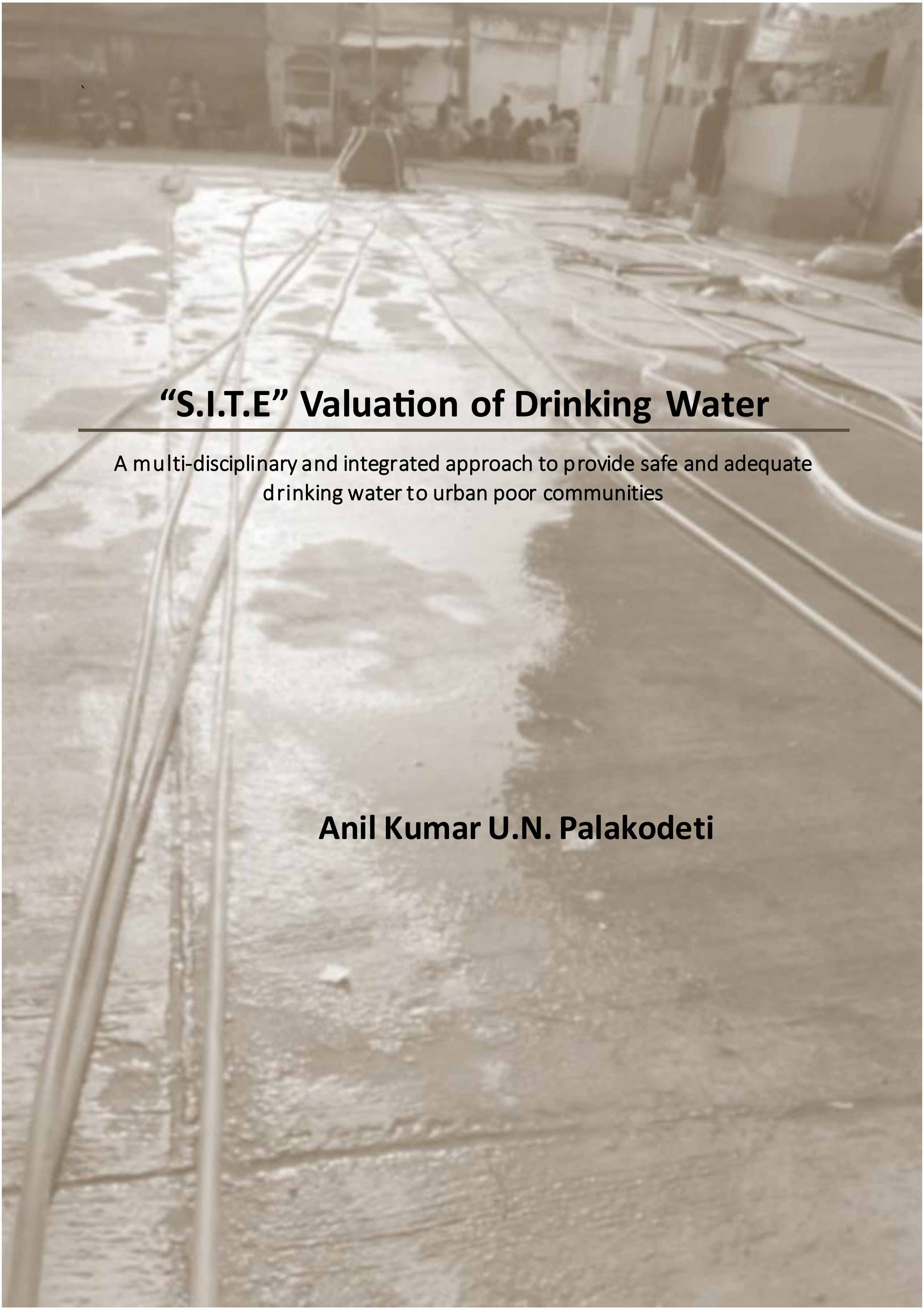
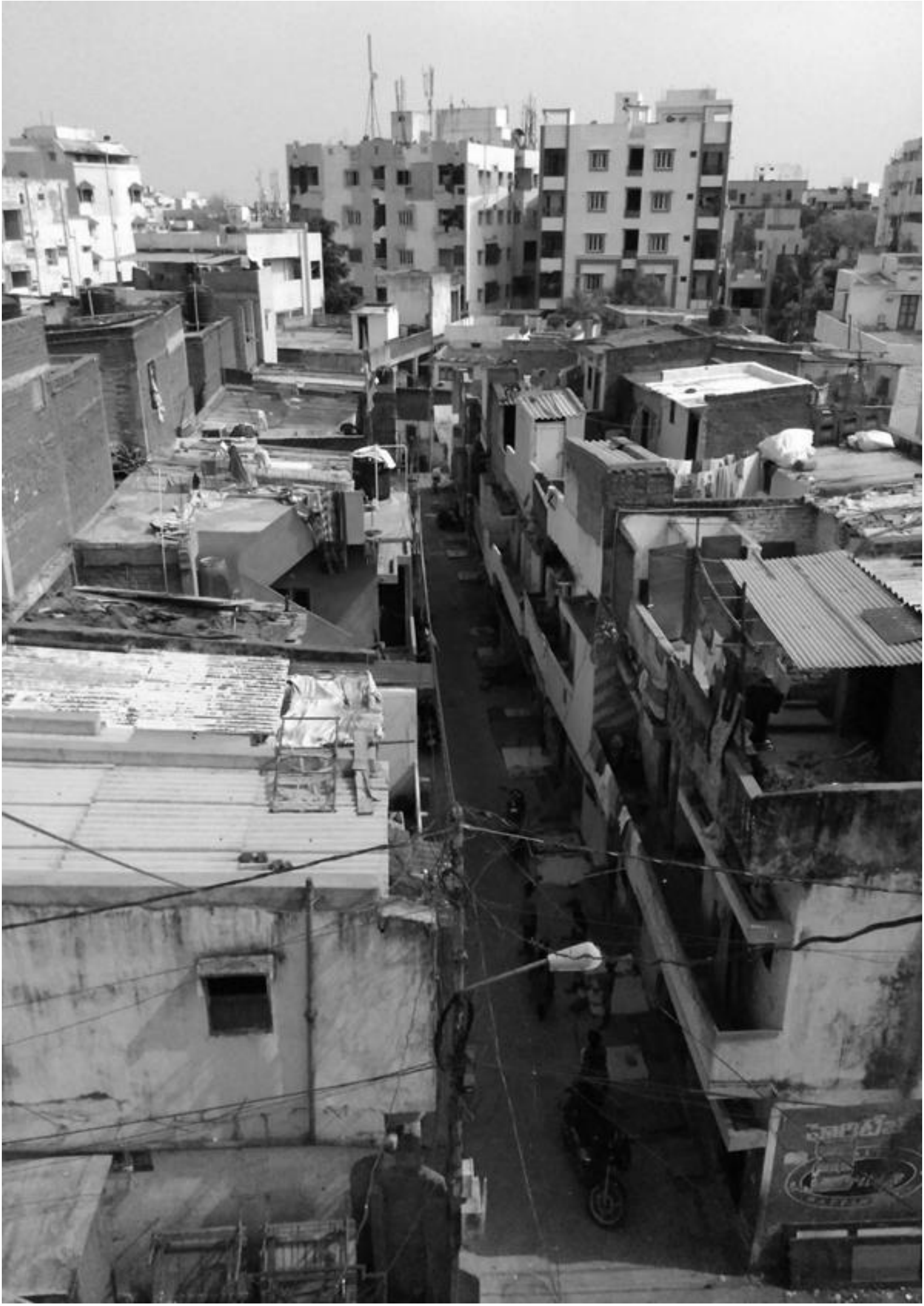


“S.I.T.E” Valuation of Drinking Water

A multi-disciplinary and integrated approach to provide safe and adequate drinking water to urban poor communities

Anil Kumar U.N. Palakodeti



“S.I.T.E” Valuation of Drinking Water

A multi-disciplinary and integrated approach to provide safe and adequate drinking water to urban poor communities

“S.I.T.E” waardering van drinkwater

Een multi-disciplinaire en ïntegreerd benadering voorzien veilig en voldoende drinkwater aan stedelijke armen gemeenschappen

Doctoral Thesis

to obtain the degree of Doctor from the
Erasmus University Rotterdam,
by the command of the rector magnificus prof. dr. F. A. van der Duijn Schouten
and in accordance with the decision of the Doctorate Board.

The public defense shall be held on
Thursday, 14th Day of January 2021 at 13.30 hours

by

Anil Kumar U.N. Palakodeti
Born in India

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Summary

Introduction.

Due to rapid population growth and limited land availability in most of the metropolitan cities in India, the concentrated growth in certain regions with unfettered developments, deteriorated environmental conditions and inadequate infrastructure facilities and services, dwindled the habitable conditions. These development patterns are commonly identified as urban poor communities or informal settlements or slum areas. They are increasingly affecting the productivity, human health, safety and ecology in different ways from region to region and diverse income groups. The poor are affected most sternly by these deteriorated conditions.

Likewise, Hyderabad city region, the capital of Telangana State in India, is a land to more than thousand urban poor communities and to millions of people living in these inhabitable areas, which lack basic needs, especially drinking water facilities and services. This is primarily because of the inability of state and local governments in Hyderabad city region to take quality decisions in an integrated and systematic way to improve the living conditions of the urban poor communities without disparities.

Research framework.

Despite having many policies, programs, projects and established government agencies for the Hyderabad city region, the research study disclosed the spatial disparities of drinking water infrastructure facilities and services due to poor decision making procedures. As part of theoretical framework, S.I.T.E valuation, the two parameters defined as dependent variables comprised of (1) drinking water quality, and (2) drinking water quantity. This drinking water quality and quantity was expected to be influenced by the independent variable as (1) decision making procedures followed by government agencies, which comprise of sub-variables (1) social-health (S), (2) institutional (I), (3) technical (T), and (4) economical (E) aspects.

This qualitative study conducted during 2015 and 2019 contributed to region-wise comparative assessment and analysis of (1) people's perception of drinking water quality and quantity, (2) expert's judgement on drinking water quality and quantity, (3) people's perception on quality of decision making procedures followed by government agencies to provide drinking water facilities and services, (4) government agency's perception of decision making procedures followed to provide drinking water facilities and services to urban poor communities. The research study focused on identifying the relationship between the drinking water quality and quantity, and the decision making procedures followed by the government agencies to provide drinking water facilities and services. This was primarily to identify the factors that are positively (or negatively) influencing decision

making procedures to provide drinking water quality and quantity to the urban poor communities.

Methodology.

Methodically, the multi-stage sampling procedures were administered to the selected slum areas, slum dwellers in each slum area, workers at the Institution and drinking water samples. A detailed selection criteria and spatial cluster sampling techniques were applied to identify 34 slum areas to be used which were located in the Hyderabad city region. Further, a simple random sampling techniques were applied in order to select 2281 subjects to be interviewed to collect the perceptions of the slum population regarding the quality and quantity of the drinking water facilities and services and the decision making procedures which were followed by the government agencies. A spatial cluster sampling technique and a stratified random sampling technique were applied to collect 18 drinking water samples from the different sources of drinking water in the slum areas for laboratory investigations. A stratified random sampling technique was applied to select 22 participants for interviewing and conducting focus group discussions to collect the decision making procedures followed at the institutional level.

This exercise was followed by data collection from the field using detailed questionnaires and checklist for (1) household level satisfactory levels (using Likert scale) of drinking water quality and quantity from different sources, actual drinking water quantity collected, stored and used, household level perceptions (using Likert scale) on decision making frameworks followed by government agencies to provide drinking water facilities and services, challenges encountered due to poor drinking water quality and quantity, (2) checklist to record the presence of microbiological, chemical and physical parameters from the laboratory tests of the drinking water samples collected from different sources, (3) stakeholders’ perception on decision making procedures followed to provide drinking water facilities and services and the factors considered during the decision making procedures.

Existing drinking water quality and quantity.

The *first research question focused on identifying the existing quality and quantity of drinking water from different sources*. The qualitative analysis carried through in this phase of research was broadly classified into two parts: (a) the slum households’ perception and (b) the expert’s judgement on quality and quantity of drinking water. The overall people’s perception analysis showed that there were variations within the sample case studies (informal settlements), in terms of access to or availability of safe quality and adequate quantity of drinking water from different sources of drinking water such as individual taps in the houses of the slum dweller, public taps, bore wells, tube wells, hand pumps and water tankers. The perception analysis of variations in availability of drinking water quantities and qualities were further strengthened by the expert’s judgement analysis.

According to the expert's judgement analysis the quantity of drinking water that was available to the slum households was far below the water quantity requirement standards. However, the analysis pertaining to quantities amongst the sample case studies (informal settlements) on relative terms showed that there were a certain number of sample case studies in the informal settlements for which the quantity of drinking water available was relatively reasonable compared to the other sample case studies from the informal settlements. Further, the expert's judgment analysis (through laboratory tests of drinking water samples) found that the quality of drinking water amongst the sample case studies in the informal settlements and from the different sources of drinking water was not consistent. There were a certain number of sample case studies in the informal settlements for which the quality of drinking water that was available met the drinking water quality standards and there was also a certain number of sample case studies for which the quality of the drinking water did not meet the drinking water quality standards.

The combination of perception analysis and expert's judgement analysis regarding the quality and quantity of drinking water facilities and services from the different sources of drinking water showed that there were variations amongst the sample case studies in the informal settlements in terms of the availability of safe quality and whether there were adequate quantities of drinking water in the Hyderabad city region. The overall quality and quantity of drinking water was compliant in some of the slum areas, partially compliant in other slum areas and non-compliant in other slum areas.

Considering the varying results in the quality and quantity of drinking water amongst the informal settlements in the Hyderabad city region, the research study further focused on trying to understand the decision making frameworks and procedures and the factors considered during the decision making process that were followed by the Hyderabad Metropolitan Water Supply & Sewerage Board (HMWSSB) to provide drinking water facilities and services, especially to the slum residents within the Hyderabad city region.

Factors constituting the existing decision making procedures.

The *second research question focused on identifying the factors that constitute the existing decision making procedures to provide quality and quantity of drinking water*. The qualitative analysis that was carried out in this phase of the research study was twofold: (a) stakeholders' interviews and focus group discussions at HMWSSB regarding the decision making process, and (b) slum households' interviews and focus group discussions regarding their perceptions of factors which they thought the HMWSSB considered during the decision making process to provide drinking water facilities and services.

During the stakeholder consultations at HMWSSB, the factors that were considered during the decision making procedures to provide drinking water facilities and services to the sample case studies in the informal settlements in the Hyderabad city region, in comparison with the S.I.T.E valuation framework, revealed that: partial consideration of social-health aspects (S) and institutional aspects (I), significant level of consideration of analysis of technical aspects (T), and complete non-consideration of economic aspects (E). In addition, a priority analysis (O1) was carried out in order to prioritise or shortlist the neighbourhoods in order to provide drinking water facilities and services. Analysing the amount of consideration that was given to the factors in the decision making process in each sample case study, the qualitative analysis of stakeholder discussions signifies that there were variations amongst the sample case studies (informal settlements) in terms of considering the analysis of socio-health (S), Institutional (I), Technical (T) aspects and Prioritisation (O1). The analysis revealed a positive corresponding relationship between socio-health (S), institutional (I), technical (T) and priority analysis (O1). The higher the level of involvement of the institutional aspects (I), the higher the level of involvement of social-health aspects (S) and the higher the level of involvement of technical aspects (T) during the decision making procedures.

The stakeholder consultations were further reinforced by the slum residents' perception analysis. The viewpoint of slum households revealed similar results that were given in the qualitative analysis of the stakeholders' interviews and focus group discussions at HMWSSB. According to household's perception analysis, the factors that were considered during the decision making procedures to provide drinking water facilities and services to the sample case studies in the informal settlements in the Hyderabad city region, in comparison with the S.I.T.E valuation framework, reveals that during the decision making processes: there was limited consideration given to the Socio-health aspects (S), there was limited consideration given to the Institutional aspects (I), there was significant consideration given to the analysis of Technical aspects (T) and there was no consideration was given to the analysis of Economic aspects (E) in the decision making processes at HMWSSB. In addition to the analysis of the above-mentioned aspects, priority analysis (O1) is carried out at HMWSSB to provide drinking water facilities and services to the slum areas.

The combination of slum residents' perception analysis and the stakeholders' analysis of the factors that were considered during the decision making processes by the HMWSSB in order to provide drinking water facilities and services showed that there were limitations in the amount of consideration that was given to the socio-health aspects and institutional aspects with variations amongst the sample case studies in the informal settlements. It can be summarised that there was significant consideration given to the analysis of the technical aspects. It can also be summarised that there was no consideration given to the analysis of the economic aspects throughout all of the sample case studies in the informal settlements during the decision making process in order to provide drinking water facilities and services, especially to the slum residents within the Hyderabad city region.

Taking into consideration the above factors, the research study then focused on understanding the relationship between the quality and quantity of drinking water in the informal settlements and in what way did the factors influence the decision making procedures and what decision making processes were followed by the HMWSSB.

Relationship between the existing decision making procedures and the existing drinking water quality and quantity.

The analysis of corresponding patterns between the independent (factors that were considered in decision making procedures) and dependent (such as drinking water quality and quantity aspects) variables, the sample case studies in the informal settlements for which the factors associated with socio-health (S), institutional (I), technical (T) and priority analysis (O) are considered during the decision making procedures at HMWSSB are having safe quality and adequate (in relative terms) of drinking water facilities and services. This implies a positive corresponding relationship between socio-health (S), institutional (I), technical (T) and priority analysis (O) and quality and quantity of drinking water amongst the sample case studies in the informal settlements. The sample case studies in the informal settlements for which the above-mentioned factors were not considered during the decision making procedures at HMWSSB did not have adequate quality and quantity of drinking water. Thus, the availability of drinking water facilities and services were influenced by decision making procedures which were compliant with socio-health (S), institutional (I), technical (T) and priority analysis (O).

The corresponding pattern analysis also revealed that the factors associated with economic (E) analysis were not considered during the decision making procedures at the HMWSSB and did not influence or determine the availability of adequate quality and quantity of drinking water facilities and services throughout the sample case studies in the informal settlements in the Hyderabad city region. Despite of the non-consideration given to the economic (E) analysis during the decision making procedures at HMWSSB, there were certain sample case studies in the informal settlements with an adequate quantity and safe quality drinking water. This implies a negative corresponding relationship between economic (E) analysis and the quality and quantity of drinking water amongst the sample case studies in the informal settlements.

Further, the availability (or non-availability) of drinking water facilities and services was also not influenced by the decision making procedures which were compliant with the technical (T) aspects. The consideration given to the technical (T) aspects in the decision making processes were mandatory. Therefore, any plans or proposals that were submitted for improving or provisioning the drinking water facilities and services in the slum areas will have to undergo consideration of resource analysis and planning and analysis of engineering and innovation aspects. However, the provision of drinking water facilities and services were largely dependent on other factors such as social (S) and institutional (I).

In addition to these, the priority analysis also played a positive role and the amount of consideration that was given to the socio-health aspects, institutional aspects and technical aspects during the decision making procedures to provide drinking water facilities and services. Currently, the analysis of economic aspects was not taken into consideration during the decision making procedures in order to provide drinking water facilities and services to the sample case studies in the informal settlements in the Hyderabad city region.

Considering this corresponding analysis which displayed the factors considered during the decision making processes that influenced the provision of quality and quantity of drinking water facilities and services, the research study further focused on determining the factors that needed, positively (or negatively), to be considered in a systematic and integrated decision making framework in order to provide a safe quality and adequate quantity of drinking water to the sample case studies in the informal settlements in the Hyderabad city region.

Factors influence, positively (or negatively), in the systematic and integrated decision making framework to provide safe quality and adequate quantity of drinking water facilities and services for the urban poor population.

The relationship analysis of quality and quantity of drinking water and the decision making framework to provide drinking water facilities and services revealed that there was a positive influence of analysis pertaining to socio-health (S), institutional (I) and priority (O1) during the decision making procedures regarding the availability of an adequate quantity and safe quality drinking water throughout the sample case studies in the informal settlements of the Hyderabad city region. Thus, the sample case studies in the informal settlements for which these aspects were considered during the decision making processes had an adequate quantity and safe quality drinking water. It was observed from the relationship analysis that for all of the sample case studies in the informal settlements the analysis of the technical aspects were considered, and the analysis of the economic aspects were not considered in the decision making processes in order to provide drinking water facilities and services.

However, the aspects pertaining to technical (T) and economic (E) analysis in the decision making procedures to provide drinking water facilities and services had a neutral influence or no influence on the availability of an adequate quantity and safe quality of drinking water throughout the sample case studies in the informal settlements of the Hyderabad city region. This meant that the sample case studies from the informal settlements for which the technical aspects were considered during the decision making processes, were unable to fulfil their objectives of producing an adequate quantity and safe quality drinking water and the sample case studies in the informal settlements for which the economic aspects were considered during the decision making process had an adequate quantity and safe quality drinking water.

It has been concluded that the aspects that were considered in the systematic and integrated decision making framework that positively influenced the quality and quantity of drinking water facilities and services in the informal settlements of the Hyderabad city region were socio-health (S), institutional (I), prioritisation (O1); and the aspects that were neutral or did not influence the quality and quantity of drinking facilities and services in the informal settlements of the Hyderabad city region were technical (T) and economic (E) aspects of the systematic and integrated decision making framework.

Conclusion.

This multidisciplinary research has achieved the purpose of disclosing the relationship (positive or negative) between the factors determining the decision making procedures and drinking water quality and quantity in the urban poor communities of the Hyderabad city region. The research study further focused on accepting the theoretical framework and restating the factors such as social-health (S), institutional (I), technical (T) and economical (E) that are constituted in a systematic and integrated decision making framework to provide drinking water facilities and services to the urban poor communities. The conclusions also further focused on further application of the findings and research framework developed in this study for academic generalisation and value add to the existing academic literature and pragmatic recommendations to policy and decision makers to improve the decision making frameworks to provide safe quality and adequate quantity of drinking water to all urban poor communities in equality and cost effective way in near future.

Keywords.

Water governance, Decision making process, Drinking water quality and quantity, Systematic and Integrated decision making process, Valuation framework, Socio-health, Institutional assessment, Technical aspects, Economic valuation, Hyderabad city region, Informal settlements, Slum areas.

Samenvatting

Inleiding.

De snelle bevolkingsgroei en beperkte beschikbaarheid van land in de meeste grootstedelijke gebieden in India, heeft in bepaalde regio's met onbelemmerde groei, verslechterde milieuomstandigheden en ontoereikende infrastructurele voorzieningen en -diensten geleid tot een verminderde leefbaarheid. Deze ontwikkelingspatronen zijn gewoonlijk typerend voor arme stedelijke gemeenschappen, informele nederzettingen of sloppenwijken. Ze beïnvloeden in toenemende mate en op verschillende manieren de productiviteit, de volksgezondheid, veiligheid en ecologie van verschillende inkomensgroepen in verschillende regio's. De armen worden het zwaarst getroffen door deze verslechterde omstandigheden.

Op deze manier is de stadsregio Hyderabad, de hoofdstad van de staat Telangana in India, het leefgebied van meer dan duizend stedelijke arme gemeenschappen. Miljoenen mensen die in dit gebied wonen, beschikken niet over basisbehoeften, met name drinkwatervoorzieningen en -diensten. Dit komt voornamelijk door het onvermogen van nationale en lokale overheden in de stadsregio Hyderabad om op een geïntegreerde en systematische manier kwaliteitsbeslissingen te nemen, om de levensomstandigheden van de stedelijke arme gemeenschappen te verbeteren zonder daarbij onderscheid te maken.

Onderzoekskader.

Ondanks dat er veel beleid, programma's, projecten en gevestigde overheidsinstanties zijn voor de stadsregio Hyderabad, bracht het onderzoek de ruimtelijke verschillen aan het licht tussen de verschillende infrastructurele faciliteiten en -diensten voor het drinkwater, als gevolg van slechte besluitvormingsprocedures. Als onderdeel van het theoretisch kader, de S.I.T.E-waardering, worden de twee parameters gedefinieerd als afhankelijke variabelen, bestaande uit (1) de drinkwaterkwaliteit en (2) de drinkwaterkwantiteit. De verwachting was dat deze drinkwaterkwaliteit en -kwantiteit worden beïnvloed door de onafhankelijke variabele van (1) de besluitvormingsprocedures gevolgd door overheidsinstanties, die bestaan uit de subvariabelen (1) volksgezondheidsaspecten (S), (2) institutionele aspecten (I), (3) technische aspecten (T) en (4) economische aspecten (E).

Dit kwalitatieve onderzoek, uitgevoerd in 2015 en 2019, heeft bijgedragen aan een regionale vergelijkende beoordeling en analyse van (1) de perceptie van mensen over de kwaliteit en kwantiteit van het drinkwater, (2) het oordeel van deskundigen over de kwaliteit en kwantiteit van het drinkwater, (3) de perceptie van mensen over de kwaliteit van de besluitvormingsprocedures die worden gevolgd door overheidsinstanties om drinkwatervoorzieningen en -diensten te verstrekken, en (4) de perceptie van de overheidsinstanties over de besluitvormingsprocedures die worden gevolgd om drinkwatervoorzieningen en -diensten te leveren aan stedelijke arme gemeenschappen.

Het onderzoek richtte zich op het in kaart brengen van de relatie tussen de drinkwaterkwaliteit en -kwantiteit en de besluitvormingsprocedures die de overheidsinstanties volgen om drinkwatervoorzieningen en -diensten te leveren. Een belangrijk doel was om de factoren te identificeren die een positieve (of negatieve) invloed hebben op de besluitvormingsprocedures om drinkwaterkwaliteit en -kwantiteit te leveren aan de arme stedelijke gemeenschappen.

Methodologie.

De bemonsteringsprocedures werden toegepast op de geselecteerde sloppenwijken, sloppenwijkbewoners in elke sloppenwijk, werknemers van de instelling en drinkwatermonsters. Er werden gedetailleerde selectiecriteria en steekproeftechnieken voor ruimtelijke clusters gebruikt om 34 te gebruiken sloppenwijken te identificeren die zich in de stadsregio Hyderabad bevonden. Verder werden eenvoudige steekproeftechnieken toegepast om 2281 personen te selecteren voor interviews om de perceptie van de sloppenwijkbevolking te verzamelen over de kwaliteit en kwantiteit van de drinkwatervoorzieningen en -diensten en de besluitvormingsprocedures die werden gevolgd door de overheidsinstanties. Een ruimtelijke clusterbemonsteringstechniek en een gestratificeerde, aselecte bemonsteringstechniek werden toegepast om 18 drinkwatermonsters te verzamelen uit de verschillende drinkwaterbronnen in de sloppenwijken voor laboratoriumonderzoek. Een gestratificeerde, willekeurige steekproeftechniek werd toegepast om 22 deelnemers te selecteren voor interviews en het voeren van focusgroepdiscussies om de besluitvormingsprocedures op institutioneel niveau te verzamelen.

Deze toepassing werd gevolgd door gegevensverzameling uit het veld met behulp van gedetailleerde vragenlijsten en (1) een checklist voor bevredigende niveaus van drinkwaterkwaliteit en -kwantiteit uit verschillende bronnen op huishoudniveau (met behulp van de Likertschaal), de werkelijke hoeveelheid opgevangen, opgeslagen en gebruikt drinkwater, percepties op huishoudniveau (met behulp van de Likertschaal) over besluitvormingskaders die worden gevolgd door overheidsinstanties om drinkwatervoorzieningen en -diensten te leveren, uitdagingen die worden ondervonden als gevolg van een slechte drinkwaterkwaliteit en -kwantiteit; (2) een checklist voor de aanwezigheid van microbiologische, chemische en fysische parameters uit de laboratoriumtests van de drinkwatermonsters die uit verschillende bronnen zijn verzameld; en (3) een vragenlijst gericht op de perceptie van stakeholders over de besluitvormingsprocedures die worden gevolgd om drinkwatervoorzieningen en -diensten te leveren en de factoren waarmee tijdens de besluitvormingsprocedures rekening wordt gehouden.

Bestaande drinkwaterkwaliteit en kwantiteit.

De eerste onderzoeksvraag was gericht op het in kaart brengen van de bestaande kwaliteit en kwantiteit van drinkwater uit verschillende bronnen. De kwalitatieve analyse die in deze onderzoeksfase werd uitgevoerd, werd grofweg in twee delen ingedeeld: (a) de perceptie van huishoudens in de sloppenwijken en (b) het oordeel van de expert over de kwaliteit en kwantiteit van het drinkwater. De algemene perceptieanalyse van de mensen in de sloppen toonde aan dat er variaties waren binnen de casestudies uit de steekproef (informele nederzettingen), in termen van toegang tot of beschikbaarheid van een veilige kwaliteit en een voldoende hoeveelheid drinkwater uit verschillende drinkwaterbronnen. Dit water kwam bijvoorbeeld uit individuele kranen in de huizen van de sloppenwijkbewoners, openbare kranen, boorputten, buisputten, handpompen en watertankers. De perceptieanalyse van variaties in de beschikbaarheid van drinkwaterhoeveelheden en -kwaliteitsniveaus werd verder onderbouwd door de oordeelsanalyse van de expert.

Volgens de oordeelsanalyse van de deskundige lag de hoeveelheid drinkwater die beschikbaar was voor de krottenwijkhuishoudens ver onder de norm voor de vereiste waterhoeveelheid. Uit de analyse met betrekking tot de hoeveelheden in de casestudies uit de steekproef (informele nederzettingen) bleek echter vergelijkenderwijs dat er een aantal casestudies waren in de informele nederzettingen waarin men kon beschikken over een vrij redelijke hoeveelheid drinkwater vergeleken met de andere casestudies uit de steekproef genomen in informele nederzettingen. Verder bleek uit de oordeelsanalyse van de deskundige (op basis van laboratoriumtests van drinkwatermonsters) dat de kwaliteit van het drinkwater in de casestudies in de informele nederzettingen en uit de verschillende drinkwaterbronnen niet consistent was. Voor een aantal cases uit de steekproef genomen in de informele nederzettingen voldeed de kwaliteit van het beschikbare drinkwater aan de drinkwaterkwaliteitsnormen, maar er waren ook een aantal cases uit de steekproef waarin de kwaliteit van het drinkwater niet voldeed.

De combinatie van perceptieanalyse en deskundige oordeelsanalyse met betrekking tot de kwaliteit en kwantiteit van drinkwatervoorzieningen en -diensten uit de verschillende drinkwaterbronnen liet zien, dat de beschikbaarheid van een veilige drinkwaterkwaliteit tussen de casestudies uit de steekproef in de informele nederzettingen varieerde, en dat de vraag was of er voldoende drinkwater was binnen de stadsregio Hyderabad. De algehele kwaliteit en kwantiteit van het drinkwater was conform de normen in sommige sloppenwijken, gedeeltelijk conform in andere sloppenwijken en niet conform in weer andere sloppenwijken.

Gezien de wisselende resultaten wat betreft de kwaliteit en kwantiteit van het drinkwater voor de verschillende informele nederzettingen in de stadsregio Hyderabad, richtte het onderzoek zich verder op het proberen te begrijpen van de besluitvormingskaders en -procedures. Het onderzoek richtte zich ook op de factoren die in overweging werden genomen tijdens het besluitvormingsproces dat de Hyderabad Metropolitan Water Supply

& Sewerage Board (HMWSSB) volgde om drinkwatervoorzieningen en -diensten te leveren, vooral aan de sloppenwijkbewoners in de stadsregio Hyderabad.

Factoren die de bestaande besluitvormingsprocedures vormen.

De tweede onderzoeksvraag was gericht op het identificeren van de factoren die bepalend zijn voor de bestaande besluitvormingsprocedures rond de kwaliteit en kwantiteit van drinkwater. De kwalitatieve analyse die in deze fase van het onderzoek werd uitgevoerd, was tweeledig: (a) interviews met stakeholders en focusgroepdiscussies bij de HMWSSB over het besluitvormingsproces; en (b) interviews met sloppenwijkgezinnen en focusgroepdiscussies over hun percepties van factoren die de HMWSSB volgens hen in overweging nam tijdens het besluitvormingsproces om drinkwatervoorzieningen en -diensten te leveren.

Tijdens de consultaties met stakeholders bij de HMWSSB lieten de factoren die mee werden gewogen tijdens de besluitvormingsprocedures om drinkwatervoorzieningen en -diensten te leveren aan de case studies in de informele nederzettingen in de stadsregio Hyderabad, in vergelijking met het S.I.T.E-waarderingskader het volgende beeld zien: een gedeeltelijke meeweging van volksgezondheidsaspecten (S) en institutionele aspecten (I), een significante meeweging van de analyse van technische aspecten (T), en het volledig buiten beschouwing laten van economische aspecten (E). Daarnaast werd een prioriteitenanalyse (O1) uitgevoerd om de wijken te prioriteren of op de shortlist te zetten voor de levering van drinkwatervoorzieningen en -diensten. Door te analyseren hoeveel aandacht er werd besteed aan de factoren in het besluitvormingsproces in elke casestudy, geeft de kwalitatieve analyse van discussies met stakeholders aan dat er variaties waren tussen de casestudies in de steekproef (informele nederzettingen) in termen van het meewegen van de analyse op het gebied van volksgezondheid (S), institutionele aspecten (I), technische aspecten (T) en prioritering (O1). De analyse bracht een positief verband aan het licht tussen volksgezondheidsaspecten (S), institutionele aspecten (I), technische aspecten (T) en de prioriteitsanalyse (O1). Hoe zwaarder institutionele aspecten (I) meewogen, des te zwaarder telden ook volksgezondheidsaspecten (S) en ook technische aspecten (T) mee in de besluitvormingsprocedures.

De resultaten van de consultaties met stakeholders werden verder bevestigd door de perceptieanalyse van de sloppenwijkbewoners. De standpunten van huishoudens in de sloppenwijken, gegeven in de kwalitatieve analyse van de interviews met belanghebbenden en focusgroepdiscussies bij de HMWSSB, brachten vergelijkbare resultaten aan het licht. Volgens de perceptieanalyse lieten de factoren die volgens de bewoners werden meegewogen tijdens de besluitvormingsprocedures bij de HMWSSB over de levering van drinkwaterfaciliteiten en -diensten aan de casestudies in de steekproef uit de informele nederzettingen in de stadsregio Hyderabad, in vergelijking met het SITE-waarderingskader, het volgende zien: er werd weinig aandacht besteed aan volksgezondheidsaspecten (S), er werd in beperkte mate rekening gehouden met de institutionele aspecten (I), er werd veel aandacht besteed aan de analyse van technische aspecten (T) en er was geen aandacht voor de analyse van economische aspecten (E). Naast de analyse van bovengenoemde aspecten wordt bij de HMWSSB een prioritering aangegeven (O1) voor het leveren van drinkwatervoorzieningen en -diensten aan de sloppenwijken.

De combinatie van de perceptieanalyse van sloppenwijkbewoners en de analyse van de stakeholders van de factoren die werden meegewogen tijdens de besluitvormingsprocessen van de HMWSSB, toonde aan dat er alleen beperkte aandacht werd besteed aan de volksgezondheidsaspecten en institutionele aspecten, hoewel dit tussen de cases in de steekproef in de informele nederzettingen varieerde. Samenvattend kan worden gesteld dat er veel aandacht is besteed aan de analyse van de technische aspecten. Ook kan worden samengevat dat er in geen enkele van de casestudies in de informele nederzettingen tijdens het besluitvormingsproces over de levering van drinkwatervoorzieningen en -diensten aan de sloppenwijken van Hyderabad aandacht is besteed aan de analyse van de economische aspecten.

Rekening houdend met de bovenstaande factoren, richtte het onderzoek zich vervolgens op het begrijpen van de relatie tussen de kwaliteit en kwantiteit van drinkwater in de informele nederzettingen, op welke manier de factoren de besluitvormingsprocedures beïnvloedden en welke besluitvormingsprocessen de HMWSSB volgde.

Verband tussen de bestaande besluitvormingsprocedures en de bestaande drinkwaterkwaliteit en -kwantiteit.

De analyse van overeenkomstige patronen tussen de onafhankelijke variabelen (factoren die werden meegenomen in besluitvormingsprocedures) en afhankelijke variabelen (zoals drinkwaterkwaliteits- en kwantiteitsaspecten), de casestudies uit de steekproef in de informele nederzettingen waarvoor de factoren samenhingen met de volksgezondheid (S), institutionele aspecten (I), technische aspecten (T) en de prioriteitsanalyse (O) worden meegewogen in de besluitvormingsprocedures bij de HMWSSB. Dit resulteert in een veilige drinkwaterkwaliteit en (relatief) toereikende drinkwatervoorzieningen en -diensten. Dit impliceert een positief verband tussen de volksgezondheid (S), institutionele aspecten (I), technische aspecten (T) en de prioriteitsanalyse (O) en de kwaliteit en kwantiteit van het drinkwater voor de casestudies uit de steekproef in de informele nederzettingen. De casestudies in de informele nederzettingen waarbij de bovengenoemde factoren niet in de besluitvormingsprocedures bij de HMWSSB waren meegenomen, beschikten niet over voldoende drinkwaterkwaliteit en -kwantiteit. De beschikbaarheid van drinkwatervoorzieningen en -diensten werd dus beïnvloed door besluitvormingsprocedures die in overeenstemming waren met geanalyseerde volksgezondheidsaspecten (S), institutionele aspecten (I), technische aspecten (T) en de prioriteitsanalyse (O).

Uit de bijbehorende patroonanalyse kwam ook naar voren dat de factoren die verband houden met de economische analyse (E) niet zijn meegewogen tijdens de besluitvormingsprocedures van de HMWSSB en geen invloed hebben gehad op de beschikbaarheid van drinkwatervoorzieningen en -diensten van zowel voldoende kwaliteit als kwantiteit gedurende het hele steekproefonderzoek in de informele nederzettingen in de stadsregio Hyderabad. Ondanks dat er geen aandacht is besteed aan de economische analyse (E) tijdens de besluitvormingsprocedures bij de HMWSSB, waren er bepaalde casestudies in de informele nederzettingen waarin wel sprake was van een toereikende hoeveelheid en veilig drinkwater. Dit impliceert een negatief verband tussen economische analyse (E) en de kwaliteit en kwantiteit van het drinkwater tussen de casestudies uit de steekproef in de informele nederzettingen.

Verder werd de beschikbaarheid (of niet-beschikbaarheid) van drinkwatervoorzieningen en -diensten ook niet beïnvloed door de besluitvormingsprocedures die voldeden aan de technische aspecten (T). De aandacht voor de technische aspecten (T) in de besluitvormingsprocessen was verplicht. Daarom zullen plannen of voorstellen die werden ingediend voor het verbeteren of bevoorraden van de drinkwatervoorzieningen en -diensten in de sloppenwijken, aandacht moeten besteden aan resource-analyse en -planning en de analyse van technische- en innovatieaspecten. De levering van drinkwatervoorzieningen en -diensten was echter grotendeels afhankelijk van andere factoren, zoals sociale (S) en institutionele (I) aspecten.

Daarnaast speelde ook de prioriteitsanalyse een positieve rol en de hoeveelheid aandacht die werd besteed aan de volksgezondheidsaspecten, institutionele aspecten en technische aspecten tijdens de besluitvormingsprocedures voor de levering van drinkwatervoorzieningen en -diensten. Momenteel is er geen rekening gehouden met de analyse van economische aspecten tijdens de besluitvormingsprocedures om drinkwatervoorzieningen en -diensten te leveren aan de casestudies uit de steekproef in de informele nederzettingen in de stadsregio Hyderabad.

Gezien deze overeenkomstige analyse, die de factoren liet zien die werden meegewogen tijdens de besluitvormingsprocessen die van invloed waren op de levering van een goede kwaliteit en kwantiteit van drinkwatervoorzieningen en -diensten, richtte het onderzoek zich verder op het bepalen van de factoren die in positieve (of negatieve) zin in aanmerking moesten worden genomen in een systematisch en geïntegreerd besluitvormingskader om een veilige kwaliteit en een afdoende hoeveelheid drinkwater te bieden aan de casestudies uit de steekproef in de informele nederzettingen in de stadsregio Hyderabad.

Factoren hebben een positieve (of negatieve) invloed op het systematische en geïntegreerde besluitvormingskader om te zorgen voor een veilige kwaliteit en voldoende kwantiteit van de drinkwatervoorzieningen en -diensten voor de arme stedelijke bevolking.

Uit de relatieanalyse van de drinkwaterkwaliteit en -kwantiteit en het besluitvormingskader voor het leveren van drinkwatervoorzieningen en -diensten bleek dat er een positieve invloed uitging van de analyse met betrekking tot de volksgezondheid (S), institutionele aspecten (I) en prioriteiten (O1) tijdens de besluitvormingsprocedures. De casestudies uit de steekproef in de informele nederzettingen waarbij deze aspecten werden overwogen tijdens de besluitvormingsprocessen hadden dus een voldoende hoeveelheid en veilig drinkwater. Uit de relatieanalyse werd geconstateerd dat voor alle casestudies uit de steekproef in de informele nederzettingen de analyse van de technische aspecten wel werd meegenomen, maar aan de analyse van de economische aspecten geen aandacht werd besteed in de besluitvormingsprocessen om drinkwatervoorzieningen en -diensten aan te bieden.

De aspecten die betrekking hebben op de technische (T) en economische (E) analyse in de besluitvormingsprocedures om drinkwatervoorzieningen en -diensten te leveren, hadden echter gedurende de hele periode een neutrale of geen invloed op de beschikbaarheid van een voldoende hoeveelheid en veilige kwaliteit drinkwater in de informele nederzettingen van de stadsregio Hyderabad. Dit betekent dat de steekproef-casestudies uit de informele nederzettingen waarin de technische aspecten werden meegewogen tijdens de besluitvormingsprocessen, niet resulteerden in de beoogde doelstelling om een voldoende hoeveelheid en veilig drinkwater te produceren. In de casestudies in de informele nederzettingen waarin de economische aspecten werden meegewogen tijdens het besluitvormingsproces, resulteerde dit wel in voldoende kwantiteit drinkwater van veilige kwaliteit.

Er is geconcludeerd dat de aspecten die werden meegewogen in het systematische en geïntegreerde besluitvormingskader met een positieve invloed op de kwaliteit en kwantiteit van drinkwatervoorzieningen en -diensten in de informele nederzettingen van de stadsregio Hyderabad, de volgende waren: volksgezondheid (S), institutionele aspecten (I) en prioritering (01). De aspecten die neutraal waren of geen invloed hadden op de kwaliteit en kwantiteit van drinkvoorzieningen en -diensten in de informele nederzettingen van de stadsregio Hyderabad waren de technische (T) en economische (E) aspecten van het systematische en geïntegreerde besluitvormingskader.

Conclusie.

Dit multidisciplinaire onderzoek heeft het doel bereikt om de (positieve of negatieve) relatie bloot te leggen tussen de factoren die de besluitvormingsprocedures bepalen en de kwaliteit en kwantiteit van het drinkwater in de stedelijke arme gemeenschappen van de stadsregio Hyderabad. Het onderzoek was verder gericht op de acceptatie van het theoretische kader en het herformuleren van de factoren zoals volksgezondheid (S), institutionele aspecten (I), technische aspecten (T) en economisch aspecten (E), die vorm hebben gekregen in een systematisch en geïntegreerd besluitvormingskader om te voorzien in drinkwatervoorzieningen en -diensten voor de arme stedelijke gemeenschappen. De conclusies waren ook gericht op de verdere toepassing van de bevindingen en het onderzoekskader dat in deze studie werd ontwikkeld voor academische generalisatie en de toevoeging van waarde aan de bestaande academische literatuur. Verder was het doel om pragmatische aanbevelingen te doen aan beleidsmakers en besluitvormers om de besluitvormingskaders te verbeteren voor de levering in de nabije toekomst van een voldoende kwantiteit en veilige kwaliteit drinkwater aan alle stedelijke arme gemeenschappen, op een gelijkwaardige en kosteneffectieve manier.

Kernwoorden.

Waterbeheer, Besluitvormingsproces, Drinkwaterkwaliteit en -kwantiteit, Systematisch en geïntegreerd besluitvormingsproces, Waarderingskader, Volksgezondheid, Institutionele beoordeling, Technische aspecten, Economische waardering, Stadsregio Hyderabad, Informele nederzettingen, Sloppenwijken.

Abbreviations

APL	Above Poverty Line
APUSP	Andhra Pradesh Urban Services for the Poor Programme
BPL	Below the Poverty Line
BPPA	Buddha Purnima Project Authority
CSOs	Civil Society organisations
CDA	Cyberabad Development Authority
DPRs	Detailed Project Reports
FGD	Focus Group Discussions
GHMC	Greater Hyderabad Municipal Corporation
HADA	Hyderabad Airport Development Authority
HH	Household
HMDA	Hyderabad Metropolitan Development Authority
HMWSSB	Hyderabad Metropolitan Water Supply and Sewerage Board
HUDA	Hyderabad Urban Development Authority
IAS	Indian Administrative Service
INR/ Rs.	Indian Rupees
IRWM	Integrated Regional Water Management
IWRM	Integrated Water Resources Management
IAIA	International Association for Impact Assessment
JnNURM	Jawaharlal Nehru Urban Renewal Mission
LPCD	Litres Per Capita per Day
MIS	Management Information System
MoUD	Ministry of Urban Development
MoWR	Ministry of Water Resources
MICS	Multiple Indicators Clusters Surveys
MCH	Municipal Corporation of Hyderabad
NGO	Non-Government Organisations
O&M	Operations and Maintenance
POPDEV	POpulation-DEVelopment framework
PIL	Public Interest Litigations
QCA	Qualitative Comparison Analysis
RAY	Rajiv Awas Yojana
RADWQ	Rapid Assessment of Drinking Water Quality
S.I.T.E.	Societal-Institutional-Technical-Economic
SDG	Sustainable Development Goals
TDS	Total Dissolved Solids

US$	United States Dollars
ULBs	Urban Local Bodies
VOs	Voluntary Organisations
WTA	Willingness To Accept
WTP	Willingness To Pay
EDP	Electronic Data Processing
MCC	Metro Consumer Care
QAT	Quality Assurance & Testing

Chapter 1

Setting the Context

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1.1. Prologue

It could have just been another meeting. On the morning of 15 January 2015, I attended a community meeting in our neighbourhood, the Sri Nagar Colony of the Hyderabad city region. In this meeting we were presented with the details of the current drinking water facilities and services that were available in Hyderabad city region, the neighbourhood where I lived and, in the neighbourhoods, adjacent to us. The discussions revealed that there was a scarcity of drinking water resources, in general, in the Hyderabad city region, it also outlined the availability of drinking water facilities and services in our neighbourhood and the non-availability, or less availability, of drinking water facilities and services in the adjacent neighbourhoods.

In addition, the meeting agenda also focused on other community related issues, like the ways to reduce the water usage and procure additional means of drinking water, if required and other general matters. All the residents were pleased with the availability of drinking water on a regular basis and they were all able to meet their household requirements. Except me. Thoughts started to take over my, until then, fairly peaceful mind and I began to consciously be aware of the variants in the provision of drinking water facilities and services to the neighbourhoods where I lived and around me.

My neighbourhood and the surrounding neighbourhoods are ones of affluent localities in the Hyderabad city region. I pondered, if this was the current situation, which seems to show a visible discrimination by the government agencies in providing drinking water facilities and services to these localities, what was the situation of the residents living in impoverished localities? Would this be more alarming? I was uncertain. On the same day, in the evening, I visited my friend who lives in an impoverished informal settlement within the city region and enquired about the conditions pertaining to drinking water facilities and services in her neighbourhood.

She described the, until then unknown to me, conditions which were even worse than I could have imagined. They were not only dealing with inadequate and unsafe drinking water, but they also had no community level associations which did not have any direct interactions with the government agencies to escalate their issues or requirements and get them addressed. They had been, in my perception, basically abandoned and deprived of the basic services. This moved me emotionally. But, as an urban planner by education and profession, keeping emotions aside, it led me to ponder the following questions: Are similar dissimilarities prevailing across the city region? If the resources are scarce, why are there disparities between different localities? Why are these scarce resources not distributed equally to all the residents in the city region? How do the government agencies determine how to provide these basic facilities and services? How do they decide which area or which members of the population should receive what sort of quality and quantity of facilities and services? This in turn triggered me to further investigate these contemplative questions to understand these disparities and the reasons behind the current situation of drinking water facilities and services in the Hyderabad city region, especially in these informal settlements.

Using an intrinsic approach, to endeavour to comprehensively understand the situation, the following sub-sections in this chapter presents the background to the research study outlining the prevailing circumstances regarding drinking water at global, national and local levels. Then, the following sub-sections discuss the problem statements which includes a list of research and sub-research questions and the significance of the current research. Also, for the ease of the readers, this chapter provides a detailed structure of this book describing the subsequent chapters.

1.2. Urban settings

Global context.

Urban settings principally denote cities and the people residing in these cities and concomitant procedures such as economic development, social development and transformation and environmental safeguard. Globally, past trends, present-day conditions and future forecasts demonstrate that the populace in urban areas is proliferating at a great pace due to a combination of reasons such as natural growth, reclassification of rural areas to urban areas, rural-to-urban migration, to name but a few. This is resulting in the world’s population becoming progressively concentrated in cities and towns.

Many studies have exposed that more than half of the global population, about 3.9 billion people are living in urban areas and this is anticipated to continue growing to up to 70% of the global population. It is estimated that about 6.3 billion people shall live in cities and towns by 2050. Though it is promising to note that the urban areas produce 80% of the global GDP. If the growth of cities and towns are not managed coherently, the aftermaths could be alarming and the root-cause to urban environmental problems (Palanivel, 2017; World Bank, 2018). The rapid and unplanned growth of the cities burdens a sustainable development, necessary policies and projects relating to infrastructure development are required to be implemented using effective, efficient and equitable approaches (WWAP, 2015).

The planning and development of infrastructure facilities and services was unable to keep up with the growth rate of many cities and towns across the world. Consequently, the critical challenges pertaining to provision and availability of affordable housing, traffic and transport and basic infrastructure facilities and services grew at an alarming rate, particularly in the provision of adequate water and sanitation. This instigated a significant portion of the Indian population, in particular the urban poor population, to live in overly crowded settlements, known as informal settlements, or slums, with few and often no basic infrastructure facilities and services. Expanding the drinking water systems to these people, a population without easy access to water was and still is an important priority (WWAP, 2018).

Today, water stress is a major concern in many urban areas. Many studies suggest that water resources and related services play a significant role in sustainable development in urban settings. The imbalance between the increasing demands and the finite supply of water are increasing the global water deficit. Considering the past trends and current water consumption patterns, by 2050, the global water demand is projected to increase by 55%. It is primarily used for manufacturing, energy and domestic purposes (WWAP, 2018). The competing demands and supplies have increased the risk of difficult allocation decisions, localised conflicts and continued disparities with regard to access to services, which has significant impacts on people and allied processes, especially with respect to water resource management and governance approaches or models.

Indian context.

Like other cities and towns across the world, the urban environment of Indian cities is also a multifaceted living unit which is comprised of components such as a man-made physical environment, existing natural resources and conditions that shape and enable a city to exist with inhabitants who reside and work in it. Natural assets include land, air and water and the man-made infrastructure is comprised of physical structures and infrastructures (Ghosh, 2003).

In addition to the occasionally occurring natural calamities, the cities transform at a rapid pace proliferating the emergent urbanism in Indian cities. Natural and man-made environmental group components are affected and degraded by the urban growth patterns and economic activities that occur within and around the cities (Hogan et al., 2012; Ramachandraiah, 2004; Lakshmana, 2013, 2008; Shaw, 1989; Jodha, 1990; Harte, 2007; Ghosh, 2003).

Due to population growth, including the rural flux into cities, economic development and other related factors, urban environmental challenges have been increasing at an alarming rate in many Indian cities (Lakshmana, 2013, 2008; Shin et al., 1997). These urban environmental challenges have been increasingly, affecting productivity, human health and safety, amenities and the ecology of the areas (Bartone, 1990a).

These different urban environmental challenges vary between the different regions and affect different income groups in different ways (Lakshmana, 2013; Roland et al., 1994).

Environmental challenges have had an effect on households and communities depending on their income levels or status.

The poor have been affected most severely by deteriorating urban environmental conditions. Studies of urban health conditions in developing countries reveal significant differences between the rich and the poor. The urban poor population, especially women and children, in many cases have been those most vulnerable to adverse urban environmental conditions (Hardoy and Satterthwaite, 1989). It has been argued in many studies that the inability of many state and local governments in emerging countries to provide adequate infrastructure services has led to the degradation of the living and natural environment in and around the cities (World Bank, 1991a).

As per CoI (2011), the population in India was approximately 1.21 billion with a national average density of 382 persons per km2. Although India's land mass is only 2.4% of the global total, in 2011, it was the home to 16.7% of the world's population (James, 2011). Considering the trend analysis of population growth rates, it has been estimated that India's population would reach around 1.64 billion by 2050. Although the population of India has significantly high in figures, concentrations of its citizens are found in specific urban cities within the country. This is one of the conspicuous features of urbanisation in India. There is a skewed distribution of the population, as much as 28% of the urban population reside in only 35 metropolitan cities. Out of the total population, which has been referred to above, the urban population was around 28% which accounts for 0.29 billion in 2001 (CoI, 2001) and increased to 31%, which accounts for 0.38, billion in 2011 (CoI, 2011). It was estimated that the urban population would increase to 0.47 billion by 2021 and 0.7 billion by 2041 (NBO, 2011).

These urban areas were the engines of economic growth and were home to various skills and capacities, employment opportunities and due to this they attracted millions of citizens, which in turn has contributed to higher and significantly increasing GDP rates (NBO, 2011). This was supported by key policies, schemes and projects at central and state levels to rejuvenate and strengthen the urban populations in India by providing the required structures and infrastructure facilities and services.

The concentrated growth in particular regions and unregulated development of the urban areas, particularly over the last two decades, without proper infrastructure services decreased the livable conditions in most of these metropolitan cities in India. It was identified that the consequences of these unregulated development patterns have resulted in the growth of slum areas. In India, it was estimated that about 46 percent of the total population were living in absolute poverty and they were prone to these adverse living conditions (Ramachandraiah, 2004).

It was also identified that the slum dwellers in the cities had been neglected which in turn led to a deterioration of conditions. Due to the consequences of the neglected slum populations and realising the importance of the slum-dwellers contribution to GDP growth, policies and strategies were formulated during the 11th five-year plan 2007-12 in India, in order to make cities "inclusive" in nature (Planning Commission, 2008). The plan wished to include all of the population in the process of growth and development and to improve the living conditions, which included providing basic services, access to affordable shelter and employment opportunities for the residents of the slum areas.

Despite having many policies, programs, strategies and projects, the Indian cities with the rapidly increasing populations, that were growing at a geometric progression, which was caused due to rapid urbanisation, industrialisation and agricultural advancements created stress on the existing limited infrastructure and in particular on the limited availability of fresh, good quality drinking water and facilities (CPCB, 2013).

According to the statistics from the CPCB (2013) the proliferating population resulted in raising concerns about the decline in the gross per capita water availability in India. There was also an increase in the demand for water that was used for diversified purposes like agriculture, industry and municipal purposes. The flourishing population created inequalities amongst its users in the urban cities in terms of its availability, access and consumption. Millions of people, particularly the poor, who were still living in inhabitable areas, lacked basic needs; especially drinking water.

1.3. Hyderabad city context

City profiling.

One of such Indian cities suffering from the above-mentioned challenges is Hyderabad. It is one of the major metropolitan cities, which has been contributing significantly to India's population and economy. Over the last 50 years, it is a city with a steadily increasing population and in last few decades, it is a rapidly growing metropolitan region in India (Dahiya, 2012; Mulligan and Crampton, 2005; Das, 2015). The city region (see Figure 1) which was initially 55 Km^2 with a population of 0.35 million in the mid-18th century is now spread across 7,228 Km^2 with a population of 7.7 million (CoI, 2011). Analysing the trends of the growth rates, the city is the sixth largest metropolitan city[1] in India and the region was expected to be 11 million by the year 2020 and 19 million by the year 2041 (GoAP, 2013).

The growth patterns of the metropolitan region depict that the population is growing at a significant rate in the surrounding municipal areas and that there is a corresponding decline of population in the core area, the former Municipal Corporation of Hyderabad (MCH) area (CDS, 2004). The city has a historical significance along with the process of industrial development and economic liberalisation that influenced the changes in state

[1] Next to Chennai, Delhi, Kolkata, Chennai and Bangalore

economy[2], population growth, socio-economic composition, city growth patterns, urban agglomeration and spatial-governance structuring patterns (Das, 2015; Rao, 2002; Rao, 2007; Rudolph and Rudolph, 2001; Kennedy, 2007; Kirk, 2005; Naidu and Ninan, 2000; Krueger, 2002).

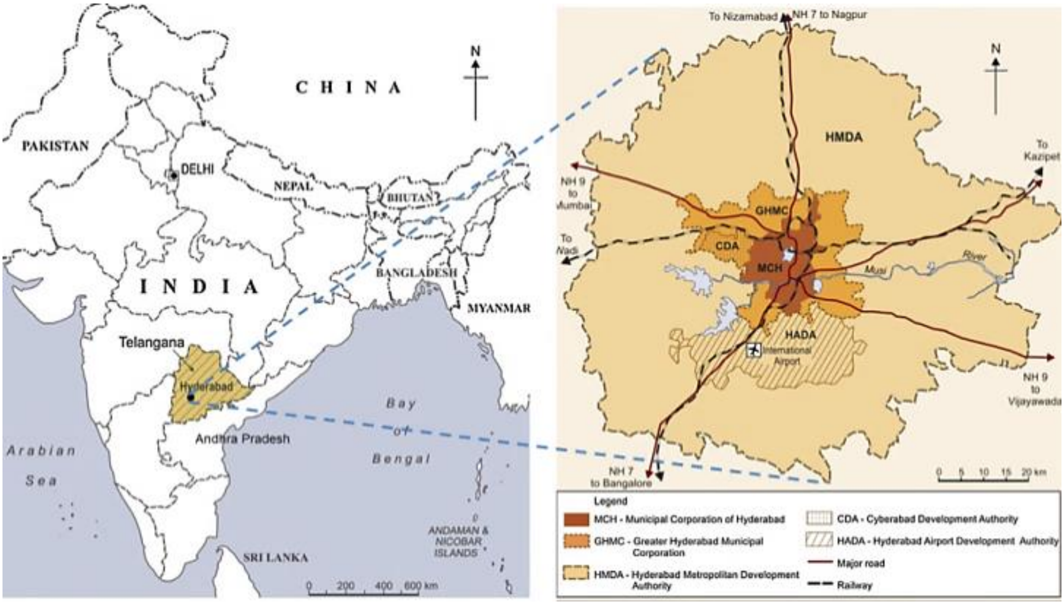

Figure 1: Map showing the location of the Hyderabad city region (study area), Telangana State

With the increasing regional growth of the city, there was also a necessity to structure and restructure the municipal bodies who were responsible to provide better amenities and development bodies who were responsible for planning and development of the complete region. The Municipal Corporation of Hyderabad (MCH) was initially the local body that was responsible for the provision of civic and infrastructure facilities to the inhabitants of the city, which covered an area of only 172 Km^2, it was transformed into the Greater Hyderabad Municipal Corporation (GHMC) which functioned similarly to the previous MCH, but was responsible for a larger area which covered 650 km^2, that included the core area (MCH region) and the surrounding 12 municipalities.

In addition to the transformation of civic bodies, the planning body Hyderabad Urban Development Authority (HUDA) was also formed as a body in charge of land-use planning, zoning regulation and infrastructure creation for the jurisdiction of GHMC. However, with

[2] Between 1980-1995, the State's economy, which was predominately agricultural, declined and the State government was forced to procure loans, drastically cut down the subsidies to welfare programmes, introduce new economic reforms to strengthen the structure of the economy to recover from the State GDP crisis and to regulate the fiscal deficit by prioritizing obtaining funds for the development of a tertiary sector.

the growth in the administrative boundaries of the civic body, the jurisdiction of HUDA also increased from 1,861 km^2 to 7,228 km^2 and the HUDA was replaced by the Hyderabad Metropolitan Development Authority (HMDA) to cater for the planning and development needs of the urban agglomeration of the municipal area and its surrounding 55 peri-urban areas (Das, 2015; GoAP, 2013).

Not only were civic bodies set up, but special development authorities were also created which included the Cyberabad Development Authority (CDA), Hyderabad Airport Development Authority (HADA) and Buddha Purnima Project Authority (BPPA). The duties of these authorities included planning and development of special infrastructure in delineated zones within the Hyderabad metropolitan region.

The Hyderabad region, especially in the territory sectors[3], became the focal point for the rest of the State for new developments, settlements, infrastructure, businesses, trading and political systems (Luther, 2006; Alam and Khan, 1972; Srinivasulu, 2002; Bunnell and Das, 2010; Moser, 2010; Sen and Frankel, 2005). It is currently the capital city of the Telangana State[4] and it is the shared administrative capital of the residual Andhra Pradesh for a period of the next 10 years (Das, 2015). This capital city, which projects itself as a smart, high-tech destination in India (PTI, 2014b) and world-class knowledge hub of information technology (Sen and Frankel, 2005) functions as a center for administrative activities, scientific research and an industrial, commercial and IT hub of the State. It also facilitates employment opportunities and acts as an economic growth center for the State. This promising status quo of Hyderabad city, with respect to industrialisation combined with new economic policies, resulted in rapid urbanisation and urban sprawl in a haphazard way (Dupont, 2007).

The structuring and restructuring of Hyderabad served only political purposes as opposed to administrative efficacy and balanced growth of the entire region (Ramachandraiah and Prasad, 2008; Naidu, 1990). It created adverse impacts on the environment and increased the burdens on the existing infrastructure, especially on the water supplies and security (Rao, 2007). This also led to challenges in providing adequate infrastructure by the civic and planning bodies to the proliferating population and to the expanding city regions (Das, 2015).

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[3] Includes IT-related services, biotechnology, tourism, logistics, healthcare and educational services

[4] Telangana officially became the 29th state of India which was bifurcated from the Andhra Pradesh state on June 2, 2014. The former Andhra Pradesh State was formed in 1956 with 3 distinct geographical regions, that were based on the dialect they spoke, namely Telangana, Coastal Andhra and Rayalaseema. Hyderabad was the capital of the undivided Andhra Pradesh for nearly six decades. However, due to the increasing economic backwardness of Telangana and the cultural domination of the people in the coastal area of Andhra, the people from the Telangana region demanded to be separated from Andhra Pradesh.

Drinking water conditions in Hyderabad city region.

The Hyderabad region, once popularly known as the "City of lakes," was blessed with thousands of water bodies which served its growing population for a long time. Since Hyderabad does not have any perennial rivers and has a low average annual monsoon rainfall[5] to feed into the available drinking water bodies within the city region, the drinking water requirements of the city residents were predominantly dependent on the naturally available resources like lakes and rivers which flowed at a nearby distance from the city (Lundqvist et al., 2003, Mukherjee et al., 2010).

Narain (2006) argued that Hyderabad received enormous amounts of rainwater and if strategically utilised, this could potentially cater for 35% of the domestic water demands (George et al., 2009). Nevertheless, over the past two decades, with the rapidly increasing urban population and the increasing size of the city, a water deficit for the city population became inevitable. In addition to this, there were localities in the city where the existing infrastructure was far below the required standards and the drinking water was contaminated (Ramachandraiah, 2002). This was mainly due to the discharge of untreated sewage waste, toxic waste and illegal encroachments of the water bodies which drastically reduced the quality standards of the water and caused insecurity of the available water resources.

The drinking water that was supplied through the taps was restricted to only two hours of fresh water on every alternate day (George et al., 2009; McKenzie and Ray, 2009). Consequently, this inadequate amount of water and the quality that was supplied by the service provider resulted in a dependency on private and ground water resources to cater for the day-to-day requirements; and the government agencies took on the task of looking for new water sources (Sahu, 2012).

The water policies and reforms that were adopted by the Hyderabad Metropolitan Water Supply and Sewerage Board (HMWSSB) did not pay the required attention to these problems for various reasons, they concentrated on innovative technological options in relation to water allocation and distribution in the city, like relying on rainwater harvesting approaches, water bodies' restorations and rejuvenation (Chakrabarti, 2001; Kumar, 2004; Narain, 2006). The most prevalent notion of water management for Hyderabad city region was to transfer a long-distance water supply to the city and distribute it there by means of pipes and tankers (Das, 2015). However, this not only drastically increased the cost of water per unit, it also resulted in huge losses due to transportation and building of pipelines for the water which increased the burdens of the city residents (van Rooijen et al., 2005; George et al., 2009). In addition to this, the proliferating demand for water in the Hyderabad region was aggravated by the rise in the number of slums and their continually

[5] The average annual rainfall for Hyderabad is 78 cm, Mumbai is 225 cm and Kolkata is 163 cm

increasing population, and the challenges of being able to cater for the basic needs of this population (Das, 2015).

Drinking water conditions in Slum areas of Hyderabad city region.

The unfavourable conditions of working in the agriculture sector in the surrounding areas of Hyderabad combined with the attraction of new employment in various jobs in the city influenced the population of the surrounding districts to migrate to Hyderabad for their livelihoods (Ramachandraiah and Bawa, 2000). However, due to the low income levels[6] of the migrated population, who were unable to afford the available housing within the city region, this in turn led to the formation of informal settlements which had limited or no basic infrastructure facilities (Rao, 2007; Afshar and Alikhan, 2002; Goli Arokiaswamy and Chattopadhayay, 2011).

In Hyderabad there were areas that had sufficient infrastructure facilities and services (Nastar, 2014). The aspiration to make Hyderabad a world class information society led to a fragmented metropolitan region with a wide range of disparities in terms of infrastructure distribution and quantity, quality and frequency of water supply (Baud and Dhanalakshmi, 2006; Das, 2015). However, the quality and quantity of water that was supplied was predominantly dependent upon the areas of economic and political importance (Saleth and Dinar, 2004; Sahu, 2012).

The disparities were not just regarding the provision of basic services, but also in the pricing of the limited services. The connection charges and tariff structures were defined by the government agencies who favoured only the affluent population (Whittington, 2003; Raghavendra, 2006; HMWSSB, 2008). This resulted in the supply of water at cheaper rates to the enormous consumers rather than the common citizens (Sahu, 2012; HMWSSB, 2008; Nastar, 2014). Several studies indicated that the slum population in Hyderabad payed more per drop of water consumption compared with the upper classes even though they were given the water at subsidised rates.

A high proportion of the wage of a lower income earner was spent on water compared to the proportion of income spent on water by middle and high-income groups (Foster et al., 2002, Whittington, 2003; Raghavendra, 2006; Water Aid, 2006; Davis et al., 2008; Kaminsky and Long, 2011).

Decreased water resources, inadequate water supply infrastructure and the lowered quality of the water, forced the residents of the region to buy drinking water. The affluent population, however, were able to pay for their needs, but the poor population who were

[6] It was estimated that an average monthly income for a member of the population living in the slum areas was 2,000 Indian Rupees (INR) about 26 US dollars ($) (per 20-04-2020)

dependent on water supplied by Hyderabad Water Board was greatly affected by the unsafe and insufficient quantity of drinking water (EBGH, 2009; IHS, 2006).

As a result of the unclean drinking water there was productivity loss, diseases and deaths that were recorded in various public and private hospitals due to unclean water (Ramachandraiah, 2004; McKenzie and Ray, 2009 cited in Nastar, 2014). In addition to the cost and access to clean drinking water, the lower income groups had to spend extra money on externalities, like doctor's fees and medication due to sickness, that were caused due to the unsafe and insufficient amounts of drinking water.

Although there were efforts made by the government agencies in terms of land tenure regularisation[7], improvement and development projects for the slum areas, there was unfortunately a lack of clear policy guidelines, which were combined with cumbersome procedures and negative political influences which became the bottlenecks that led to limitations and provision of basic services like drinking water by the service provider to these slum dwellers which in turn put pressure on the decision-makers of the concerned agencies (Robbins, 2003; Raghavendra, 2006; Greig et al., 2007; Bakker et al., 2008; Davis et al., 2008; HMWSSB, 2008; Baindur and Kamath, 2009; GIZ, 2013).

The conditions of slum areas in terms of the availability of these services was rudimentary, disparate and required WHO standards. The gap between formulation of strategies and the implementation of outcomes was ambiguous regarding how the water governance systems function, how the decisions were taken and what aspects were considered during the decision making processes in order to provide safe and adequate drinking water facilities and services.

1.4. Problem statement and significance

To date, there have been various household and community level projects to improve the water supply[8] in India and in particular in the Hyderabad city region. Many of them are still ongoing in order to meet the Sustainable Development Goals (SGDs) and the proliferating demands. However, although there was huge attention given to these issues both at the global and local levels, the water related challenges still persist, particularly in slum areas (or informal settlements). The lack of basic infrastructure facilities in order to provide safe and adequate drinking water has led to adverse consequences in terms of poor health, loss

[7] According to this policy, the tenure of all slum dwellers residing in the city for more than 5 years is regularized. This allows the government to be able to make slum improvements and introduce development projects / programmes to the areas

[8] The improved water supply is defined as piped water, public tap, borehole or pump, protected well, protected spring or rainwater. Improved water sources do not include vendor-provided water, bottled water, tanker trucks with water, or unprotected wells and springs

of work, decreased productivity and it has made the lives of the urban poor population even more difficult.

All of these consequences were against constitutional mandates and official proclamations that were developed throughout the world, including India, that recognise the importance of "safe[9], adequate[10], affordable[11] and accessible[12] drinking water" especially as a "right to life" and a necessity for the existence and well-being of any society (GoI, 1986; APPEN, 1998; Smets, 1999; ILR, 2001; Petrella, 2001; Sengupta, 2001; Sinha, 2001; UNESCO, 2002; United Nations, 2002; Venugopal, 2003; Ramachandraiah, 2004).

When structural adjustments and readjustments took place, there was also a shift towards the private sectors involvement in providing basic services for the poor sector (ISODEC, 2002). In addition to this, a strategic instrument, namely Public Interest Litigations (PIL), was also formulated that strengthened the power of the citizens and gave them more rights (ILR, 2001). From a human rights perspective, the decreasing access to these services signified a violation of human rights (United Nations, 1995; Gleick, 1999; ISODEC, 2002) and according the UN (1995) it was the states' responsibility to form laws and policies in a way that every citizen, without discrimination, shall have access to water (UNESCO, 2002; UDHR, 1948; Gupta et al., 2010; Meier et al., 2012; Gleick, 1999; Lisbon Principles, 2001). The right to water means access to adequate drinking water, that is not polluted (Ramachandraiah, 2004).

The right to water forced government agencies to be more aware of the situation and take the necessary steps to provide safe and adequate drinking water for all the individuals at affordable prices (Ramachandraiah, 2004). According to Smets (1999), having access to safe and adequate drinking water should reduce externalities like diseases which were caused due to unclean water.

Due to the new laws, various approaches, policies, institutional, technological and economic interventions and instruments were adopted (CPCB, 2013). Various decision making frameworks that had been based on water governance, management and assessment frameworks were proposed, with the intention of being applied throughout the world. Examples included:

- OECD Water Governance Indicator Framework
- OECD Principles on Water Governance
- Ten Building Blocks for Sustainable Water Governance

[9] Free from microorganisms, with an acceptable color, odor and flavor

[10] Approximately 50 liters or the minimum essential level of 20 liters per day per individual

[11] Without direct or indirect extra costs

[12] A regular and constant supply of water, without any waiting time to receive it and it must be available within the premises or immediate vicinity

- Global Water Governance
- Socio-Ecological Systems
- Integrated Water Resource Management
- Integrated Urban Water Management
- Integrated Rural Water Management
- Multi-Level Water Governance
- Polycentric Water Governance
- Analytical Hierarchy Processes
- Water Safety Plans
- Water Accounting
- Water Auditing

In Hyderabad city region, there is a need to create an easy-to-use model that incorporated factors that were specific to its urban poor communities in order to provide facilities and services specifically for these communities. Efforts to address water sector challenges in the past had shown that a single technological solution, economic tool or institutional setup in isolation cannot be applied to all water related problems and societies. There were no shortages of potential solutions to improve the water supply conditions within the urban poor communities. However, the criteria for selecting the appropriate solution(s) for a given community were not always clear and largely technical in nature.

A comprehensive analysis of the challenges pertaining to the specific communities needed to be carried out, which varied from place to place. Research on existing decision making frameworks and processes to provide drinking water services revealed that they had failed to adequately serve the water sector practitioners and inadequately achieved the objectives of sustainability, equity, effectiveness, efficiency and good governance. The existing decision making support tools or water governance frameworks did not fully take into account the regional variations, for example some of them only took the technical parameters into consideration. Technical analysis needs to include aspects such as:

- Soil conditions
- Social structure
- Existing services, including:
    - Infrastructure
    - Water quality
    - Quantity
- Analysis of what is required
- Possible strategies to address the prevailing challenges
- Broad overview of which institutional body/bodies is/are responsible for implementation, operating and monitoring

In addition to technical aspects, financial aspects such as estimates of potential costs that might be incurred to implement, operate and maintain the project were also necessary. Thus, both technical and financial aspects are important considerations that need to be taken into account in the decision making processes, which were challenging, especially in slum areas.

The research revealed that, during the researchers' research period, the current urban water systems decision making practices were socially, institutionally and economically unsustainable, especially in providing drinking water services for the urban poor population. Technical aspects were predominately taken into consideration, it could be argued that the most commonly missing aspects, which also played a crucial role in the decision making processes, were the social, institutional and economic aspects (Meena et al., 2008).

By drawing from debates on decision making processes, it is commonly recognised that a comprehensive analysis of social, institutional, technical and economic aspects pertaining to the communities are important. They need to be able to be integrated in a decision making support tool that allows the practitioners to be able to weigh the feasibility and effectiveness of all of the different solutions to make informed and effective choices (Meena et al., 2008). It is vital for urban practitioners, water administrators and relevant stakeholders to consider and assess different ways to provide fresh, clean drinking water in a systematic and integrated fashion in order to find implementable and impartial solutions, taking into consideration the technical, social, economic and institutional aspects pertaining to infrastructure facilities and services (OECD, 2015; Rijswick et al., 2014; Edelenbos et al., 2013; Meena et al., 2008; Biswas, 2005).

It is important to assess the social impact of what is proposed in order to make sure that the current inequalities are reduced to provide drinking water services and without the risk of building infrastructure facilities that people do not want and for which they are not willing to pay. The analysis needs to consider that the local population need to have control over their resources and that the end users are able to pay for it, that there is social cohesion in the process, no resources conflict and that it does not have a detrimental impact on the different age groups and genders.

It is also important to consider the economic aspects, the long-term sustainability of the strategies as well as the various communities' needs. If the communities cannot afford, or are not willing to pay for the solutions, then the water service infrastructure is more likely to fall into a state of disrepair and will not be sustainable (Meena et al., 2008). However, it is not only important to estimate the communities' willingness to pay for the solutions, but it is necessary to estimate the burdens on communities' in terms of costs that are able to be reduced. An ideal decision making support system needs to include all of these necessary elements in order to implement a water project to reduce the current burgeoning challenges (Meena et al., 2008).

However, it is a significant challenge to include all of these aspects in the decision making support system, which requires concrete efforts from institutions so that they are able to be implemented. To be successful, it is vital to understand, analyse and transform the existing institutional set-up that is responsible for the service delivery. The analysis needs to consider the existing formal and informal stakeholders, financial aspects, existing policies and projects and their role within the decision making processes.

Focusing on bottom-up approaches, this research draws its attention to the possibility of building a systematic process of decision making through integration of social, institutional, technological and economic analysis which aims to improve the living conditions of the entire metropolitan regions in a balanced way through developing integrated solutions that are best suited to each context (Pethe et al., 2014; Ballas, 2013; Baud and Dhanalakshmi, 2006).

The integration of the aforesaid aspects of the decision making process has been negligent (Meena et al., 2008), especially in the provision of safe and adequate drinking water services to the slum areas. Having identified the gaps in decision making support systems in improving the drinking water conditions, the new integrated approach is intended to guide the organisations and individuals to make sustainable improvements to the community water systems (Meena et al., 2008).

The water sector practitioners in developing countries, in order to resolve the escalating challenges effectively, efficiently and in a comprehensive manner, need to include the following design tools: *socially fitting, economically viable, technically suitable, institutionally capable*, to cater for the needs of the communities (Meena et al., 2008). This needs to address the needs and be able to guide the policy makers to make appropriate water strategies, which are sustainable, equitable, effective, efficient and have good governance (DFID, 1998).

1.5. Research objectives and questions

In this research, the study focused on the assessment of (drinking) water within slum areas in a selected metropolitan region in India, namely Hyderabad city region and the decision making processes that Hyderabad Metropolitan Water Supply and Sewerage Board (HMWSSB), the service provider, had adapted to provide drinking water facilities and services for the slum areas in the Hyderabad city region.

The study started by analysing the regional variations, which included forming a perception of the slum households and then making laboratory test observations of the drinking water that had been supplied to the slum areas to identify specific parameters, that were comprised of the quality, quantity and existing infrastructure aspects pertaining to the drinking water that was supplied by the service provider. The study also compared the results with the standard quality and quantity of drinking water in India to identify the disparities or similarities.

The study also analysed the perceptions of slum households and stakeholders at the institution, service provider level, in order to identify the parameters determining the decision making processes that were followed at the Institution (service provider) level to provide safe and adequate drinking water facilities and services. Based on the findings and relationship analysis between the quality and quantity of drinking water and the decision making processes involved to provide the drinking water facilities and services, the study intended to confirm or modify the conceptual framework to involve the aspects pertaining to it in a systematic and integrated decision making process to provide safe and adequate drinking water to the urban poor population.

This preliminarily involved social, institutional, technical and economic aspects and then appended or rejected other aspects identified during the field study. Based on the above, the research focused on the following overarching research question: ***What factors influence, positively (or negatively), in the systematic and integrated decision making process, to provide safe quality and adequate quantity of drinking water for the urban poor population.*** This main research question was further bifurcated into the following sub-research questions:

a. What is the quality and quantity of drinking water from different sources in urban slums.
    - During this phase of the proposed study, different sources of drinking water were identified based on the perceptions of slum households
    - The perception of the quality of drinking water was analysed
    - The actual physical quality of the drinking water was analysed in the laboratory based on the drinking water samples collected from the different sources of drinking water used by the slum households
    - The quantity of drinking water supplied through the sources was quantified
    - Then, a corresponding pattern analysis was used to identify the similarities or dissimilarities amongst the slum areas in terms of quality and quantity of drinking water supplied through different sources

b. What are the factors determining the decision making process to provide quality and quantity of drinking water in urban slums.

    During this phase of the research study:

    - The overarching decision making processes were identified

- Identification of the service provider(s) who provides the drinking water facilities and services to the slum areas.

These were identified through interviews and discussions with the stakeholders at an institutional level.

- Which factors were considered during the decision making process to provide drinking water facilities and services to the slum areas.

These were also identified based on interviews and discussions with the stakeholders at Institutional level.

- What the perception of slum households on decision making procedures of the government agencies to provide drinking water facilities and services was identified

This was based on household interviews and focus group discussions in the slum areas.

- Identifying similarities or dissimilarities amongst the perceptions of slum dwellers households
- Institutional level stakeholders’ analysis of the factors considered and found to influence the decision making processes

c. What is the relationship between the decision making process and the quality and quantity of drinking water.

This phase of the research focused on:

- Identifying the relationship between the quality and quantity of drinking water at slum area level
- What factors that were considered during the decision making process(es) to provide drinking water facilities and services to the slum neighbourhoods
- Identify the significant and less significant factors, such as social, institutional, economic and institutional factors and other factors that were identified during the field study that were considered during the decision making process(es)
- To determine the quality and quantity of drinking water at slum area level
- The final stage of the research analysis confirmed or modified the conceptual framework, this was based on the factors determining the quality and quantity of drinking water at slum area level

The intention of this research study was to develop a governance framework through considering the economic, social, institutional and technical aspects and any other relevant characteristics, that supported the reduction of the negative externalities and to improve the outcomes of the decision making processes. The involvement of the stakeholders, both societal and institutional, in policymaking including economic and technical perspectives regarding all of the issues have been included in the decision making processes in order to reduce the environmental impacts and make the entire process sustainable.

As mentioned, this drinking water study has been approached from various perspectives including social, institutional, technical and economic in order to be able to adequately embed a sustainable approach into an already existing system. Using the wide range of perspectives enabled the possibility of studying possible unforeseen links and in turn being able to embed the "new" approaches within the existing decision making processes in a systematic and integrated way.

a. Social Perspective - The social perspective analysed the social determinants of health (socio-health) impacts of the existing and future policies and included the peoples' participatory roles and perspectives within the decision making processes.

b. Institutional Perspective - An institutional perspective looked at the institutions involved and their policies.

c. Technical Perspective - The existing institutional processes and structures were analysed using a technical perspective, by analysing the resources, requirements and engineering aspects of the drinking water.

d. Economic Perspective - The economic perspective involved analysing the monetary values of drinking water

It should be noted that the research did not aim to develop a new method or overlay the existing valuation methods. Also, this research did not aim to provide an improved measurement or identification of the right, or proper values of drinking water. The research developed a new approach to the valuation processes. It has developed a new structuring procedure which has integrated existing and proven techniques and methodologies. The research intention was to add to already existing methods of (e)valuation[13].

[13] Valuation is an estimation of an object's worth, while an evaluation is an assessment of its worth

The framework for the Societal-Institutional-Technical-Economic (S.I.T.E.) valuation needs to take into account the social, institutional, technical and economic aspects in the decision making process, regardless of what these values may be.

This new framework has been tested using structural equation modelling to identify the interplay between the aspects, in order to evaluate the challenges and bottlenecks within a selected population in a specific metropolitan region in India.

To be able to do this the process needs to identify and analyse the stakeholder involvement in the decision making processes, to identify and analyse the social-health (impact) assessment in decision making and the decisions made, to analyse the technical values of the actual drinking water and to analyse the economic values of the problems caused due to providing drinking water. Which in turn helps to make policies that will be designed in a way to reduce the environmental costs of unsafe and insufficient drinking water.

By using the new evaluation framework in a scenario of processes-to-be-developed and integrated into water management and policy making for governing authorities in urban spaces to achieve the environmental objective of: *"sufficient clean drinking water for everyone, at a cost-effective price as well as being sustainable"*

1.6. Scope and Structure of the study

This section provides the structure of this document and navigates the reader step-by-step through the various sections of the research by giving an overview of each section.

Research setting.

The research setting took into account the problem statement and research objectives, it then focused on the drafting the decision making framework as a theoretical model to provide drinking water facilities and services to the slum areas and looked at possible settings for this research, based on literature review and secondary research. It was then decided to choose the slum areas which were located in the Hyderabad city region of Telangana State, India.

In order to facilitate the household level interviews within the slums and stakeholder interviews at an institutional level and also to ensure the sampling group was effectively representing the entire slum population or areas in the city region, the Hyderabad city region was systematically categorised into eighteen different circles for administrative purposes by the Development Authorities of Hyderabad, India.

From each circle, two slum areas were selected based on selection criteria. The section criteria included:

- What was the status of the area?

- What was the status of the slum area?
- Which agency was responsible for providing infrastructure facilities?
- Which agency was responsible for providing services?
- Were the slums tenable?
- What was the availability of all water related infrastructure facilities?
- What was the availability of all water related services?
- What were the characteristics of the slum population or households?

Thirty-four (34) slum areas were selected to be included in the study. This was because there was one circle which did not have any slum areas. The numbers of slum areas selected were both geographically and statistically representative in nature.

Population and sampling group.

The following three sets of sampling groups were chosen for the research:

a. Slum households within the slums (slum area level)
b. Drinking water samples within the slums (slum area level)
c. Stakeholders at institutional level

The population of this study refers to the slum residents in the selected slum areas located in the Hyderabad city region. The entire population in the slum areas, at the time of research in Hyderabad city region was more than 190,000 people. Therefore, the sample size for this study was taken based on statistically significant values, which were 10% of the total number of households in each of the selected slum areas.

Due to the limitation of resources, in both time and money, only one sample of drinking water was collected from each source of drinking water. The sources were:

- Household tap water
- Public tap water
- Water from a bore-well or hand-pump,
- Water from water tankers
- Bottled water

The water samples were collected from 50% of the selected slum areas, which were 17 out of 34 slum areas from each circle in order to achieve geographical spread and sufficient representation.

The study also involved interviewing stakeholders from various institutions who were responsible for providing drinking water facilities and services to the selected slum areas. Stratified random sampling was used to select the various stakeholders from the identified institution which was the Hyderabad Metropolitan Water Supply and Sewerage Board (HMWSSB). Out of 31 identified stakeholders, 21 were interviewed at an institutional level.

The entire study was solely conducted by the researcher using a random sampling technique for both the slum residents, who were at the time of research living in the selected slum areas and the stakeholders at institutional.

Research instruments.

Three primary research instruments were invented, specifically intended for this study, in order to conduct field level data collection and discussions. The instruments were developed based on the integration of multidisciplinary concepts and the study and context specifically, to understand the quality and quantity of drinking water and the decision making procedures that were followed to provide drinking water facilities and services to slum areas in Hyderabad city region.

As the drinking water quality and quantity and decision making procedures involve a measurement of physical conditions and the perceptions of the respondents, that needed to be collected very accurately, each research tool was meticulously designed for its distinctive purpose and with the ability of being fully practical in the field. The three instruments that were invented in this research are described below:

a. Drinking water quality and quantity assessment. This research assessment tool was designed to collect demographic information, perceptions of households pertaining to quality and quantity of drinking water from various sources in the slum areas in the Hyderabad city region. The tool was also designed to collect the quantitative aspects pertaining to drinking water quantities to be able to perform expert level assessments. In addition, the tool was also designed to collect the data regarding the effects and consequences in lieu of poor drinking water quality and quantity.

b. Decision making procedures assessment. This research assessment tool was designed to note the perceptions of households at slum area level and the stakeholders at institutional level regarding factors that were considered important during the decision making procedures to provide drinking water facilities and services to the slum areas in the Hyderabad city region.

c. Drinking water quality testing. This research assessment tool was designed to record the laboratory test results of the drinking water samples collected from the slum areas in the Hyderabad city region and analyse the drinking water quality with respect to microbiological, chemical and physical parameters.

Research procedures. Since the research aimed to explore and reveal the perceptions of drinking water quality and quantity and identify factors influencing the decision making procedures in order to provide drinking water facilities and services in the slum areas of Hyderabad city region, the procedure for this study was carefully designed to achieve the research objectives.

a. **Literature and secondary data review**. The objective at this stage was to collect and study the literature and secondary data which was derived from reliable sources pertaining to the research objectives and the context of the topic.

b. **Operationalizing variables and research instruments**. During this phase of the research the following steps were taken:
   - The conceptual models were developed based on the facts and knowledge that was extracted from the literature and secondary data review.
   - Background data was collected, which involved finding factors that were associated with systematic and integrated decision making to provide safe quality and adequate quantity of drinking water to the slum population which was deduced from the theoretical concepts.
   - Variables and indicators associated with the conceptual model were developed.
   - The approach and methodology to be followed in order to arrive at the desired results was developed.
   - The units and sub-units of measurements that were to be analysed were finalised during this stage of research study.
   - Research instruments were developed in order to assess the variables and indicators defined in the theoretical framework and in the sample study areas.

c. **Finalising research instruments**. During this phase of the research the following steps were taken:
   - The conceptual models were developed based on the facts and knowledge that was extracted from the literature and secondary data review.
   - Background data was collected, which involved finding factors that were associated with systematic and integrated decision making to provide safe quality and adequate quantity of drinking water to the slum population which was deduced from the theoretical concepts.
   - Variables and indicators associated with the conceptual model were developed.
   - The approach and methodology to be followed in order to arrive at the desired results was developed.
   - The units and sub-units of measurements that were to be analysed were finalised during this stage of research study.
   - Research instruments were developed in order to assess the variables and indicators defined in the theoretical framework and in the sample study areas.

d. **Detailed interviews focus group discussions and sample collection**. During this phase of the research the following steps were taken:
   - Full-scale interviews were carried out, both in the selected slum areas and at the institution(s)
   - Focus group discussions took place, both in the selected slum areas and at the institution(a)
   - A multi-stage sampling technique was applied.
     - Firstly, a selection of criterion including a cluster sampling technique was applied to define the thirty-four slum areas as part of the research setting.
     - Secondly, a simple random sampling technique was applied to administer the research instruments in the selected slum areas. Similarly, the drinking water samples were collected from all the sources of drinking water from the selected slum areas using a simple random sampling technique.
     - Thirdly, a stratified random sampling technique was applied to administer the research instrument in the Institution(s).

e. **Data analysis**. During this phase of the research the following steps were taken:
   - The entire collection of data was categorised and analysed by different methods depending on the type of data, with a focus to answering the research questions.
   - The analytical procedures applied in this stage were significantly qualitative in nature.
   - A comparative analysis was carried out based on the results pertaining to all the variables which were defined in the theoretical framework.

f. **Summing-up research report**. In this final phase of the research, the following steps were taken:
   - The results of the study were discussed.
   - The acceptance or rejection or modification of the theoretical framework was also summarised and communicated in the form of this document.

The figure 2 below illustrates the outline of this research document. The stage 1 introduced the research study by setting the context of the research by formulating the problem statement, research objectives and questions that steered the research study. The stage 2 then focused on theoretical background and framework that discussed systematic and integrated water governance. Going forward, the stage 3 detailed out the research design, strategy and methods to operationalise the independent and dependent variables defined in stage 2. The stage 3 also focused on defining the unit and sub-units of analysis and identified the case studies based on the case selection criteria. This chapter also focused on designing the questionnaires and checklists for data collection. These questionnaires and checklists were tested on pilot case studies and rectified for final roll-out to all the identified case studies. The stage 1, 2 and 3 were primarily based on literature and secondary data review. The next stage 4 of the research study focused on data collection on full-scale. The stage 5 focused on presenting the data analysis of both dependent and independent variables, based on the data collection using research instruments. The analysis focused on people's perception and expert's judgement on drinking water quality and quantity, and people's perception and stakeholder's perception on decision making frameworks. The stage 5 also focused on presenting the relationship between the independent and dependent variables. The stage 6 finally concluded by presenting the answers to the research questions, reflections on conceptual framework, value addition to existing literature, pragmatic recommendations and potential areas for future research.

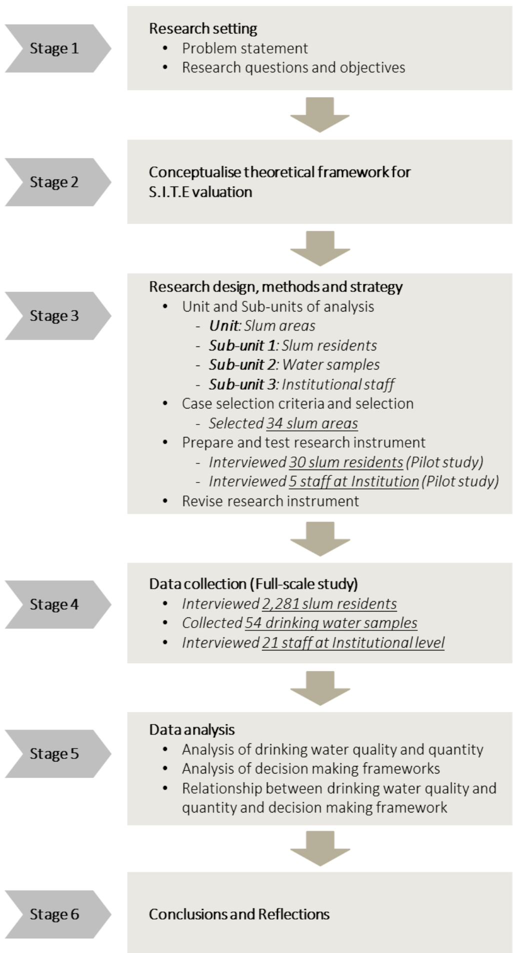

Figure 2: Outline of the thesis

Chapter 2

Valuation Framework – A Conceptual Model

Chapter 2 | Valuation Framework – A Conceptual Model

2.1. Water Crisis

Demands, withdrawals and consumptions.

In recent past decades, it was evident that the treasured gift "water" has undergone devastation with impunity (Panjabi, 2014). World-wide, there have been societies with proliferating populations, rapid industrialisation and urbanisation patterns, growing economies, changing lifestyles and cultures, shifting diets and man-made infrastructures which have had an influence on the water resources with varying water demands, usage and consumption patterns (Kathpalia et al., 2002; Fishman, 2011; Panjabi, 2014; Shiklomanov and Rodda, 2003; Bigas, 2012; Vaux, 2012; Solomon, 2010; Tucci, 2008; Jose, 2008; Lerebours, 2017).

The wide-ranging and significantly increasing water demands and usage for a diverse set of purposes (consumptions) typically include domestic, manufacturing, construction, agriculture, energy and recreation (2030 Water Resources Group, 2009; Lux Research, 2008; DOE, 2017; WEF, 2009; Bellie, 2011; Guppy et al., 2017; Jury and Vaux, 2007; Vaux, 2012; Solomon, 2010; Bigas, 2012; Panjabi, 2014).

According to Curmi et al (2013), the agriculture sector is water heavy (70% of total global water demand, but about 90% in some countries), followed by energy with 12%, and the domestic purposes with 10% of total global water demands, and so on. All of these sectors are important and interlinked producing an overall economic growth at local, regional and global levels (World Bank, 2010; Roger et al., 2015; Jose, 2008; Bhatia and Bhatia, 2006; Lerebours, 2017). It is extremely difficult to lessen the quantities of water given to each sector as they do not remain static and every sector needs its share of water (Vaux, 2012; Bigas, 2012). Citi Research (2017) and Gleick (2000) highlighted this, they noted that considering the trends, the demands for water from every sector were expected to increase and they predict that this will have significant impacts on the already stressed water resources and eventually on every sectors economic and human growth across the world, if it is not managed appropriately by the water management institutions.

Resource Availability.

Water is the foundation of societal development; it is vital for human survival. There were many ancient civilisations that were largely riverine in nature and water is treated as a divine element in many cultures (Panjabi, 2014). Contemporary societies and economies were shaped and have adapted to the availability, per region, of the water resources. Studies have shown that the availability of water resources is lower in the regions with a higher amount of the global population and vice versa.

For example, Asia is home to 60% of the global population it has only 33% of global freshwater resources, followed by Africa with 16% global population and 10% of global freshwater resources. Whereas, North America, which is home to only 5% of global population has 29% of freshwater resources, followed by Latin America with 9% global population and 16% of global freshwater resources (Curmi et al., 2014; Hejazi et al., 2014; United Nations, 2019; Citi Research, 2017; Lloyds, 2010).

The Figure 2 below illustrates the percentage share of global population and freshwater availability across different regions in the world (adopted from Citi Research, 2017). A closer look at the statistics showed that the regions with the least amount of freshwater resources are the emerging regions that have higher water consumption and demand patterns, together with rapid economic growth, profound poverty and insufficient infrastructure facilities.

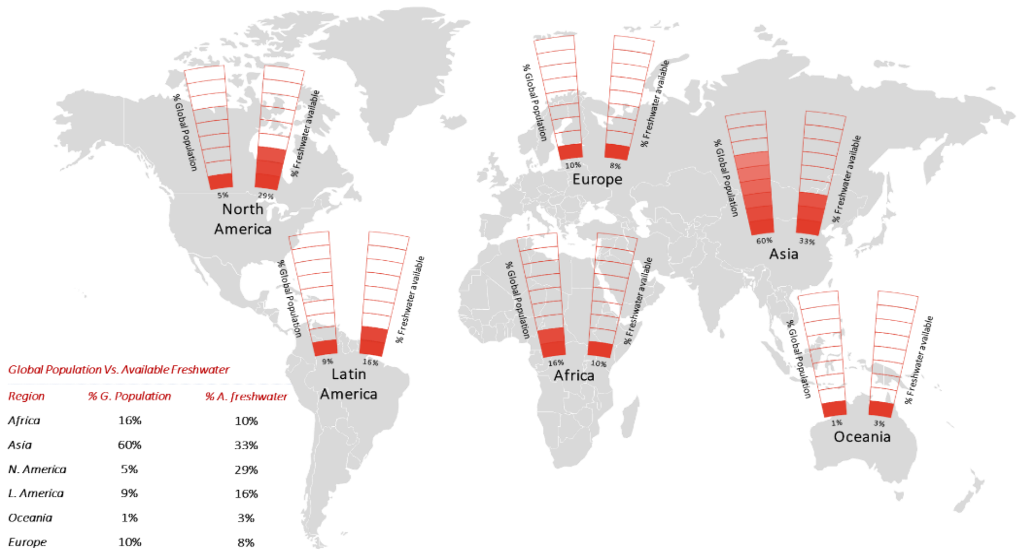

Figure 3: Percentage share of global population and freshwater availability across different regions

India, which is one of the emerging countries in the world, currently is a continent with about 17% of the global population but only has 4% of the global freshwater resources (Chakraborty and Mukhopadhyay, 2014). Considering the past trends and the current conditions, it is forecasted that by 2030 the water demand in India will be doubled, resulting in a severe water scarcity for millions of people, which will eventually have an effect on the sectoral growth and overall country's GDP (Niti Aayog, 2018).

Regional disparities of freshwater resources have aggravated these concerns. India has dissimilar spatial distribution patterns with limited available freshwater resources. All the perennial and seasonal freshwater sources, such as: Kaveri, Krishna, Godavari, Narmada and Tapti rivers, flow across India serving the needs of millions of people for multiple purposes. Each source is yearly decreasing in its total volume and they no longer reach the oceans or seas in the low rainfall or dry seasons.

The inflows of domestic and industrial effluents into these stressed resources aggravated the pollution levels, turning the natural resources inconsumable. The proliferating demands have also affected the ground water levels, which act as the main water sources for various societal purposes, particularly for domestic purposes and irrigation. According to Niti Aayog (2018), it was estimated that about 40% of the total water supply was from ground water sources.

Over the last few decades, the ground water exploitation has been unsustainable, leading to a demand and supply gap of about 50%. It is also important to note that it was not only the availability of resources that had regional disparities, even the unsustainable withdrawals of water resources had regional disparities. There are regions in India with higher water exploitation rates than other regions (FAO, 2016; Chakraborty, 2017; Planning Commission, 2013). This combined with (global) climate change, disturbances in the hydrological cycles and regional effects are leading to detrimental consequences pertaining to drinking water challenges for the societies in India (Kathpalia et al., 2002).

Finding other sources.

Our planet Earth, though it comprises of 70% of waters (approximately 1.4 billion cubic meters), about 2.5% (35 million cubic meters) is suitable for human consumption purposes. The residual is in the form of oceanic salt water and saline ground water. Out of the 2.5% fresh water, about 0.26% (90 thousand cubic meters), is currently available in a multifaceted system, the surface water and ground water are the main sources, which are readily usable, for the above-mentioned human demands and consumption patterns.

The residual water is inaccessible to humans, as it is in the form of glaciers, snow covered mountains and deep ground water resources. According to Gleick (2006) and Lloyd (2010) global water consumption is only a fraction of the water that is available approximately 0.01% of the limited available fresh water. Thus the "limited" water resources are "not actually limited" and managed correctly could cater for the desires of the growing population and their demands. UNDP (2006) and HDR (2006) have also claimed that the real concern pertaining to the water crisis is not the physical availability of water, but the authorities governing the available water, poverty and inequality.

Looking through the lens of bio-physical notions, the concept of "limited" resources is associated with naturally occurring hydrological cycles such as droughts and low rainfall. From an anthropogenic viewpoint, the concept of "limited" resources or "water scarcity" is linked to human perceptions in terms of inadequate access to water sources (Mehta, 2001). Despite having various viewpoints and measures to understand if the resources are limited or not, it is evident that there has been overuse and abuse of these resources, which has caused a disturbance in the natural capacities of water to recoup (Kathpalia et al., 2002). There are many studies which have argued from different perspectives and have used different measurement scales to state the above-mentioned scenarios as water scarcity or "limited" resources (Pallett, 1997; Falkenmark and Rockstrom, 2004; Swatuk, 2002; Rockstrom, 2001).

It goes without saying, life finds ways to survive. Similarly, human beings always find ways to tap resources to survive. Despite disparities in the availability of water resources, the population is not only dependent on locally available fresh water or any one resource. During the pre-industrial revolution, the regions were predominantly dependent on locally available water resources for societal developments. Post industrial revolution, with the advent of new technology and infrastructure developments, the existence of virtual global water transfers, trade and global hydro-commons was prominent for the primary and secondary regions that depended on multiple sources of water resources. A primary region is dependent on the water resources that are available in their own (primary) region. Secondary regions are further away from their own primary region. (Hoekstra and Chapagain, 2008; Hoekstra and Mekonnen, 2012; Allan, 2003).

This can be stated as adaptive capacity in the social construct, and moving away from natural construct, i.e., the societies finding new ways to resolve their water non-availability. This is the ability of the societies to overcome the water issues. Sometimes the societies get accustomed to the natural construct, i.e. limited water resources that are locally available, without depending upon other sources (Ohlsson, 2000; Winpenny, 1994; Mehta, 2001).

What often occurs, over a period, is that the primary regions not only exploit the locally available resources, but also exploit the water resources that are available in the more distant, secondary, regions. Thus, any stressed water resource, in particular, the primary region is not only affecting the growth of the primary region, but also the secondary regions globally.

The sharing of these limited water resources amongst inter- and intra-regions and the continuous dialogues between the administrations for the same resources is not always a smooth journey. In the first place, these water resources are typically regional assets which are unable to be transferred or transported physically with ease and it is only feasible for certain distances at significant costs and efforts and large-scale infrastructure (Lloyds, 2010).

Secondly, studies have also pointed out that the concerns and tensions, also commonly known as water wars or conflicts, between various stakeholders, which can include individuals, corporations or political bodies, regarding water resources and related infrastructure developments are used as instruments, showing dominances by the water "haves" over water "have-nots", which are involved in political and ideological differences

(Gleick, 2004; Solomon and Turton, 2000; Postel and Wolf, 2001; Iyer, 2007; Swain, 2011; Uprety and Salman, 2011; Wolf, 1999; Prud'homme, 2011; Dinar, 2004; Bigas, 2012; Panjabi, 2014).

These water wars are worsening in developing and underdeveloped regions. For instance, India faces water conflicts both within the region, such as between Tamil Nadu and Karnataka, Andhra Pradesh and Telangana and also with the adjoining countries such as Pakistan, Bangladesh and Nepal. Various reports point out that there are more than 100 areas in India with unsettled raging water conflicts which include disputes and disagreements pertaining to equity in usage patterns, allocations, quality, resource mining and construction of infrastructure such as dams, reservoirs, canals and bridges (Niti Aayog, 2018).

Disparities.

At present, the world's population reached 7.7 billion people (United Nations, 2019). It is estimated that there will be a population growth of 30% between 2000 and 2025 and 50% between 2000 and 2050, the population is expected to grow up to 9.5 billion people by 2050 raising legitimate concerns about sufficiency levels of water resources (OECD, 2012; WHO, 2012; Gleick and Palaniappan, 2010; Srinivasan et al., 2012).

Past trends and projections on population and water demands or requirements determine the regional variations in terms of issues pertaining to the water resource crisis, competition, controls, regulations and conflicts over accessibility and equitable supplies or allocations of available water resources (IUCN, 2014; Srinivasan et al., 2012; Gleick, 2004; Gosselin et al., 2010). According to Curmi et al (2013), the total water demand in Asia is close to 2,500 Km^3, followed by North America about 500 Km^3 and the total water demands in Europe, Latin America, Africa and Oceania are below 500 Km^3. Despite of the large quantities of water demand, the studies signify that the total global water withdrawals are only a fraction, approximately 0.01% of the total available fresh water (Gleick, 2006; Lloyd, 2010).

According to Solomon (2010) there are differences in regional developments that are increasing with the variations in the availability and supply of adequate water. Although there are sufficient levels of water resources, the disparities in terms of having access to water for life and livelihoods are rampant (UNDP, 2006; HDR, 2006; Roger et al., 2015). The evaluation reports on the Millennium Development Goals (MGDs) which assess the progress of the levels of water resources, stated that more than 200 million people have access to improved water facilities and services over last 10 years, thus about half of the world's population is without sustainable access to adequate and safe drinking water. They also pointed out that there are also disparities in providing improved drinking water services in certain regions. For example, a significant proportion of the population in China have improved drinking water services, however in African a significant proportion of the population is without improved drinking water services (Roger et al., 2015).

In general, there has been an increase in the total number of populations with improved services on a global scale, but this has shadowed the regions where the improvements were negligible. Within each of these regions, with the increasing competition to provide drinking water facilities and services, the poorest and marginalised communities are at highest risk being most affected by unimproved drinking water services (Roger et al., 2015).

On a global scale, the current estimates indicate that about 1 billion people are currently without access to safe and reliable water supplies. However, this situation is even more disturbing in the emerging countries where they have higher population growth rates and water demands and limited accessibility to water to meet the basic needs of their population. Currently, there are millions of people across the developing and underdeveloped nations without access to safe and adequate drinking water (WHO, 2012; Gleick, 2007).

As in case of India, which is a land with various emerging cities and towns, who are also significantly suffering from water related issues such as poor availability, access to and supply of safe, quality and adequate quantities of drinking water facilities and services, particularly in the rural areas, tribal areas and within the urban poor population which includes children and women.

It is estimated that at present there are more than 600 million people facing water stress and deaths of up to 200 thousand per annum due to poor access to safe and adequate drinking water. Further, the households have to spend longer durations in looking, travelling and collecting only limited quantities of quality drinking water from different sources resulting in loss of working hours, loss of income, loss of health and an increase of household level conflicts (Niti Aayog, 2018; Planning Commission, 2013; WSP, 2007; Wutich, 2013; Chakraborty, 2017).

These disparities in the availability of safe and adequate drinking water facilities and services are not only physically affecting the people, but it also has an emotional effect on the well-being of the populations, particularly the people who have a limited supply of water or no water facilities and services.

Jury and Vaux (2007) estimated that there will be an increase from 29 to 48 water stressed countries between 2000 and 2025, with more than half of the countries being emerging nations (Roger et al., 2015). In terms of population sizes, it is estimated that there will be an increase from 450 million to 2.9 billion between 2000 and 2050 who will suffer from water related issues. Currently, the total population in towns and cities is about 3.9 billion and this is expected to increase to 5 billion by 2030 (Citi Research, 2017). It is estimated that by 2050, over 40% of the World’s population, particularly in emerging cities and towns will have water related issues, if not appropriately managed (OECD, 2012; Biswas, 2006; Biswas, 2009; Gleick, 1993; de Villiers, 1999; Barlow, 2007; Clarke and King, 2004). The box 1 below illustrates the key water related initiatives which have been developed over a period of time across the world including India to manage the burgeoning water related issues.

Box 1: Initiatives within the water sector

Considering the above-mentioned concerns pertaining to the water crisis and water governance crisis, there have been major efforts that have taken place across the globe within the past few decades in the water sector to influence the policy makers and urban administrators in preparation and implementation of policies, laws, regulations of water management and improving the knowledge base.

Some of the significant water initiatives have included the International Hydrological Decade, International Hydrological Programmes, International Drinking Water Supply and Sanitation Decade, Berlin Rules, Helsinki Rules, UN Watercourses convention and World Water Forums. These water initiatives have largely focused on the development of associations, councils and institutions and conducting conferences for better stakeholder participation, network building, developing a knowledge base (scientific, application, education and innovations), regularisation of observation instruments, capacity and awareness building activities, initiatives to improve access to water, preparation of principles, laws and rules (Varady and Iles-Shih, 2009; Biswas and Tortajada, 2009; ILA, 1966; Bourne, 1996; Salman, 2011; McCaffrey, 1998; McCaffrey, 1992; ILA, 2004; Salman, 2007; McCaffrey, 2001; Ait Kadi et al., 1997).

There are scientific theories that have significantly gained importance in recent times that primarily dealt with large scale problems within the water sector namely the complex system theory and the network theory (Cilliers, 1998; Cilliers, 2001; Cilliers, 2000b; Watts, 1999; Buchanan, 2000; Albert & Barabási, 2002; Newman, 2010).

Previous water related initiatives in India. India has encountered water related problems for many years and urban administrators within the country have developed and implemented many initiatives to address India's water-related issues. Some of the major initiatives taken at country level include the Central ground water board in 1970, who integrated the watershed management program in 1999, National water policy in 1987, 2012, Water laws which have been made in different periods and the National Water Mission.

All of these initiatives typically included resources quality and quantity reports, conducting programs and educating the public, managing projects with a focus on integrated water resource management, guiding and coordinating with various stakeholders to frame the solutions with a focus on sustainability, the amount of consideration given to the impacts of climate change on water resources, developing knowledge repository, laws and regulations with special focus on human rights to water. The 11th and 12th schedules of 73rd and 74th Constitutional Amendments in India aimed at strengthening the local governments with an objective to transfer the powers of urban and rural water management and service delivery.

2.2. Water Governance Crisis

Challenges in water sector: it is more than a technical issue; it is a governance issue.

Regardless of the various arguments, perspectives, measures and initiatives that have been used to address the water crisis, as mentioned in the previous section, it is pertinent that the water resources are limited; however, there should be enough to meet the demands of mega-trends, such as urbanisation and population growth.

The resources are under severe threat of human activities like the dumping of sewage in the fresh water which can lead to water stress and crisis and in turn have an effect on the growth of the populations. Although significant efforts have been made in last few decades in engineering and infrastructure developments and investments, the traditional top-down governance and water-centric management approaches with the below mentioned traits or shortcomings have continued to have a limited water problem solving efficiency (Teisman et al., 2013; Tripathy, 2015).

The most common water governance and management challenges which has been noted by many sources can be broadly classified into "core" challenges emphasising stakeholders and agencies; and "peripheral" challenges emphasising other functional areas relating to the water sector (Teisman et al., 2013; Lubell and Lippert, 2011; Castells, 2000; Sabatier et al., 2005; Tropp, 2007; Leach and Pelkey, 2001; Edelenbos and Teisman, 2011; Edelenbos, 2010; van Schie, 2010; Cooper, 2018; Cooper, 2018). The following detail the key challenges -

a. Core challenges. The core challenges include, but are not limited to, the lack of participation and co-ordination between various stakeholders at different levels, including social and gender discrimination and agencies and lack of coordination mechanisms. This is further worsened by inadequate technical and managerial capacities of various stakeholders and agencies and human resources. In addition, within and amongst these agencies due to isolated and non-appropriate structures, procedures, regulations and legislation, there is a lack of clarity in roles and responsibilities, there are fragmented and duplication of roles and responsibilities and limitations in terms of fuzzy functionality and geography. Due to these conditions, there are overlapping and often conflicting interests of various agencies with no long-term objectives. The rise of informal players in this whole cluster of challenges and perpetuating inequitable power relationship infested water system management can also be unexpected and troublesome.

b. Peripheral challenges. The peripheral challenges include, but are not limited to, having a water-centric approach to solving the problems by non-consideration, non-cooperation and non-integration of various functional domains with a common responsibility and objective such as agriculture, engineering, technology, health, energy, resource planning, spatial planning and development, regional development, social development, economic development, climate change and financial planning to handle water related issues. In addition to these shortcomings, NITI Aayog (2018) also highlighted that due to a lack of reliable and adequate data this created hurdles for the decision makers and policymakers who wish to have efficient water governance and management.

Inefficient ways that water governance and management are being dealt with have led to a wastage, over exploitation and misuse of available water resources to further worsen the conditions with disparities and conflicts over the service delivery amongst the regions and population. The OCED (2011; 2015) clearly position themselves regarding this problem as being a governance crisis but not really a water crisis. They point out that the real concern is not the availability of fresh water or the lack of appropriate technology to harvest the fresh water, but the various water related issues are due to mismanagement and gaps in governance. In simple words, this signifies that water related issues are not a technical problem, but a governance problem.

In an attempt to address the current and future water governance problems, the OECD (2015) treated water as a fragmented sector which has been largely dependent on multi-governance aspects and they drafted twelve principles (OECD, 2015, Pp. 9-12) which have been built on water governance dimensions: *effectiveness, efficiency, trust and engagement, in order to improve the water governance cycle* (OECD, 2015, Pp. 5) and in turn aid the public administrators and government agencies to enhance and manage water related systems by dealing with multi-actor, multi-agency and multi-domain in a decentralised region and context specific, inclusive, bottom-up, integrated approach and implementable in a consistent, cost-effective and sustainable fashion. It is also important to note that these principles do not make any distinctions between water management functions, uses and ownership (OECD, 2015, Pp. 8).

Thus, the solution, or the water governance framework, to deal with water issues should focus, in addition to technical aspects, on governance aspects comprising of multi-actor, multi-agency, multi-domain, multi-functional, decentralised, region-specific, context-specific, bottom-up approach, inclusive and implementable in a systematic, consistent, integrated and sustainable fashion. This paradigm shift from technocratic towards cohesive, adaptive, bottom-up approaches is widely accepted (Sabatier et al., 2005; van der Brugge et al., 2009; van Buuren et al., 2012 cited in Teisman et al., 2013; OECD, 2015; OECD, 2011; Rijswick et al., 2014).

Complications into having an integrated governance or an analytical framework.

Over the last few decades, numerous efforts were put forth to address the water management concerns. The initial focus and efforts were directed towards centralised government systems, technology and large-scale infrastructure development in order to manage water. Over a period of time, the government agencies responsible for managing resources that were also related to water, became too complex with too many dependencies, such that the notion of government was no longer able to handle the increasing pressure.

The notion of government then moved to the concept of water governance and management with the development of the "Dublin Principles" during the Dublin International Conference in early 1990s and Second World Water Forum in The Hague in 2000. The governments' ideas changed to the concept of water governance and of governance in general, for effective design, development and implement policies and procedures to manage natural resources and address water related issues (Teisman et al., 2013; Rhodes, 2000; Kooiman, 1993; Sorensen and Torfing, 2007; Cooley et al., 2013).

Eventually, this led to the formulation of the Integrated Water Resources Management (IWRM) with the objective of a coordinated development and to improve the social, economic and environmental aspects in an equitable, efficient and sustainable fashion (GWP, 2000). This integrated approach to water management is well-recognised, with certain level of exceptions on effective implementation (Biswas, 2004) and remains predominant even today.

Subsequently, various frameworks were developed which are largely grounded on the principles of the IWRM framework. Some of these notable water governance and management models, assessment frameworks and contributions include (but not limited to):

- OECD water governance indicator framework (OECD, 2018)
- Water accounting and auditing (FAO, 2018)
- Importance to outcomes in terms of access, livelihood, social structures, political voice and ecosystems (Franks and Cleaver, 2016)
- OECD Principles on water governance (OCED, 2015)
- Community-led water governance (Tripathy, 2015)
- Ten building blocks of sustainable water governance (van Rijswick et al., 2014)
- Importance of water resources information in water system management (Dai, 2014)
- Contribution of economics to water problems (Dijk, 2014)
- Integrated Urban Water Management (World Bank, 2012)
- Adaptive management and governance model (Bogardi et al., 2012)
- Co-management or Adaptive co-management and inter-sectional policy making for water management (Hanjra et al., 2012; Carlsson et al., 2008; Armitage, 2008)

- Reference to social-ecological system integrity, democratic governance, generational equity, interconnectivity from global to local scales, economic opportunity, resource efficiency and maintenance (Wiek and Larson, 2012)
- Polycentric structures for effective water governance at different spatial scales and places (Pahl-Wostl, 2012)
- Water footprint to assess the consumption patterns (Water Footprint Network, 2011)
- Integrated and adaptive management of water resources (Engle et al., 2011)
- Co-valuation of water – an institutional perspective on valuation in spatial water management (Schie, 2010)
- Socio-ecological systems (Ostrom, 2009)
- Analytical framework for global governance (Kennedy, 2005; Uruena, 2009)
- Participation and evaluation of social and institutional aspects for sustainable river basis governance (Antunes et al., 2009)
- Global water governance (Pahl Wostl et al., 2008)
- Social learning and Collaborative governance (Pahl Wostl et al., 2007)
- Techno-scientific, policy-administrative, ecological, historical, cultural, socio-political perspectives for water management (Castro, 2007)
- Use of both green and blue-waters and trade systems (virtual waters) for water governance (Falkenmark and Lannerstad, 2004)
- NITI Aayog's Composite Water Management Index for Water measurement, management and improvement

Many water related challenges are constantly being debated upon, what direction to take and how to address these challenges and meet the Millennium and Sustainable Development Goals. They have been discussed in various summits, forums, conferences, events and various other platforms across the world.

Studies also debate that there has been a shift from a top-down supply-driven approach to a bottom-up demand-driven approach in providing drinking water facilities and services. The notion of distributed water governance systems, where the ideology was based on command and control or a hierarchical central State system was substituted by market-led water governance models. This was to take into consideration the human perspectives, coordination and cooperation for service delivery and enhance the inclusiveness, communications, trust and transparency.

This includes the participation of a multi-level network of stakeholders and actors with shared roles and responsibilities, which were comprised of:

- Government organisations
- Non-government organisations
- Grass-root organisations

- Self-help groups
- Residents
- End-users
- Women and children
- Private sector
- Academia
- Media

This level of integration plays a significant role in the overall approach, by combining the experiences and knowledge of local communities and experts, to improve water related governance practices and policies, impact decisions, the services and facilities at community level and build commitments (Rijswick et al., 2014; Dijk, 2008; Blanco, 2019; Tripathy, 2015; Naiga et al., 2015; Gallego-Ayala and Juizo, 2014; Garande and Dagg, 2005; Engle et al., 2011; Castro, 2007; UNESCO, 2006; Fenemor et al., 2008; Schoeman et al., 2014). Also, Krchnak (2005) highlights that improving public access to information and participation will have positive impact on Water governance. Further, in the current age of information technology, there is no dearth of information and knowledge on water related aspects and in the exchange of information.

These established water governance and management practices reveal that it still takes an invariably complex and challenging effort to develop and implement the water governance approach in such a way that the water related challenges (issues, stress and crises) are handled in a comprehensive, systematic and integral (multi-actor, multi-level, multi-domain) manner. This argument is well reinforced by OECD (2015) through its' study of various water governance frameworks across different countries. To address the water governance crisis and restructure the existing water governance frameworks or structure new water governance frameworks, it is fundamental to understand the crisis.

In order to identify and bridge the governance challenges, OECD (2015) developed an analytical framework "Multi-level Governance Framework: Mind the Gaps, Bridge the Gaps" (OECD, 2015, Pp. 3) to assess the water governance challenges pertaining to the policy, objectives, administration, information, capacity, funding and accountability aspects across different countries. The results however showed that the challenges were varied across the regions and it recognised the importance of place-specific governance solutions. Decentralisation approaches across the regions caused both opportunities in terms of developing policies, which are region specific and at the same time concerns in terms of capacities and co-ordination challenges in the delivery of fresh water. However, on a positive note, the importance of bottom-up and inclusive decision making procedures were recognised as being effective water policies.

Even the most progressive, well-recognised and principled approaches of water policy, governance and management frameworks (Rijswick et al., 2014; Lubell and Edelenbos, 2013; White, 1964; 1977; 1998; Borchadt et al., 2011; Biswas, 2004; Hering and Ingold 2012; Margerum, 1999; Lubell and Lippert, 2011) across the World (Biswas, 2004) such as Integrated Water Resource Management (IWRM) and Integrated Regional Water Management (IRWM), which were typically known for being functional[14], societal[15] and institutional[16] integration (fragmentation) (Lubell and Edelenbos, 2013; Sabatier et al., 2005; Lubell and Lippert, 2011; Margerum; 1999; Edelenbos and Teisman, 2011) also encountered similar criticisms and challenges.

These integrated frameworks were typically designed for encompassing joint responsibilities of multiple disciplines which stimulated the cooperation and coordination of multiple stakeholders with the objectives of development and management of water and related sectors in an integrated fashion, targeting the social-economic welfare in an equitable and sustainable fashion (Global Water Partnership, 2003; Edelenbos and Teisman, 2011).

Although different researchers have different approaches in defining IWRM, it is generally kept vague and abstract so that it would be easy to accept and adopt (Molle, 2008). However, the real challenge is considering IWRM as a panacea notion, a cure for all, given the complications in water management contexts such as the different physical, economic, social and cultural differences (Medema et al., 2000; Biswas, 2004).

Some researchers believe that IWRM should be more specific and at the same time flexible and adaptive in nature as context demands, it should be upgraded based on what has been learned and have a constant control on integration aspects (Lubell and Edelenbos, 2013; Edelenbos et al., 2013). Although Teisman et al (2013) points out that these integral frameworks reduced the complex water challenges to merely managerial issues and OECD (2015) notes that there are still persistent operationalisation and implementation issues to these holistic approaches.

Other researchers argued that these integrated frameworks were very impractical and non-implementable, especially in emerging economies with varied socio-cultural values, political or bureaucracies, bio-physical values, environmental and institutional values (Biswas, 2005).

[14] Functional integration (fragmentation): Multiple agencies with similar (different) functional responsibilities and consideration of multiple domains

[15] Societal integration (fragmentation): Multiple stakeholder participation (non-participation)

[16] Institutional integration (fragmentation): Coordination (non-coordination) within and across multiple levels of agencies

This status quo of integrated frameworks was acknowledged by Lubell and Edelenbos (2013) in their cross-country comparative study of integrated water resources management.

a. **Functional fragmentation**. Cross-country analysis is often carried out using a traditional technocratic approach but often does not take into consideration other domain and functional issues, such as social, ecological and governance issues. In most countries, especially countries that have young water management institutions, not considering the other social issues jeopardies the notion of functional integration in IWRM. Due to the limitations in functional integration, the participation of a very wide range of stakeholders in the water management approach has also been proved to be restricting, especially the non-technical experts such as local groups, communities and citizens.

b. **Societal fragmentation**. Lubell and Edelenbos (2013) in their cross-country analysis, point out that the countries following a decentralised approach in the governance or decision making procedures were able to include non-technical experts as well in order to understand more fully the local conditions. However, there are various factors, other than a technocratic approach and centralisation of powers, such as stakeholders' capacities, rules and regulations of the institutions and norms and cultures of the societies, that are taken into consideration in most of the countries in the world which encourages the societal fragmentation and affecting the principles of IWRM.

c. **Institutional fragmentation**. Lubell and Edelenbos (2013) mention the cross-country analysis that highlighted the difficulties in institutional integration with respect to stakeholders at various levels namely: local, regional and national. Though the decentralisation approach encourages stakeholder integration by actively involving various agencies and it discourages institutional integration through non-cooperation between various levels.

- **Decentralised approach** - Countries with decentralised approaches, as a necessity, have developed new collaborative approaches where in the agency participation is voluntary, thus there are fewer accountabilities in the decision making processes (Larson and Soto, 2008; Larson and Ribot, 2004; Schneider, 2003; Rodden, 2004).
- **Centralised approach** - However, in the countries with strong centralised approaches to water governance and management, the participation of local and regional agencies became pointless. There are also countries using weak centralised approaches which have led to the development of self-organising bodies at the local level leading to a stronger functional integration. When there is a weak culture of local administrations or civic

engagements this puts the centralised institutions in difficulty in being able to achieve the goals of IWRM. There are also countries which use a centralised approach that are able to seamlessly coordinate with local implementation agencies and are able to incorporate the principles of IWRM into their institutional and political culture; an example of this is Singapore.

Thus the notion of polycentric institutional integration, or fragmentation, in order to meet the objectives of IWRM is largely contextual in nature with influencing factors such as agencies’ capacities, political and agencies’ culture, constitutional rules and external influences such as political, informal agencies and bilateral relationships (Folke et al., 2005; Ostrom, 1998; Ostrom, 2005; Betsill and Bulkeley, 2006; Edelenbos and Teisman, 2011).

In summary, the cross-country analysis of IWRM applications clearly displays difficulties in meeting the integral objectives of IWRM where functional and institutional fragmentations are observed in decentralised (or bottom-up) water governance and management approaches to water issues, societal fragmentation is prevalent in centralised, or top-down, water governance and management approaches.

In order to achieve certain integration requirements often compromises need to take place with certain integration requirements of IWRM. Despite of the IWRM to date being the most noteworthy approach in theory and practice for water governance and management, it is possible to claim that the adoption, implementation and effectiveness of IWRM is largely reliant on the predominant state of local affairs, or forces, such as political authorities, economic development, societal norms, administrative (de)centralisation, institutional capacities and financial resources.

Lubell and Edelenbos (2013), Edelenbos et al (2013) agreeing with Biswas (2005) argue that developing countries typically lack resources and political will in order to implement the IWRM approach despite having an administrative (de)centralisation, low level of economic development activities which focus on infrastructure development and many international organisations who play active roles.

On the whole, developed countries with centralised administration typically follow a “stick and carrot” approach for compelling to the principles of IWRM in water governance and management. Nevertheless, even in the cases of developed countries with a decentralised approach, the lack of an overseeing authority to monitor the non-cooperative agencies has resulted in institutional and functional fragmentation in the IWRM approach.

Based on the above-mentioned arguments, it is evident that there is a need for next generation integrated water governance and management frameworks to tackle water related issues by integrating functional, societal and institutional aspects, in addition to technical aspects, with more specificity and including being both adaptive and implementable in nature and able to suit local conditions.

In order to support a smooth implementation, the following points need to be taken into consideration:

- What functions?
- Which domains need to be considered?
- How can it be adaptive?
- How can the governmental structures be improved? (perhaps with a hybrid of centralised and decentralised approaches)
- What procedures are necessary?
- What legal aspects need to be considered?
- Which organisational aspects need to be taken into consideration?
- What are the management capacities?
- How can the public be made aware?

According to Lubell and Edelenbos (2013) there is an urgent need to move away from water to other functions in order to deal with water related issues and call for a new improved systematic and integrated water governance and management framework.

2.3. Systematic and Integral water governance and management

Based on the above stated arguments, it is evident that there are water related challenges throughout the world, especially in emerging nations like India and as a consequence the human growth and economic development have been affected in disparities. In order to address these burgeoning water challenges, there have been huge investments made in developing water related infrastructure. However, it can largely be concluded that the real challenge is not with the water related systems, but the traditional water governance and management approaches which have had in the past limited water problem solving efficiency.

Thus, as has already been pointed out, the water crisis is not solely an engineering or technical problem, but a governance problem. It can clearly be seen that has been acknowledged widely by the rise of water governance and management approaches that view the problem from a public administration angle, in order to deal with water related challenges across the world and in emerging economics like India.

Good governance and management are important in order to deal with the alarming uncertain conditions such as population growth, lifestyle changes, economic development, water availability, demands and competition, climate change and ecological changes. The positive human growth and economic development is part of well-governed and managed waters and it is a hindrance to growth and development when water is badly governed and managed. This has led to multifaceted domains, functions, institutions, actors and their integration into governance and management frameworks across the world in order to treat water related challenges.

The widely accepted Integrated Water Resource Management (IWRM) frameworks and other renowned water governance and management frameworks have their drawbacks. It is challenging for the water governance and management to cope with the multitude of functions, domains and institutions. And it is daring to try to establish a comprehensive, systematic and integral approach which will be able to suit the contextual conditions and at the juncture adaptable in nature and be sustainable. Due to the above stated complex nature of water systems, it is important to understand and analyse the factors that need to be considered in the systematic and integrated water governance and management framework to successfully deal with various aspects of the water crisis.

Importance of systematic and integral governance frameworks.

According to Levi-Flaur (2012) the concept of governance has many definitions and perspectives. Governance can be better explained through empirical phenomenon such as what the association is between multi-stakeholders at multiple levels and through normative phenomenon such as how multi-stakeholders are influenced by diverged actions and procedures in the complex system (Teisman et al., 2013; Pierre and Peters, 2000; Papadopoulos, 2003). However, both phenomena indicate one of the most important side-effects of modernisation which is that the world has an increased interdependency and the need for collective action. That is also what is needed in the domain of water and therefore it is crucial to understanding the essentials of water governance.

Though the integration in water governance and management is recognised, Rijswick et al (2014), in their interdisciplinary method to assess the water governance approaches clearly states that developing such a water governance framework is challenging. As mentioned earlier, water is a complex and interrelated system. Researchers, practitioners and public urban administrators believe it requires immediate attention in order to improve the existing or developing novel water governance and management practices in a comprehensive manner (Edelenbos et al., 2013; Teisman and Edelenbos, 2011).

There is a need to overcome the social and resources unrest and to achieve economic and human development in a sustainable fashion. To achieve this, there is both a necessity and an opportunity to avoid repeating what has already been done without a good result and to begin connecting information resources regarding resource management and governance with existing bodies of knowledge and analysis of governance and politics which have been learned over the last few decades or more (Kathpalia et al., 2002).

Based upon what has been learned, and how much has been earned, from previous and ongoing practices, it is evident that there is a need for immediate attention in the field of effective water governance and management. There is a necessity for a systematic and integrated approach, in an easy to implement fashion, in order to overcome the above-mentioned issues and to have well-managed water systems as a fundamental long-term objective.

The advantages in having integrated approaches in dealing with water related challenges are well known. The analysis of various water related dogmas in developed and developing nations reported in, "Managing Water for All," highlights the benefits in economic, social and environmental terms (OECD, 2009; IIED, year unknown). The limited available natural assets, which are typically under the control of local administrators, should be effectively governed and managed in a systematic and integrated fashion, on doing so one needs to consider various dimensions in order to achieve sustainable development of the societies (OECD, 2011).

Basing on the resilience theories and adaptive approaches, it has been recognised that it is important to understand and protect the social, economic, environmental and ecological aspects in a society and be aware of the effectiveness of institutions and their relevant political, managerial and operational setup, policies, regulations and frameworks in an integrated fashion, without any assumptions, to overcome the constantly changing water related issues (Brain, 2014; Folke, 2006, Walker and Salt, 2006, Norris et al., 2008, Miller at el, 2010; IIED, year unknown).

Water is not just associated with any one particular stakeholder. The most important dimension should be considered, such as the involvement of multi-level stakeholders through a bottom-up or a horizontal involvement (Ward et al., 2017). It should be looked at within the complete project or programme cycle, from the inception of the project until the maintenance phase. It should to be considered for instating governance and management in an effective way and in looking for solutions to the same problem from different angles by different stakeholders and agencies in a cohesive manner (Teisman et al., 2013; Leach and Pelkey, 2001; Kuks, 2004).

It is also recognised that the focus should be more on people or beneficiaries and their use and need for water and less on governance and management from a top-down and unrealistic approach (OECD, 2011; Roger et al., 2015). Further, since the water related challenges are significantly affecting the citizens in poor communities, the water resources management should also have a pro-poor approach which include an active involvement of poor communities and they should be one of the key stakeholders (Hepworth et al., 2012; IIED, year unknown).

Factors to be considered in systematic and integrated water governance and management.

In order to address the above-mentioned concerns of water crisis, competition, conflicts and disparities, the framework for governance and management of these limited available water resources in an implementable approach is essential (Biswas, 2006; Biswas, 2009;

Bellie, 2011). Biswas (2006) also states that the water related issues were not just because of limited available resources, but also due to mismanagement and poor governance. If the current state of affairs is not good, then the future will be even worse, unless the required measures are not taken both at global and local levels. This also connotes that more emphasis should be given to managing these limited resources in order to meet the proliferating demands, and less emphasis should be given on understanding the availability of fresh water.

This showed that there was a need for drastic changes in the systems that differ per region. There was a need to be flexible in the approaches of how to solve each problem effectively. It was important to investigate and deduce the amount of water supplies that are needed. There was a demand for continued planning and management with the support of strong governing principles to achieve the Sustainable Development Goals (Pereira et al., 2009) by integrating biophysical science related aspects and human science related aspects (Bellie, 2011).

Besides utilising the existing effective urban management practices (Koutsoyiannis et al., 2008), there was also an urgency for developing and implementing new water planning and management frameworks (Biswas and Tortajada, 2009) to address the neoteric challenges. These planning and management approaches should not only focus on the traditionally utilised technical aspects of the water systems which typically include assessment of water availability, distribution, demand, quality, etc., but also focus on the analysis of social-economic, human attitudes and perceptions, political, economic, cultural, legal, regulatory, environmental, institutional (include political bodies, government agencies, NGOs, research institutions, etc.), capacities and education, awareness, communications aspects of water issues (Iyer, 2007; Pereira et al., 2009; Bellie, 2011). This involves designing concepts and theories comprising of new techniques for assessing the technical aspects of water, innovative technologies for water supply systems, new methods of improving capacities, and new water laws and regulations.

This is in order to instigate more flexible approach regarding the above-mentioned aspects of water issues. The integration of the above-mentioned aspects into the new concepts and theories are essential for resolving the varied and rapidly changing conditions and issues in a holistic way targeting the fundamental changes in the water sector, is of the highest priority.

2.3.1. Socio-health aspects in the integral water governance and management

Socio-health elements.

The proliferation of the population will have impacts on development activities and vice-versa. The POPulation-DEVelopment framework usually known as POPDEV framework is based on the Training Module on Integrated Population and Development Planning which helps understand the human and development factors. The POPDEV framework has been institutionalised at national, state and local levels in various development projects (NEDA, 1993).

The macro perspective of the POPDEV framework illustrates the interactions between human and development factors in terms of different processes and possible outcomes. As per NEDA (1993), this framework analyses the POPulation-DEVelopment relationships at any given point. For instance, human processes can lead to development outcomes and vice-versa; development processes can influence the population and vice-versa. The POPDEV framework implies that any policy level interventions or any kind of economic activities will have an impact both at population levels and development processes.

The POPDEV framework also illustrates that there are three pillars for demographic processes namely: fertility, mortality and migration. These demographic processes lead to demographic outcomes of population size, age-sex structure and spatial distribution of the population. These outcomes influence the development processes, such as consumption and production of goods and services which are human-made or natural resources. Further, these development processes lead to development outcomes like employment, education, health and environmental quality damages. These socio-economic outcomes also alter the population processes of fertility, mortality and migration. The entire process in the framework is a vicious cycle (NEDA, 1993).

A POPDEV framework[17] at micro-level was developed which recognised that the success of the project primarily dependents on the population at the community and household levels (Villareal, 2004). The interactions between demographics and socio-economic factors play an important role and can be analysed using the POPDEV framework, along with variables associated to them. The household decision making processes are dependent on the household characteristics and they also have an effect at the community level.

The POPDEV framework acts as a planning and management instrument which comprehends the household decision making processes which are influenced by the factors at household level, community level and external levels. The analysis of these interactions and interrelationships between various indicators at household level and community level helps appreciate the situation.

The prime focus of any development activity is human (ICPD, 1994). The ICPD (1994) Programme for Action also argues that, by improving the health and protecting human rights of the citizens, this will lead to a better socio-economic future and it also contributes to a regulated population growth. This led to develop the POPDEV framework by emphasizing on human well-being and environmental sustainability. In line with this, the

[17] The framework was adopted from Training modules on integrated on planning and development for the Fisheries Resource Management Project (Villareal, 2004)

policies and strategies were targeting the empowerment of the people and secure conditions.

An operational review[18] was conducted on different thematic issues and a progress analysis since 1994[19]. The results showed an uneven progress across multiple sectors which failed to achieve universal respect of human rights (UNESCO, 2014). The POPDEV framework which illustrated the interrelationships between various variables of population and development, took new strands[20] of development in terms of POPulation-DEVelopment relationships by including environmental, sustainability and governance aspects, in order to ultimately get a better quality of life. The POPDEV framework beyond 2014 is now based on five integrated thematic pillars of dignity and human rights, namely: Health, Mobility, Place, Governance, and Sustainability.

Although there was a shift from the POPulation-DEVelopment theory, the central focus remained the same; the individual dignity and rights. However, there was an increasing poor population with low living standards, low dignity, insufficient human rights and high environmental burdens, were conflicting with the fundamental purposes of interrelationship between population and development. To attain the sustainable development goals are only possible with a robust analysis of the population and development variables. It is required to analyse the interrelationships between various variables of population and development as an integral process of comprehensive planning of strategies and policies.

In order to be able to achieve the set objectives of the development programme, both the analysis of accurate information and knowledge and effective involvement of stakeholders at different levels are vital. It was further argued that data and information systems on population variables were critical for effective governance and planning development. It is very important to gather, analyse and disseminate data regarding the population, in order to monitor the progress and address any problems (UNESCO, 2014). The population variables' data help analyse the people dynamics and their effects on the changing environment.

Since the commencement of the ICPD Programme for Action in 1994, data was collected which was related to the objectives of ICPD, along with new methodologies and technologies but unfortunately only limited effort was given to improving the data collection processing, dissemination and democratising the data. However, it is to be noted that it is vital to analyse the interrelationship of all of the various variables of the population and development, subject to requirements of the research analysis, to understand the related concerns at area level.

[18] ICPD Beyond 2014 Global survey
[19] POPDEV framework was development in this year
[20] In International Conference for Population and Development Beyond 2014

The Statistical Research and Training Centre (1998) focused on core indicators for area or local level planning and FAO (1993, 1997, 1998, 2000, 2004), described the core indicators for a Population Development framework which need to be analysed in order to understand the problems at area level. These indicators were also categorised according to the type of information required. For instance, indicators related to demography include socio-economic data to analyse the people's state of well-being and quality of life.

The Statistical Research and Training Center (1998) developed a list of 109 recommended core indicators or variables which help analyse the population processes[21], development processes[22], population outcomes[23] and development outcomes[24]. However, these core indicators can be selective depending upon the requirement of the area or population study at community, household and individual level.

Assessment indicators of socio-health elements.

The prominence of the "human" in the environment and development activities is not new. It is the framework of the human environment tradition and population development framework, their primarily focus is on the well-being of the human. These concepts depict that any change in the environment, human activities, development activities or economic activities will have an influence, either positive or negative or both, on the population and its environment. There is increasing research and scientific advancement abetted to identify and analyse these social and environmental influences. This kind of analysis helps to rationalise the policy processes and improve the quality of the policies or strategies. It was argued that there were certain assessment methods[25] which were politically driven (Dietz, 1987), but social impact assessment and other methods[26] are scientific in nature and enhance public participation in policy preparation (Dietz, 1987) and understanding the impacts.

There is an increasing emphasis on social characteristics along with the assessment of economic and environmental impacts of policy level decisions or approvals for development projects (USCEQ, 1986; Esteves et al., 2012; Lord, 2011; Momtaz, 2005; Suopajärvi, 2013; Vanclay and Esteves, 2011). The definition of the environment in impact assessment has been expanded to include the "social component". Due to the increasing

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[21] Include fertility, mortality and migration

[22] Include population size, population structure, spatial distribution and household characteristics

[23] Include Macroeconomics, financing, labor, employment, agriculture, fishery, agrarian reform, industry, trade, environment, natural resources, education, health, family planning, housing, water, sanitation, energy, transportation, communication, public safety, social welfare, tourism, science, technology, community development and administration

[24] Include employment status, income status, education status, nutritional status and health status

[25] Benefit-cost analysis, systems analysis and risk analysis

[26] Include technology assessment and environmental impact assessment

concerns, it is required to assess the indicators determining the population, development and environment.

With a similar inclination towards the assessment of human impact, USNEPA legislation[27] and CEARP[28] formulated a social impact assessment framework, which primarily applies the knowledge of sociological sciences and concepts of community and cultural changes. The social impact assessment is commonly defined as identification, analysis and evaluation of the social impacts caused due to a specific incident (Duncan et al., 1976; Cramer et al., 1980).

It was argued that the assessment was either subjective[29] or objective[30], but most of the studies were objective in nature (Dietz, 1987), making the purpose of the study redundant. Cramer et al. (1980) suggested that one has to only focus on the assessment of the net impacts[31] of the actual[32] events[33] without any prejudice. Careful consideration should also be payed to the spatial and time dimensions of the impacts. Unlike economic assessments of any projects, the social impact assessment is not limited to spatial and time boundaries (Dietz, 1987).

The importance and requirements of this assessment was recognised and developed through a series of international conferences with the International Association for Impact Assessment (IAIA). The products of these conferences produced the formulation of regulations by US agencies and European communities, which were put into practice by the World Bank for most of their development projects including the environmental impact assessment (Vanclay, 1996; Vanclay, 2003a; Vanclay, 2003b; Esteves et al., 2012; Suopajärvi, 2013; Mahmoudi et al., 2013).

It was criticised and argued that the social impact assessment, although it was widely recognised and many of its methods were used[34], it lacked a theoretical or conceptual framework and details of appropriate methods for assessment (Suopajärvi, 2013;

[27] United States National Environmental Policy Act legislation of 1969

[28] Canadian Environmental Assessment and Review Process

[29] Impacts perceived by the affected population

[30] Impacts that are considered important by an expert

[31] The net impacts here refer to the only impacts caused due to one particular event; also consider "no project" or "continuation of current project" alternatives to overcome the impacts of other events (Dietz, 1987)

[32] The assessment should be carried out for actual events i.e., realistic implementation scenario of the policies and strategies, rather than taking the scenario of the policies and strategies – as proposed

[33] In case of events or policies or strategies that have a long duration, the assessment should cover the time period

[34] Traditional social analysis tools – ethnography, survey research, social indicators, demographic analysis

Mahmoudi et al., 2013; Dietz, 1987). The majority of the literature points out that social impact assessment provided a vital contribution to decision making processes of policy formulation through community-led approaches (Esteves et al., 2012) and it was scientific in nature (Dietz, 1987), capable of providing mechanisms in which human and social ecosystems are integrated (Ahmadvand et al., 2009) and it has been the current good practice with social impact assessments.

The guidelines and principles for social impact assessment were first developed in 1995 and then updated and published in 2003. Although they have been criticised by many scholars, it was the prime source that contributed to the development of the social impact assessment (Gomez et al., 2014; Esteves et al., 2012).

The procedural framework of the social impact assessment (ICGP, 1995; ICGP, 2003) is primarily based on the environmental impact assessment framework (CEQ, 1986), that follows sequential steps in the assessment. It was however argued that this procedural framework was based on a technical approach, which is heavily relied upon by social experts using quantitative methods for valuing the selected variables or indicators to determine the impacts or assessment of the selected policies (Asselin et al., 2009; Ziller, 2012; ICGP, 1995). It was also further discussed that the impact assessment of these social variables for select policies should depend on stages of the project and policy[35] and project types[36]. Table 1 illustrates the possible indicators that can be used in assessing social-health aspects (ICGP, 1995).

Table 1: Assessment indicators of social-health aspects

S.No.	Indicators	Sub-indicators
1.	Population characteristics	a. Resident population b. Relocated population c. Influx or outflows of temporary workers d. Seasonal residents
2.	Community and institutional structures	a. Voluntary associations b. Interest group activity c. Size and structure of local government d. Historical experience with change e. Employment and income characteristics f. Local, regional, national, global linkages g. Industrial and commercial diversity h. Presence of planning and zoning activity

[35] Planning and policy development, construction and implementation, operation and maintenance, closure or abandonment or decommissioning

[36] Mining extraction, hazardous waste, power plants, reservoirs, industrial plants, land-use designations, social and physical infrastructure, commercial developments, religious places, housing, etc.,

S.No.	Indicators	Sub-indicators
3.	Political and Social Resources	a. Distribution of power and authority b. Identifications of stakeholders c. Interested and affected public d. Leadership capability and characteristics
4.	Individual and Family Changes	a. Perceptions of risk, health and safety b. Displacement or relocation concerns c. Trust in political and social institutions d. Density of acquaintanceship e. Perceptions and Attitudes toward policy and project f. Family and friendship networks g. Concerns about social well-being
5.	Community Resources	a. Community infrastructure b. Land use patterns c. Cultural, historical and archaeological resources

It was suggested by various experts that the theoretical basis for impact assessment theory should be based on core concepts, like political sciences (Bartlett et al., 1999), policy theory (Kornov et al., 2000), decision theory (Nitz et al., 2001), international principles (Vanclay, 2003 a, b) and planning theory (Hilden et al., 2004). Later, Esteves et al. (2012) revised the core concepts with culture, community, power, human rights, gender, justice, place, resilience and sustainable livelihoods. However, there are key gaps in the recommendations that were made and being able to put them into practice that can be classified into the following three categories:

- Unable to deal with beliefs, values and interests of stakeholders (Lockie in Gomez et al., 2014)
- Overlooking of the non-quantifiable variables such as cultural changes (Ahmadvand et al., 2009; Rowan in Gomez et al., 2014)
- The technical approach of ICGP (1995) only focuses on quantifiable variables (Gomez et al., 2014)

Vanclay (2006) prepared a list of 17 activities underlying the social impact assessment process known as the international principles for social impact assessment in order to take into account the local community's knowledge and to be able to understand the impacts on the community in a contextual way.

The information that is accumulated can be classified into specific variables and views of the communities that incorporate a more participatory approach to social impact assessment. Though the participatory approach is well appreciated (Buchan, 2003; Lane et al., 2003; O'Faircheallaigh, 1999; Ross, 1990; Vanclay, 2003a; Vanclay, 2003b; Vanclay, 2006), the public participation process and impact assessment process were not integrated into the decision making processes (Esteves et al., 2012; Lockie, 2001). Becker et al (2004) and Ziller (2012) also argue that the participatory approach may lead to identifying the public's fears, wants and needs, which can make it difficult to assess the extent of the impacts.

Suopajärvi (2013) further argues that there was a significant gap between various academic recommendations on the social impact assessment guidelines and principles framework which was designed by ICGP and the case studies. Esteves et al (2012) further suggest that was necessary to assess, consolidate and incorporate the recommendations from various authors into a procedural framework.

Gomez et al (2014) attempted to develop a new framework for social impact assessment by consolidating the academic recommendations[37], technical approaches (Becker et al., 2004), participatory approaches (Lane et al., 1997) and current practices[38] into the procedure framework of the ICGP (1995) framework, which was able to act as a base for further studies. The above-mentioned framework was primarily designed so that decision-makers and policymakers would be able to understand the social consequences of their decisions and allow the general public to participate in the process of decision making incorporated with the technical knowledge of the experts. Considering the complexity of social conditions and consequences caused due to decision-makers, better outcomes in decision making can result by using the social impact assessment.

There are many technical assessments which also play an important role in policy level intervention processes. At the stage where a decision has to be taken for one particular policy or strategy, it is difficult to purely establish this based on technical grounds. Habermas (1979, 1970) argued about the difficulties of technical policy analysis in a democratic way. He also mentions that it is not possible for an unrestricted participation of the general public in the process of policy formulation and this also applies, to an extent, with the participation of experts.

Specialists from one set of disciplines are often unable to participate in an analytical work conducted by other specialists using the assessment tools of a different discipline. However, when using the social impact assessment[39] this not only provides values from the

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[37] Good practices (Esteves et al., 2012; Vanclay, 2003a); upgrading of each step in the framework (Ross and McGee, 2006); screening process (Ahmadvand et al., 2009; Momtaz, 2005; Suopajärvi, 2013); Profile developments (Harris et al., 2003); Scoping process (Momtaz, 2003 and Rowan, 2009); Assessment of predicted impacts (Asselin and Parkins, 2009; Becker et al., 2003, Becker et al., 2004; Franks et al., 2009); Alternative strategies (Égré and Senécal, 2003 ; Vanclay and Esteves, 2011); Mitigation strategies (João et al., 2011 ; Loxton et al., 2013); Monitoring process (Rossouw and Malan, 2007); Management and evaluation (Franks and Vanclay, 2013) cited in Gomez et.al., 2014

[38] In particular the 'best practice' as articulated through the International Principles for Social Impact Assessment (Vanclay, 2003a; Vanclay, 2003b) and Social Impact Assessment: the state of the art (Esteves et al., 2012)

[39] The assessment is primarily based on individuals at community level, who have been or shall be impacted by the policies

information derived from the scientific analysis of the public regarding different possible policies, it is highly supportive in the decision making processes in a democratic way. Though this assessment tool does not indicate which decision is optimal, it is able to derive all the possible impacts that resulted from the scientific analysis and it also is able to include the values from the general public on these impacts (Dietz, 1987). And, according to Habermas (1979) this is one of the ideal modes of decision making.

It was also criticised that the social impact assessment remained a technical document (Schnaiberg, 1980; Meidinger et al., 1980; Dietz, 1987). However, the social impact assessment study is able to be used within different contexts and specific models depending on the required outcomes (Esteves et al., 2012), throughout the world (Suopajärvi, 2013; Ahmadvand et al., 2009; Momtaz, 2005). Most of the projects related to tourism, mining, dams, nuclear power, infrastructure projects, along with development studies have used social impact assessment (Leistritz et al., 1981; Bowles, 1982; Bowles, 1981; Cottrell, 1951; Sharp, 1952; Foster, 1964; Cohen, 1971, 1972, 1979, 1984; Francis, 1973; Pilbara Study Group, 1974; Brealey, 1974; Burvill, 1975; Colson, 1971). It became an integral part of the policy-making process after the formation of directive from the U.S. Forest Summit. It was argued that the social impact assessment does not have any legal framework which is similar to the environmental impact assessment (Pope et al., 2013). Also, it remained as a subset of the environmental impact assessment and is restricted largely to baseline studies rather than also taking into consideration the social impacts (Esteves et al., 2012).

There are guidelines and principles which have been developed for social impact assessment (Becker et al., 2003; Vanclay and Esteves, 2011; Ziller, 2012; Asselin et al., 2009; O'Faircheallaigh, 2009; Rossouw et al., 2007; Rowan, 2009) in line with NEPA processes and regulations. The process of social impact is directly linked to the environmental impact assessment. The NEPA directives, processes and regulations were later followed by the U.S. Council on environmental quality, American Sociological Association and U.S. Agency for international development (Clark and Canter, 1997).

The social impact assessment was also among the six core practice areas in the state of the art impact assessment established by impact assessment and project appraisal (Pope et al., 2013). For development of programmes or projects or policy level interventions, the social impact assessment is now considered as a mandatory stand-alone process, it is regarded as a quasi-environmental impact assessment process, with support from international social performance standards and legitimate mandates (Esteves et al., 2011). It is not independent from regulatory drivers, but it has an objective to be consistent with community and public functions than with the environment functions (Esteves et al., 2012).

This assessment, as a process, assists in assessing the social consequences that have occurred or are likely to occur due to a specific policy or project development or any economic activities (Vanclay, 1996; Association for Social Assessment, 1994). It was argued that this impact assessment is highly volatile and depends upon the context of the assessment and it produces variations in the analysis and the results from place to place (Pope et al., 2013). However, if the assessment is considered to analyse similar parameters in similar contexts, this can facilitate a decision making process to choose between alternative possibilities or improvements or mitigation strategies to reduce the potential of negative social impacts or evaluate the social impacts caused by existing or earlier development activities.

It was argued that conducting a social impact assessment adds to the project expenses (Vanclay, 1996). However, the community involvement within the assessment process will not only reduce uncertainties in the project's success, but it will also increase the capacity to plan mitigation strategies and alternatives. This will further reduce the costs of the government agencies involved for rectifying the social and environmental impacts of economic development activities (Association for Social Assessment, 1994).

It was also mentioned that in the case of any large-scale development activities, there are mechanism strategies for compensation or other form of payments to the communities from the representative agencies (Vanclay, 1996). It is very difficult to value everything in monetary terms, especially when human values are involved. However, it should also be noted that: "prevention is better than cure." Thus, by preventing a major social impact[40] of economic or development activities before they actually could happen are possible with the aid of the social impact assessment. It helps to be able to understand and analyse the effects of the project in advance or side-effects of implemented projects in order to make better proposals through proper mitigation and monitoring procedures.

Spatial elements.

The relationship between human and environmental resources is not a new concept. It has a history as long as the existence of our species on this earth. Human dependency on water bodies goes hand in hand with the start of human civilizations, for instance, the first civilizations started along the banks of the River Nile. Due to the human's nature of activities has resulted in deteriorating environmental conditions which is in turn has led to phenomenon of global warming and climate changes. Even though the toxic levels in the environment took a steep raise after industrial revolution, there were certainly negative influences from the start of the civilization. But people tend to adapt to the environment and its changes.

For instance, people build homes above the flood plains, grow crops suitable to the local soil conditions and build temporary structures in earthquake prone areas. In recent times, the natural disasters have resulted in loss of human life and properties. Nevertheless, humans persevere; they adapt and continue to live in these unstable areas. The human-

[40] Regarding the people's way of life, culture, communities, political systems, environment, health and well-being, personal and property rights, fears and aspirations (Vanclay, 2003)

environment interface has remained and remains as a continuous process. This is directly related to one of the five themes of geography from Pattison (1990) "human-environment interaction" also known as man-land tradition or culture-environment tradition, which explains the relationships between people and their environment, answering questions like: How do people depend on the environment? How do people adapt to the environment? and how do people alter the environment? Until the introduction of these themes or traditions, there were more of singular definitions to geographical terms (Floyd, 1963). These traditions are multi-dimensional, widely used, well-appreciated and well-received by various professionals, researchers and also the common man.

The term land in "man-land tradition" relates to earth or the physical environment (Robinson, 1976), for that matter any natural resources on the earth. It primarily deals with the human impact on nature, impact of nature on humans, environmental problems, perceptions of environment, cultural, political and population geography.

In contrast, Hippocrates, in his book: "On airs, waters and places"[41] was only confined to unidirectional reflections on human health and conditions of the environment. The inquiries concentrated on the effects of environmental problems and what the changes were upon man (Spate, 1960). However, the man-land tradition in combination with other schools of thoughts, in particular social sciences, provided a significant scope for analysis and results for public improvements (Pattison, 1990). The evidence of this dominance may be found in Davis's 1905 declaration: "Any statement is of geographical quality if it contains . . . some relationship between an element of inorganic control and one of organic response". It was also argued by environmentalism[42], which viewed the environment as an important factor in the cultural and intellectual development of an individual or groups (Lewthwaite, 1966; Merriam Webster). This was also dominated by man-land or human-environment tradition and its usage by the majority of the academics and practitioners (Robinson, 1976).

In line with the environmentalism, the concerns for the man's impact on his environment led to the development of new discipline of ecology which deals with the issues about the relationship between organisms and their environment. It was the zoologists or botanists who are concerned about plants and animals in their environment, who have very limited knowledge about human as an organism or otherwise, according to Aristotle's writing wherein he describes in his Greek literature "Man is by nature a social animal"[43].

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[41] Hippocrates' seminal work "On Air, Waters and Places" written almost 2,500 years ago cited in Robinson (1976)

[42] The concept was used in a collection of papers titled: "Man's role in changing the face of the earth", where man appears as an independent agent and the land as a sufferer from the actions of man

[43] Aristotle. Aristotle in 23 Volumes, Vol. 21, translated by H. Rackham. Cambridge, MA, Harvard University Press; London, William Heinemann Ltd. 1944.

Most of the psychologists and behavioural geographers argue that the critical element in man-land relationships is the perception of the man about the environment and not what the environment is. It is the behaviour of the man in the physical and social environment. There were also many arguments in terms of dealing with "resources" or the "environment" as part of the "human-environment relationship".

Many geographers argue that there are multiple forms of environment and its interrelationship in which the human lives. It is not only the physical environment of the earth that human deals with, but there are other components like social, political, or urban environments. There were studies that were conducted to only understand partial components of physical environment, but not the whole environment in its totality (Robinson, 1976). Even though there are many arguments around the perceptions of man's actions influencing the environment or the environment influencing man's actions, or arriving at a concluding point for these arguments, it is crucial to have a middle view of man-resource or environment relationships and analyse the relationship between man and the resources that are available, to better understand the problems and provide suitable solutions.

In order to understand the relationship, there are other traditions of Pattison (1964) which help describe and comprehend the man, resources and environment related issues. The four themes of geography include:

a. **Spatial** tradition describes the positions and distribution of people and places on the earth in absolute and relative locations, for example, their location, position, direction and distance

b. **Area** studies describe the physical[44] and human characteristics[45] of the space or area

c. **Movement** tradition is the relationship between people in different spaces or areas, specifically, the study of spaces that are dependent and shaped by the constant movements of people, ideas, goods and also the physical systems of the earth[46]. The study is also about how the physical environment[47] interacts in particular areas and how it varies from one place to another around the world

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[44] Includes physical aspects such as roads, houses, parks and infrastructure; geological aspects such as landforms; hydrological aspects such as water bodies; atmospheric aspects such as climatic conditions; and biological aspects such as soil, vegetation and animal life.

[45] Includes land-use, population density, age-sex ratio, gender, caste, architecture and political systems.

[46] Physical systems of the earth include components of lithosphere, hydrosphere, atmosphere and biosphere; and earth-sun interaction.

[47] Physical environment includes landforms, drainage, climate, natural vegetation and soils

d. **Region** deals with classification of areas with common characteristics, primarily, these are classified into physical[48] and political[49] regions

The five traditions of geography act as a vital framework for understanding and analysing various aspects of the areas or regions, depending upon the purpose of the research. It also appreciates the importance of aerial maps, which can give a clear picture which enables spatial distributional analysis of various aspects or characteristics that are needed to be considered in the study area. The aspects or characteristics can be defined based on the objectives of the study.

2.3.2. Technical-Institutional aspects in integral water governance and management

Technical and institutional elements.

These are processes that are conducted in the municipal service delivery systems and are of particular interest in this the current research; they are designed to deliver safe and adequate drinking water to slum areas. To understand the service delivery challenges and their consequences, it is first essential to evaluate the causes of the problems, the decision making processes in an institutional setup which delivers services.

The "process" here is defined as a "series of actions or operations that are carried out to an end" (Merriam Webster) performed to arrive at a decision for a particular purpose. The key to valuation from an institutional perspective in the current research was to analyse the institutional aspects responsible for the series of actions and operations to arrive at a decision or make choices based on the conditions prevailing within the organisation.

This primarily dealt with understanding the existing management and finance (plans, demand, targets, capacities, approaches and methods), governance (reforms, policies, legal, regulatory, communications) and external constraints (natural resources, conditions and political climate, interdependency on other infrastructure). To be able to understand this in a holistic way, it is important to understand the term "choice" (or preference) in the decision making processes.

The choices of the individuals depend on various conditions. In political sciences, the individuals who are responsible for decision making are influenced by the societies. The actors or the stakeholders who is concerned with public interests will make the decisions that are best for the societies (Faber et al., 2002). But, in social sciences, the individual(s)

[48] Physical characteristics include landforms, climate, soil and natural vegetation
[49] Defined by man-made characteristics include economic, social, political and cultural

who is/are responsible for decision making is/are connected to other stakeholders in various forms (Swedberg, 1987).

The decisions are not individual-centric, but highly influenced by the prevailing conditions of the institutional arrangements within the organisations along with considering the social and ecological contexts. The choices or the decisions of these individuals or group of individuals keep varying depending on the circumstances. For instance, the decision to provide reliable goods and services to the general public is reliant on the availability of resources and feasibility of providing the required facilities or select services to the society.

The general public or the consumers also make choices or decisions for which goods and services they require, which is generally explained by an economic valuation of the individual’s choice or preference using a neoclassical approach. Schuijt (2003) argues that understanding an individual’s behaviour in making choices or preferences in social sciences or political sciences cannot be explained using neoclassical approach.

Neoclassical approach of understanding an individual’s choices is, in principle, dependent on the individuals’ self-interests and their willingness to pay a specific price or accept a particular good or service, without there being any influence of social and ecological contexts. Whereas, the decision making process or choices of the individuals as “decision makers”, in political and social sciences are, in principle, dependent on the satisfaction and acceptable levels of satisfaction of the citizens (van den Bergh, 2000).

However, by assessing the economic restraints of the individuals’ choices using a neoclassical approach is one of the peripheral factors influencing the decision making processes of the individuals in a political or institutional set-up. Though the decision makers consider the individual preferences, the decisions made are based on a rational balance between costs and benefits. The individuals make choices that increases the utility whereas the organisations make choices that increases profits. The motivation for these choices is usually external to the cost and benefit analysis (Schuijt, 2003).

In addition to the above-mentioned rational approaches, political power also plays an influential role in the decision making processes (Schuijt, 2003). It was argued that economic instruments had no objectivity in decision making processes (Spash et al., 2001). In addition to the subjective position of the economic instruments, the output analysis of these instruments often was tampered with intentionally to support the political power play within the decision making process.

These economic instruments which consider social perceptions influence not only the outcomes of the economic analysis that was conducted by the experts, but also the political power that was involved in the decision making processes (Goodstein, 1995; Spash et al., 2001). In order, to understand the choice behaviour and the factors influencing the decision making processes, an institutional perspective is also required, which shall be better clarified using the institutional theory (Knight, 1992).

Institutional theory.

The institutional theory claims that the institutions are classified as either formal or informal (North, 1992). The formal institution deals with the formal arrangements between various actors, for example the political rules, economic rules and contractual arrangements, whereas the informal institutions deal with the informal arrangements which are extensions of the formal political and economic rules, such as unofficial rules that are recognised by the societies, norms of behaviour and standards of conduct.

It is known that institutions exist where individuals live and work and establish a framework in which social interactions take place. Institutions, that also include technical institutions, can be analysed from various perspectives.

a. Explanatory perspective. Institutional analysis can be used from an explanatory perspective, in order to explain institutional developments and changes, for example, the history of society and its current events.

b. Critical perspective. From a critical perspective, institutional analysis may be applied to determine whether the existing institutions pursue the goals for which they were developed.

c. Normative perspective. Using a normative perspective, institutional analysis helps to understand the development of institutions, which can give direction as to how to reform them.

Other applications exist, but institutional analysis was chosen as it can be applied to study many different aspects of social and economic life. The key to any institutional analysis is social interaction and institutions determine human behaviour. It is therefore a very useful perspective in order to answer the research question of this thesis, which asks, what factors influence the choices of stakeholders in the process of decision making procedures.

Assessment indicators of technical-institutional elements.

Institutional assessment.

To understand the factors affecting the decision making processes, USAID (2006) also designed an assessment framework for managing municipal service delivery that is able to be used in combination with institutional analysis. It has also been used to help analyse the institutional perspective for the current research.

This assessment framework is primarily used in order to understand the local municipalities who are responsible for effective delivery of municipal services like water supply, sanitation, wastewater, solid waste management and transport facilities. However, the current research focus on services related to drinking water.

USAID (2006) argued that local government agencies lacked the capacity to function effectively to meet the proliferating needs of the population. The principle purpose of the assessment tool was to evaluate the institutional perspective by understanding the following:

- Who exactly were the set of actors?
- What choices did they have to make?
- What were the stakes in the decision making processes?
- What concrete outputs were they trying to achieve?
- What the actual purpose was?
- How were the choices or decisions made?

This was done by analysing the prevailing conditions within the organisation that influence the stakeholders in order to make the choices they made. This helped to analyse the municipal body so that it was possible to identify the existing capacities and potential areas for improvements; and in order to help develop new potential projects and interventions with the intention of catering for the needs of the general public, especially the poor in effective ways.

The assessment framework illustrated in Table2 has been classified into assessing the aspects related to technical, financial, legal, regulatory, institutional frameworks, community participation and customer relations, that will be further explained in more detail (USAID, 2006).

Table 2: Institutional assessment framework indicators

No.	Parameters	Indicators
1.	Technical	a. Coverage and service levels b. Performance in terms of reliability, satisfaction, quality and quantity, operation and maintenance c. Capital investments
2.	Financial	a. Revenue sources b. Expenditures
3.	Legal, regulatory and institutional issues	a. Legal and regulatory frameworks for service provisions b. Issues related to frameworks, tariff, staffing patterns, operational and maintenance, human resource and capacities
4.	Community participation and customer relations	a. Involvement of communities in decision making processes b. Willingness to pay and demand assessments c. Social, cultural and community education

The technical aspects primarily deal with water assessment of:

- Existing infrastructure
- Engineering parameters of water supply
- Water supply quality

- Water supply quantity
- Water supply operation
- Water supply maintenance

The information needs to be gathered in order to understand the whole picture, including what is working optimally, what can be improved on and what is necessary to cater for new services and how to improve the current conditions. It also analyses what the paying customers required, to understand the needs and willingness of the communities to pay and/or accept new services. This analysis provides insights in order to formulate operational and capital investment estimates that are required to improve the services.

During this phase of the assessment, the analysis can be based on interviews with relevant stakeholders and secondary literature analysis of existing literature and reports on the current physical infrastructure, operational and maintenance reports, tariff and billing methods, existing and future project cost estimates and returns on investments; technical, engineering and financial reports; and focus group discussions with local experts and communities to understand the prevailing conditions. In order to meet the increasing demands of the reliable services, the financial status of the service provider plays a crucial role. It is important to analyse the financial aspects which primarily deal with the revenue sources[50] and expenditure patterns[51]. This results in understanding the financial challenges of the service provider in terms of perceived and actuals and they target towards *financial sustainability, affordability to customers and equality in the allocation of costs to end users*. In this phase of assessment, the analysis can be based on interviews and focus group discussions with relevant stakeholders and secondary literature analysis of annual balance sheets, profit and loss statements and tariff structures. Further, to understand the affordability of the end user, this phase also includes the analysis of households' income and expenditure patterns through interviews.

The analysis of legal, regulatory and institutional frameworks which act as a backbone to the service providers will help understand the existing challenges related to:

- Frameworks at local, national and central levels
- Different types of contractual structures between different agencies in providing services
- Decision making capacities of the authorities in terms of management and finances
- Organisational structures which manages day-to-day operations and communications
- Performance indicators

[50] Tariffs, user charges, loans, bonds equity investments, municipal subsidies, intergovernmental transfers
[51] Fixed and variable costs which include construction, operation and maintenance charges, salaries, depreciations, debt services, capital investments

- Human resource and its managerial and technical capacities
- Capacity building
- Training activities

This analysis will aid in planning for improvements in order to support a better working environment and any new interventions of the service provider. In this phase of assessment, the analysis can be based on interviews or focus group discussions with relevant stakeholders and secondary literature analysis of existing manuals, systems and procedures for departmental coordination, regulations, constitutions and chartering documents, law, organisational structures, staffing charts, employee agreements and statutory authorises.

The communities and customers play an important role in institutional assessment for effective service provision. It is important to understand the role of community participation and customer relations and what they perceive that they need in terms of their requirements, preferences, priorities and willingness to pay for services in the project planning or development phase, or decision making processes of the service providers. This phase of institutional assessment will also help to understand the gaps in the satisfaction levels of communities or customers with reference to existing services. The involvement of communities and customers in this phase of institutional assessment can be in the form of sample surveys, focus group discussions, public meetings and the formation of a citizen's advisory group that can create a platform for disseminating and collecting the required information between the public and the service provider(s) and it also has a secondary role of giving a sense of ownership to the communities.

Asset management framework.

The infrastructures in cities are the physical and financial assets of the municipal service providers. The proliferating populations within the cities are increasing the demands for reliable and affordable services. The assets of the municipalities in terms of service provisions include, but are not limited to, physical, financial and human resources (Lutchman, 2006). In order to cater for the infrastructure demands it is necessary to provide safe services that are financially sustainable and are safe for the public.

In order to make plans, it is vital to thoroughly understand the current status of the assets of the municipalities and plan for future interventions accordingly. The assessment of municipal service providers (or agencies) should be comprehensive and assessed in a systematic way which includes all of the possible indicators. The indicators that are needed for the assessment could be derived from an asset management framework (INGENIUM, 2006; Lloyd, 2010; R.V Anderson Associates Ltd., 2011).

There is a wide range of literature on asset management (BSI, 2008a; BSI, 2008b; INGENIUM, 2006; Hooper et al., 2009). However, it was claimed that even though the literature sources are vast, the International Infrastructure Management Manual[52] (INGENIUM, 2006) and the Institute of Asset Management's BSI PAS 55[53] (BSI, 2008) are internationally accepted as currently the most user-friendly and well-designed frameworks which help to evaluate Organisations for effective asset management (Esmaili, 2012).

The concept of asset management aims to enhance the life cycle[54] of physical assets by managing processes[55] in line with the current organizations polices and to develop a database for decision making (Hooper et al., 2009; Lloyd, 2010). In addition to these frameworks, with the growing concerns about the need for knowledge on the best possible practices for a prosperous municipal infrastructure (Hilton, 2007), "InfraGuide" on governance and integrated sustainable infrastructure (FCM, 2019) was formulated.

Deadman (2010) suggests that these asset management frameworks and best practice reports in principle provides guidance on asset management, identifies the management processes, challenges the identified processes, suggests plans or requirements for good asset management, gives operational perspectives, and provides guidance for implementation of the plans to improve the existing management processes. The asset management framework primarily deals with management, financial, economic, engineering aspects; activities and practices; risks and expenditures; targets; communication and data management; training needs and capacity building; interdependency on other services. All these aspects are broadly classified into six core areas viz. "climate"[56], "complexity"[57], "goals"[58], "tools"[59], "organization"[60], and "teams"[61].

Deadman (2010) further states that all of these elements operate as a function of social and environmental aspects. The literature on asset management also points out that effective management will result in cost-effective and sustainable service levels; optimise the service delivery and minimise the associated risks within the municipalities. It was argued that even though the challenges among different municipalities are similar in nature, the factors influencing them are often unique from one municipality to another.

These factors include demographics, geography and organisation (Coad, 2009). It is important to understand these factors before planning for improvements. There are various indictors from asset management frameworks for analysing the municipal service

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[52] Guidance manual for asset management
[53] Specification and self-assessment tool
[54] Include planning, designing, developing, operating, maintaining, monitoring
[55] Include planning, management, assessment, forecasting, decision-making, human resource,
[56] Deals with legislative and economic aspects
[57] Deals with physical infrastructure networks
[58] Deals with policies, goals and objectives
[59] Deals with management systems and procedures
[60] Deals with task grouping and optimizing processes
[61] Deals with shared objectives

provider (see Table 3) (INGENIUM, 2006; Lloyd, 2010; R.V Anderson Ltd., 2011; Hooper et al., 2009; Lloyd, 2010).

Table 3: Asset management framework

No.	Parameters	Indicators
1.	Technical Activities	a. Level of defined services b. Capacity, demands, needs and forecasting c. Performance and condition monitoring d. Risk analysis and management e. Financial evaluation and modelling f. Operations, maintenance and rehabilitation planning
2.	Organisational management	a. Strategies, plans and polices b. Customers and stakeholders' engagement c. Human resource management d. Roles and responsibilities
3.	Information management	a. Information and communication technology infrastructure b. Software architecture c. Data collection and management d. Internal and external communication
4.	External constraints	a. Political environment b. Legal and regulatory requirements c. Interdependent infrastructure networks d. Customer needs and expectations e. Demand and resource patterns f. Economic climate

Many Organisations use these indicators to assess their performance. Although there are many quality frameworks available, they are all broadly based on one or more of the following frameworks which are highly in use to improve the performance levels of the organisations (Rigby et al., 2011):

a. **Benchmarking performance.** A widely used performance measuring tool in terms of products, services and practices against competitors (Camp, 1989)

b. **Balance scorecards**. A widely used management tool and performance measurement framework dealing with customer satisfaction, internal business perspective, innovation and learning perspective and financial perspective. It not only provides the current performance scenarios, but it also helps to provide a future outlook of the organisation's performance (Johnson et al., 2007)

c. **Total quality management**. A comprehensive strategic management tool that focuses on improving the quality of processes and optimising the value of the customer (Montgomery, 2010; Thamizhmanii et al., 2010)

d. **Six-sigma**. A quality management tool which provides sigma levels to the measurements of the variability of the organisation's processes and reduce the variability. The measurements are carried out in the following six stages (Baskarada, 2009; Harry et al., 2010; Pyzdek et al., 2010):

- Definition of the problem
- Measuring the performance
- Analysing the measured performance
- Identification of problems
- Provide improvement solutions to the identified problems
- Control the improved performances in order to prevent the same problems happening again

e. **Lean**. A management philosophy that is aimed at improving the organisations processes by reducing the redundant or non-value-added activities (Lutchman, 2006).

All of these indicators primarily deal with leadership, policies, customers, performance, processes, human resource and outcomes; and they primary focuses on continuous assessment and performance improvements of the organisation (Esmaili, 2012). However, whatever may be the targets whether it is effective management or measurement, it is important to primarily have the knowledge of the current conditions of the organisation (or assets) to ensure optimum performance, reliability and plan for better future. The aspects or characteristics can be defined based on the objectives of the study.

2.3.3. Economic aspects in the integral water governance and management

Economic elements.

The degradation of environmental conditions all over the world raised the efforts of valuing or pricing environment and natural resources in order to prevent them from over-utilisation (Constanza, 1997; Navrud, 1992). Despite many studies and wide attention to the issue, the following questions have been widely discussed:

- What exactly are environmental goods and services?
- Can everything be valued?
- How can something be valued if it cannot be bought on a market?
- Can everything of value be monetarised?

Valuation in economics refers to the choices that are available to choose the best possible resources based on various values and value differences in a competitive market situation. This is a neoclassical value theory approach, which is based on monetary and expert-based analytical tools. Unfortunately, practical applications scarcely pay attention to the fundamentals of value theory and its assumptions. There are various approaches to valuation including the following:

a. **Hedonic utility**. This is cardinal based, focusing on physiological assumptions and pre-suppositions of the individual or group of individuals, helps to determine the best possible resources (Bentham, 1780; Jevons, 1871; Edgeworth, 1881).

b. **Utilitarian approach**. Similar to Hedonic utility, this is also cardinal based, focusing on physiological assumptions and pre-suppositions of the individual or group of individuals, helps to determine the best possible resources (Dolfsma, 1997; Camerer and Loewenstein, 2004; Muramatsu, 2006).

c. **Ordinal Theory**. Hedonic utility and the utilitarian approach were substituted with the ordinal based approach which focuses on the rational choices of select individuals the rationality of the choices is reinforced by instrumental actions. This valuation method has a monetarist approaches such as cost-benefit analysis, multi-criteria analysis (Schie, 2010).

d. **Utility Theory.** The utility theory (Loewenstein, 2000) based on the ordinal theory, the results are the weighted sum of the expected utilities with the assumption that the social actions are rationally motivated (Schie, 2010). However, this approach does not explain the actual behaviour of the individuals. The expected utility theory was then modified to subjective expected utility theory which primarily combines the individual utilities and probabilities (Savage, 1954).

e. **Neoclassical Approach**. Later, estimating the economic values used a neoclassical approach which is defined by the individual preferences (or choices) (Holland, 2002). The results of valuation in this particular approach are based on estimating the preferences of the individuals for any particular situation, in which the options for preferences are based on a constant factual information. The individual preferences are ideally dependent on the utility or the functionality of the options (goods and services) provided to them for selection. "It is the functions of goods and services to individuals that provide them with value" (Schie, 2010, Pp. 54).

   In an economic world, with competitive market situations, the value of goods and services depends on supply and demand. And to measure the value of these goods and services in any market situations, the market value (monetary) is taken as an appropriate indicator. It is evident that the market values of any goods and services are driven by market competition. And it also important to note that, not all values of goods and services are able to be expressed in the market, especially with respect to environmental goods and services. However, the neoclassical approach treats all the environmental goods as any other commodities in the open market (Vatn, 2005) and estimates the economic values of goods by utilising available market-based instruments. In certain circumstances, the values are appraised in terms of individual's Willingness to Pay (WTP) or Willingness to Accept (WTA) for any particular goods or services in monetary terms.

The neoclassical approach, which took the new face of valuation in economic analyses which was derived from the economic behaviour (Friedman 1953), is based on non-emotional perceptions (Bromley and Paavola, 2002) of the individuals in perfect market conditions. The perfect market is characterised by complete information to everyone, no transaction costs and only homogenous goods and services.

It is also important to consider the effective allocation of environmental resources for perfect competitive markets. However, in a pragmatic situation, perfect markets are hindered by market failures such as "imperfect competition, imperfect information, inappropriate government interactions, the existence of goods that are not reflected on the market, or existence of externalities" (Schie, 2010, Pp. 56).

The prime reason for market failures are due to the consequences of not appreciating the values (in terms of money) of environmental goods and services (Baarsma and Lambooy, 2005). Externalities are the side effects of human interactions with common collective environmental goods and services like, air, water and land (Pigou, 1938; Marshall, 1925). These common goods, otherwise known as Common pool resources, are disturbed by human actions which in turn affects the efficiency of other human actions (Ostrum, 1990).

In these circumstances, it is challenging to identify the information which is related to the polluters and sufferers. It is also important to consider that the maintenance of these goods and services, which are open to all, seems to have a free raider problem, resulting in failure of mitigating or reducing the externalities (Schie, 2010). The damages caused by an individual result in the suffering of other individuals and the efforts made by an individual to maintain the goods and services results in benefit of others. Pigou (1938), during this period introduced the concept of "internalise the externalities", where the government agencies collect money from the public to protect the environmental goods and services in the form of taxes and subsidies.

f. **Coase Theorem**. The concept of "internalise the externalities" was contended by the Coase Theorem which states that there need not be any government interventions in the markets for externalities, it claimed that the environmental goods markets and services work at optimum levels, irrespective of tax collections (Coase, 1960). However, in reality, transactions costs cannot be zero and these assumptions cannot be applied to the markets of environmental goods and services (Kahn, 2005).

g. **Environmental Economics**. The development of environmental economics led to the integration of economics and ecosystems (Turner et al., 1994). This undermined the basic principles of the neoclassical economic approach (Hardin, 1968). The externalities caused by the environmental problems need economic valuation. The environmental problems caused due to economic activities have an impact on ecological systems which in turn affect human welfare (Turner et al., 1994). The economic values of these environmental problems come into play during the analysis process of existing policies or when proposing or prioritising the policies and strategies (van den Bergh, 2001).

   In order to identify these economics values, which do not have market values, there is a need to use hypothetical markets, such as an individual's willingness to pay or accept. There are many other factors that influence the externalities that have an effect on the development policies, programmes and projects. The interaction between the environment and economics is influenced by social, institutional, political and cultural aspects. These are the underlying assumptions of ecological economics (Gelders, 2005).

   Ecological economics considers the interdisciplinary approach to appreciate the interrelationship between human economics and natural ecosystems. Ecological economics also argues that by using market mechanisms alone will not be effective enough to develop strategies and policies (Van den Bergh, 2001). However, despite the controversies, currently in practice, every economist still uses both the neoclassical approach and environmental or ecological economics in order to analyse the problems caused due to economic activities (Turner et al., 1994, Gowdy, 2004; Vatn, 2004; Gelders, 2005).

Economic valuation in terms of monetary measurements is very much needed to support the decision making processes regarding environmental issues (Ascher and Steelman, 2006). There are various methods available that applies a theoretical base using a neoclassical approach that are able to estimate the monetary values of the environmental problems, defined as total economic value. This is primarily based on the estimates of willingness to pay and accept. The monetary methods include, cost benefit analysis (Pearce et al., 2006; Navrud, 1992; Hanley and Spash, 1993) and (societal-) cost-based analysis (Pearce, Atkinson and Mourato, 2006), are most widely recognised and used methodologies, primarily based on societal values that are based on individual preferences which are expressed in terms of economically possible choices. These methods are based on hypothetical markets and shadow pricing, which measures either people's willingness to pay or to accept compensation for losses.

Many studies have been carried out on valuation methods by many authors. However, the common distinctions in various valuation methods described in various literature over a time period include: "the concern the perspective of the evaluator (internal or external), the manner of evaluation (rational or constructivist) and the timing of evaluation (ex-ante or ex-post)" (Schie, 2010, Pp. 38). It is evident that different evaluation methods and approaches are utilised with various combinations depending on what suits the study. There is also a transition in the applications of these methods and approaches, which require understanding.

The applications of valuation methods have shown over time a paradigm shift from unilateral decision making processes to more participative, constructive and responsive types of evaluation (van der Meer and Edelenbos, 2006). Now-a-days, the involvement of stakeholders in decision making processes has become a predominant practice, contrary to this, in the past it was subject to experimental designs and quantitative methods which focused on outcomes (House, 2001).

Regardless of the availability of various modes of (e)valuations, in practice, the evaluation modes that the government agencies in India often use remain embedded within the traditional top-down and non-participatory approaches of measurement, contrary to the more modern approach of: "more collaborative, bottom-up and integral fields of study characterised by interaction, communication and negotiation" (Schie, 2010, Pp. 44). For the best possible results, it is imperative to have democratic modes of evaluations focusing on the end users or stakeholders, reinforced with qualitative and quantitative methods. The economic effects of many policies are local, so the spatial horizon in economic analysis is sharply limited (Dietz et al., 2007).

Assessment indicators of economic elements.

Different environmental impacts require different valuation methods as shown in Table 4 (Shin et al., 1997).

Table 4: Assessment indicators of economic elements

Valuation methods	Pollution				Congestion			Degradation of natural support systems			
	H/S	P	A	EV	H/S	P	A	H/S	P	A	EV
Physical linkage											
Cost of productivity loss	-	X	-	-	-	X	-	-	X	-	-
Cost of illness	X	-	-	-	X	-	-	-	-	-	-
Human capital	X	-	-	-	-	-	-	-	-	-	-
Replacement cost	-	X	-	-	-	X	-	-	X	-	-
Behavioral linkage											
Revealed preference											
Hedonic pricing: property value differen	X	-	X	-	X	-	X	X	-	X	-
Hedonic pricing: wage differential	X	-	X	-	X	-	X	X	-	X	-
Travel cost	-	-	X	-	-	-	X	-	-	X	-
Averting/ mitigating behavior	X	X	-	-	X	X	-	X	X	-	-
Stated preference											
Contingent valuation	X	-	X	X	X	-	X	X	-	X	X
Contingent ranking	X	-	X	X	X	-	X	X	-	X	X

H/S – Health and Safety; P – Productivity; A – Amenity value; EV – Ecological value; X – useful method; - - method unusable

This matrix is based on the assumption that the major urban environmental problems can be classified into pollution, congestion and the degradation of natural support systems. These problems have adverse effects on health and safety can be evaluated and or given an ecological value. The environmental impacts for health and safety can be measured by either physical or behavioural linkage methods. Productivity loss and material damage mainly require valuation by physical linkage methods, although the averting or mitigating behaviour approach can be applied as a supplementary technique. Amenity value is estimated either by revealed or stated preference methods. Ecological value refers mainly to the nonuse values attached to the extinction of species of the destruction of ecosystems; it is primarily derived from stated preference methods. Valuation techniques will be used to estimate the environmental benefits expected from pollution control – that is, the value of environmental improvements over the original condition.

However, the focus should be on estimating the total costs of identified urban environmental pollution. To do so, the monetary costs of identified environmental pollution from a natural clean state must be evaluated (Scott et al., 2007; Barry et al., 2002; Turner et al., 1993; Markandya et al., 1992; Hussen et al., 2003; Burningham et al., 2004; Vincent, 2003; Maler et al., 2003; Hanley et al., 2002; Balsdon et al., 2000; Kolstad et al., 2000).

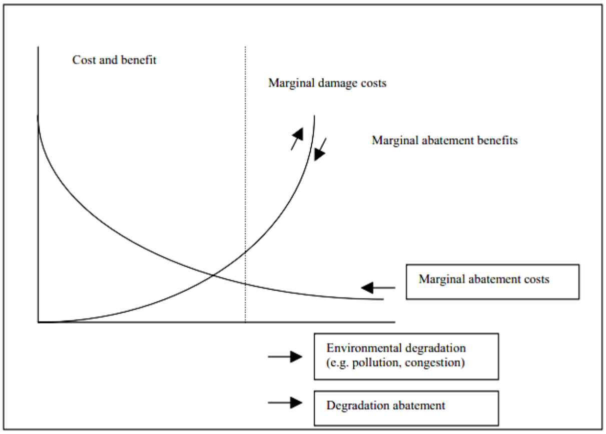

Figure 4: Costs and benefits of environmental degradation

In figure 4, at any point, the marginal damage costs of one additional unit of pollution is the same as the marginal abatement benefit of preventing one unit of pollution. Marginal damage costs are the mirror images of marginal abatement benefits. However, when all existing pollutants are eliminated, the total damage incurred at the existing level of pollutants becomes identical to the total benefits of pollution control. Understanding this distinction is critical in applying the various techniques of valuating total environmental damage. To obtain the total cost of environmental problems, abatement costs, plus the costs of defensive measures undertaken, must be added to the remaining damages (Edwin, 1975).

In reality, the total damage cost of one additional unit of pollution will not be the same as the monetary values of reducing one unit of pollution, unless there are additional values that are measured. Therefore, additional strategies, action plans and policy interventions need to be proposed to make the marginal damage costs equal to the marginal abatement costs (Langer et al., 2007). The damage costs and abatement costs are also dependent on the socio-economic status of the individual or household (Wasike, 1996). The better the socio-economic status of the individual or household the more willing the individual or household is to pay towards abatement costs. They are directly proportional. In the case of a low socio-economic status, the ability to pay towards abatement costs is reduced and they are more prone to increased damage costs. Therefore, the aspects or characteristics for economic valuation can be defined based on the objectives of the study.

2.3.4. Systematic and integrated approach

Having a systematic and integrated approach.

The prime objective for any possible solutions is to satisfy the proliferating requirements that support the human activities, support sustainability of services, taking into account the environmental and social demands and support the sustainability of institutions. Since provision of safe and adequate drinking water for slum populations is becoming more complex due to the factors that were discussed in the previous sections, there is a need for a decision making approach in order to provide drinking water services to the slum populations to prevent the negative impacts on the environment, society and institutions.

In order to achieve these objectives, the decision making must take place using systematic and integrated processes which should be standardised (Caswell, 1990; DFID, 1998).

There is an extensive range of literature that discusses the need for decision making processes that need to be integrated and conducted in a systematic way. Considering the negative impacts on the environment and society caused due to the management practices over the past few decades. There is a need for a paradigm shift towards a systematic, interdisciplinary and integrated approached of natural and social sciences in planning and decision making processes in development projects (Soentoro, 2011). At this juncture, understanding what the various terms are is vital. According to oxford dictionary, the term "systematic" is defined as "done or acting according to a fixed plan or system; methodical"; and the term "integrate" is defined as "combining (one thing) with another to form a whole".

Systematic analysis is when a process broadly follows the basic steps of theory formulation, deriving and making observations and drawing conclusions (Moore, 1966; Skocpol, 1979; Collier and Collier, 1991; Rueschemeyer et al., 1992; Moravcsik, 1998; Hall, 2006). Another definition of systematic analysis is a step by step procedure involving definition of a problem, observations, declaration of hypotheses, design of experiments and testing of hypothesis (Turban and Meredith, 1985). It was claimed that all the definitions of "research" include the essential notion of "systematic" (Godin, 2001; Oxford dictionary; Webster dictionary). However, it was argued that there was a transformation of the definition of systematic analysis in definitions of research from an emphasis on the scientific method to an emphasis on institutionalised research; it is used for measuring research and to its limitations (Godin, 2001; UNESCO, 1977). Despite these changes, it can be argued that the more systematic the process of a decision taking place, the greater the possibility of taking a prioritised correct decision (Caswell, 1990; Gilb and Maier, 2005).

As there are both human and technological elements within the process, by taking a step by step, sequential or an organised approach in the decision making process one is less likely to miss vital elements and be able to reach the solutions in a logical, critical thinking and intelligent way and this consequently leads to better outcomes or results by overcoming negative externalities, reducing the number and severity of the mistakes, errors and failures (Frank, 1975; O'Looney, 1998; Hammond et al., 1999; Walker, 2000; Malakooti, 2011).

On the other hand, the process is said to be an integrated decision making analysis if it has the potential to take into account conflicting, multidimensional, incommensurable and uncertain effects (Ananda et al., 2003). It was argued that decision making cannot be based on a single decision criterion and a single scale of measurement, which would make it impossible to make decisions only based on intuition and limited knowledge (Schmoldt et al., 1994).

The approach needs to consider and analyse all crucial aspects that are influenced or influencing the decision making in the service provision that includes the hydrological systems, the economic, social, technical and environmental aspects and the institutional system that exists in the area. This not only integrates all important aspects of the system as an integrated whole system, but it also improves the quality of decisions that are made by preventing negative impacts. It was also argued that if the solution can not satisfy all the objectives, trade-offs which involves giving relative importance to preferences of the goals should be considered to find the best solution (Walker, 2000; Sharifi, 2002b; Soentoro, 2011).

The decision process framework which has integrated the above-mentioned aspects could help decision makers to reach a consensus and gain stakeholder participation, accountability and commitment to the decisions that have been made (Soentoro, 2011). According to DFID (1998) the challenge is not just to set up a multi-component analysis, but to make the components work together coherently, so that the whole is greater than the sum of the parts, especially when dealing with community participation as an integral component of the decision making process.

2.4. Conceptual Framework

Taking into consideration the importance of “systematic” and “integrated” approaches within the decision making processes, it is important to define clear objectives for the decisions that need to be taken in the drinking water sector. The decision making process in the services provision sector is said to be systematic and integrated unless and until the decisions taken result in providing services to all of the consumers in a sustainable way in terms of financial status of the service provider, environmental aspects of the community, technological aspects of the services, equity considerations in terms of treating all users groups, effectiveness in terms of universal access to the services, efficient in terms of service delivery and good governance in terms of accountability to users, transparency, and customer involvement in decision making process (DIFD, 1998).

Therefore, all of the decisions taken should lead to the delivery of drinking water satisfying these following conditions with respect to the delivery of drinking water services. Table 5 illustrates the factors influencing the elements of the systematic and integrated decision making process.

Table 5: Factors influencing decision making process

Elements	Description	Factors influencing	Category
Financial Sustainability	Financial sustainability of the service provider	Managerial, financial, governance, external constraints	Institutional

Elements	Description	Factors influencing	Category
Environmental Sustainability	Environmental sustainability of the community	Physical infrastructure pertaining to drinking water suiting the conditions of the communities; spread of water pollution conditions in the communities; depleting water resources; social-health conditions in the communities	Social and technical
Technical Sustainability	Technical sustainability of the physical infrastructure in the community	Physical Infrastructure pertaining to drinking water suiting the conditions and acceptance of the communities	Technical
Equitable	All the users are treated equally	Quality drinking water, quantity of drinking water, coverage of physical Infrastructure pertaining to drinking water without any discrimination in terms of the community’s socio-economic conditions	Technical and social
Effective and Efficient	Universal services in cost-effective and efficient way	Innovative technologies; damage costs and preventive costs and estimate caused due to unsafe and inadequate drinking water; communities willingness to pay and accept	Technical, economic and social
Good Governance	Accountability to users, transparency, stakeholder involvement	Managerial, governance, external constraints and stakeholder involvement in decision making processes	Social and institutional

Table 5 also suggests a relationship between the factors determining systematic and integrated decision making processes and S.I.T.E valuation. Considering the above-discussed theoretical notions, in the current research, the decision making process “S.I.T.E. valuation” which intends to provide safe and adequate drinking water to slum areas is based on understanding and analysing four vital aspects namely: social, institutional, technical and economic in order to have a systematic and integrated decision making process. The factors affecting the decision making processes are considered from these four distinct, but interrelated areas as illustrated in figure 5.

The first level of influence are the ***institutional aspects***, which are part of decision making processes that reflect the interplay of various stakeholders, functions and influencing factors in an organisation responsible for providing safe and adequate drinking water.

The second level of influence are ***technical aspects*** that are required to provide safe and adequate drinking water. It refers to the immediate inside element of institutions and is directly related to the institutional aspects. This level of influence reflects the quality, quantity and infrastructure conditions that are related to drinking water services.

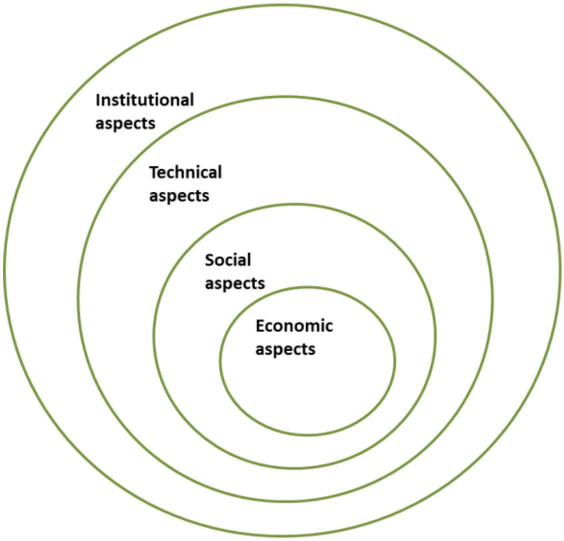

Figure 5: Institutional, technical, social and economic aspects

The third and fourth levels of influence are the most significant levels of influence as they are related to the consumers. These are the ***social and economic aspects.*** They are directly influenced by the technical aspects of drinking water. These aspects play a significant role in the decision making processes. These levels interplay between the social-health conditions and the economic (monetary) values that were caused due to drinking water services in the case study area. These levels consider the socio-economic health impacts that were caused due to the drinking water challenges and are under the influence of the technical aspects. The social-economic-health conditions influence the economic values (monetary costs) caused due to the drinking water challenges, which directly influence the institutional aspects and, in turn, the decision making processes.

The context of this research was based in slum areas in metropolitan cities in India where the challenges faced by the municipal service providers and policy makers was the poor quality and quantity of drinking water and the opportunity realised was the systematic and integrated approach to (e)valuate the challenges and collective actions in decision making process for improving the deteriorating conditions in cost-effective way. The decision making processes in providing safe and adequate drinking water in India were built on the above mentioned four aspects (see Figure 5). They formed the research circle with broad queries that needed to be integrated in the decision making process such as:

- Which technical values of drinking water are there?
- Which social-health impact(s) were caused due to this?
- What were the economic (monetary) values of the impacts?
- What were the values of the institutions (service providers) responsible for better service provision?

The relationship between these four levels of influence in the decision making process has been illustrated in Figure 6. It shows that the technical aspects of drinking water affect the social health conditions of the society. These, in turn, affects the economic (monetary) values. The economic (monetary) values of the impacts have an effect on institutions, which in turn affects the technical aspects of drinking water. Figure 6 shows how understanding and estimating the values of these aspects of drinking water are able to provide a comprehensive understanding of the prevailing challenges for taking decisions in order to provide safe and adequate drinking water.

It is important to have a clear goal or objective for decision making processes in the drinking water sector. The ***decision making process*** is considered to be ***systematic and integrated*** if the ***decision taken*** for providing safe and adequate drinking water is:

- ***Sustainable*** - Financially, environmentally and technically
- ***Equitable*** - All the users are treated equally with safe and sufficient drinking water
- ***Effective and efficient*** - Universal services in a cost-effective way without any social health impacts and damage and preventive costs
- ***Good governance*** - Accountability to users, transparency and customer involvement in the decision making processes

Therefore, a good "decision" should have these states of affairs with respect to the provision of safe and adequate drinking water services. The factors influencing the decision making process in drinking water sector in Indian metropolitan cities has formed the basis for the conceptual framework used in this study. The ***technical aspects of drinking water, social-health conditions, economic (monetary) values and institutional values*** of unsafe and inadequate drinking water are the functions of ***systematic and integrated approach to the decision making process for providing safe and adequate drinking water*** in the Figure 6.

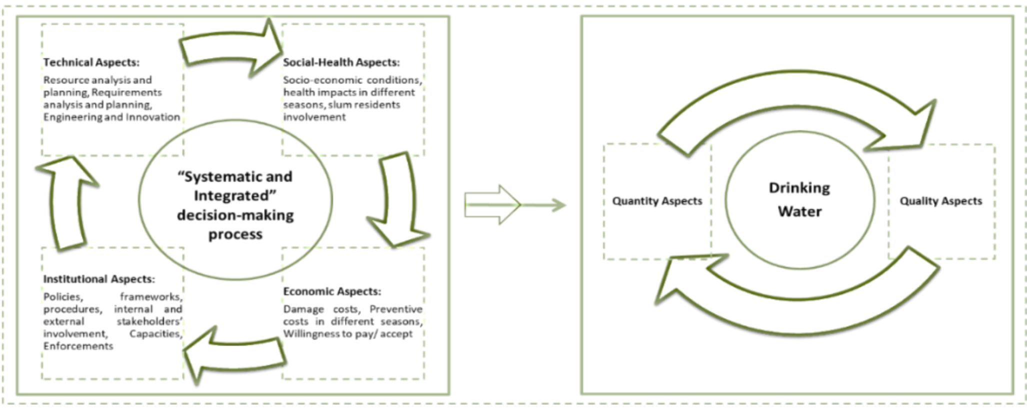

Figure 6: Conceptual framework

As shown in the Figure 6, the key technical values influencing the decision making process are resource analysis and planning, requirements analysis and planning, engineering and innovation aspects. In addition, the key economic values of the whole of the population in terms of damage costs, preventive costs and willingness to pay and accept new or better drinking water services play a critical role in decision making processes. The social health impacts act as a bridge between technical and economic (monetary) values. The key social-health values are to identify the socio-economic statutes, the health impacts that have been caused due to unsafe and inadequate drinking water and the involvement of slum residents in the decision making processes. This provides vital information to understand the effects of the poor technical values of drinking water services and to estimate the economic (monetary) values. In addition, any decision making processes are influenced by policies, legal and regulatory frameworks, political interferences, roles and responsibilities of all stakeholders and agencies, interplay between different agencies, community participation, availability of resources and feasibility of providing services.

Broadly, the key factors relevant to institutional values are to understand the policies, frameworks, procedures, internal and external stakeholders’ involvement, capacities, and enforcements, etc. They should provide a clear and appropriate policies and a stable institutional framework, to achieve a transparent, comprehensive, systematic and integrated approach to decision making. The current research also aimed for this. Institutional analysis played an important role in this process, in addition to the analysis of technical, social and economic (monetary) aspects.

The research conducted an appraisal of the academic literature regarding the concepts of environmental economics and their applications in evaluating the environmental costs caused due to increasing pollution levels. It also considered various limitations to the concepts of environmental economics. The research further conducted an appraisal study of existing policies, concepts of environmental economics as policy tools, policy application of the tools and its limitations. Further, it considered the applications of environmental valuation methods and policy frameworks at the city level of Hyderabad, India.

The analysis of academic literature policies and supporting documentation critically reflected upon the background basis of the study and helped to understand environmental economics and its usage. By reviewing the policy frameworks of valuation methods in general and at the city level, it was possible to analyse the nature, applications and implementation processes, which would be at a later stage useful in developing policy related recommendations or proposals in order to nullify the externalities or environmental costs caused due to environmental problems.

The research also conducted an in-depth literature study on the institutional theory, institutional economics, value theory, theories on the decision making process in public administration and on the practical findings in Government and other parastatal agencies who are responsible for water supply and distribution to the case study area of Hyderabad metropolitan region.

A detailed analysis was carried out in the selected case study area which primarily focused on the social aspects, physical conditions, environmental conditions and existing (e)valuation methods that were used to analyse the environmental conditions and in particular, the water related conditions. The study included a collection of relevant data from the concerned departments, reconnaissance surveys, focus group discussions and detailed documentary analysis. Further, a detailed analysis was conducted on the processes that were aimed at the involvement of social and institutional stakeholders in the selection and implementation of existing or proposed strategies and policies and current or proposed practices related to the valuation methods of the environmental conditions.

This analysis considered the participatory action research, which was predominately qualitative with a participatory research methodology. This kind of participatory research is often related to participant observation, in-depth focus group discussions and a literature analysis. The analysis focused on identifying the different stakeholders that were involved, analysis of existing institutional relevant government and parastatal agencies, what were the existing strategies and policies that were already in place and what were the proposed strategies and policies for betterment, practical and scientific goals of the strategies and policies, integration of strategies and policies for the improvement of the drinking water quality and standards with different strategies related to other infrastructure facilities and services, different National and State level policies, vision documents, master plans, development plans, ward plans, infrastructure plans and detailed project reports.

Social-health considerations.

The focus on valuing the social-health aspects of the problems and solutions used the notion and indicators of social (impact) assessment methods. The social assessment or social (impact) assessment of the existing or proposed strategies and policies and the government actions is the estimation of social consequences that have occurred or are likely to occur. Social assessment provides a framework for prioritising, gathering, analysing and incorporating social information and participation into the design and delivery of strategies and policies for the improvement of conditions. It ensures that solutions: (i) are informed and take into account the key relevant social issues; and (ii) incorporate a participation strategy for involving a wide range of stakeholders.

Social (impact) analysis was very appropriate in the current research because it helped to frame the strategies and policies which were more inclined to social development concerns, especially enhancing the standard of living conditions of the urban poor population and minimising the adverse social impacts (CGG, 2006).

Social (impact) assessment is an iterative process that can be organized in a phased manner in several stages, which is primarily based on documentary analysis, and participatory action research. The indicators of social (impact) assessment, as a part of current research study includes identification of relevant human environment and area of case study and baseline conditions (viz., demographic factors, socio-economic determinants, health conditions, social organization, social-political context, needs and values), the social factors or variables, relevant information and priorities, stakeholders and public participation.

Institutional considerations.

The current research which focused on services related to drinking water used an institutional analysis approach to understand the factors affecting the decision making processes. The principle purpose of the assessment tool was to value the institutional perspective by understanding the set of actors that have a stake in the decision making processes, how the choices or decisions were made, this was done by analysing the prevailing conditions within the organisation that influenced the stakeholders in making the choices.

The assessment framework that was used was typically classified into assessing the aspects related to financial, legal, regulatory, institutional frameworks, community participation and customer relations. The analysis of legal, regulatory and institutional frameworks which act as a backbone to the service providers helped to understand the existing challenges that were related to the frameworks at local, national and central levels; different types of contractual structures between different agencies in providing services; decision making capacities of the authorities in terms of management and finances; organizational structures that manage the day-to-day operations and communications; performance indicators; human resource including their managerial and technical capacities; capacity building and training activities.

In this phase of assessment, the analysis was based on interviews and focus group discussions with relevant stakeholders and secondary literature analysis of existing manuals, systems and procedures for departmental coordination, regulations, constitutions and chartering documents, law, organisational structures, staffing charts, employee agreements and statutory authorises. Further, the communities and customers play an important role in institutional assessment in order to have effective service provision.

It is important to understand the role of community participation and customer relations and hear their voices in terms of requirements, preferences, priorities and willingness to pay for services in the project planning and development phases, or decision making processes of the service providers. This phase of the institutional assessment also helped understand the gaps in the satisfaction levels of communities or customers with reference to the existing services. The involvement of communities and customers in this phase of institutional assessment was in the form of sample surveys, focus group discussions, public meetings and the formation of a citizen's advisory group in order to create a platform to disseminate and collect the required information between the public and service providers and it also demonstrates a sense of ownership among communities.

Technical considerations.

The technical aspects primarily deal with the assessment of existing infrastructure, and engineering parameters of water supply and current conditions of the water supply quality and quantity, operation and maintenance levels are to understand the deficiencies and for new services or improvements from the current conditions. It also deals with customer requirements to understand the needs and willingness of the communities to pay (or accept) for new services. This analysis will provide insights for formulating operational and capital investment required to overcome the identified deficiencies.

In this phase of the assessment, the analysis was based on interviews with relevant stakeholders and a secondary literature analysis of the existing manuals and reports on the existing physical infrastructure, operational and maintenance reports, tariff and billing methods, existing and future project cost estimations and economic returns on investments; technical, engineering and financial reports. There was also focus group discussions with local experts and communities to understand the prevailing conditions.

In order to meet the increasing demands of the reliable services, it was important to investigate the financial status of the service provider(s) that played crucial role(s). It was also important to analyse the financial aspects, which primarily dealt with the revenue sources[62] and expenditure patterns[63]. This resulted in understanding the financial challenges of the service provider in terms of perceived and actuals and targets. In this phase of assessment, the analysis was based on interviews and focus group discussions with relevant stakeholders and secondary literature analysis of the annual balance sheets, profit and loss statements and tariff structures. In order to understand the affordability of the end user, this phase included the analysis of relevant households' incomes and expenditure patterns through interviews.

Economic considerations.

The valuation of the environment requires (e)valuation of multiple factors, which involves different approaches and methods to arrive at the desired outcomes. The current research study focused on the indicators of ***physical linkage*** and ***behavioural linkage*** methods to

[62] Tariffs, user charges, loans, bonds equity investments, municipal subsidies and intergovernmental transfers

[63] Fixed and variable costs which included construction, operation and maintenance charges, salaries, depreciations, debt services and capital investments

estimate the damage costs of drinking water pollution problems and preventive costs of problems and solutions to mitigate problems caused by drinking water pollution.

a. **Physical linkages**. The physical linkages method or damage function methods examine the technical relationship between environmental degradation and physical damage without taking in to account the subjective preferences of the affected people.

b. **Behaviour linkages**. The behaviour linkage method assumes that the value of environmental goods should be based on people's willingness to pay to secure a better environmental quality or to escape environmental deterioration. Behaviour linkage methods can be subdivided further depending on whether preferences are revealed indirectly through market behaviour or stated directly, as in a survey.

c. **Revealed preference/ Surrogate market**. The revealed preference approach, also referred to as a surrogate market approach, which occurs wherever an individual must consume some amount of market goods in order to get utility from a non-market good such as environmental quality. The stated preference approach assumes that people would respond to hypothetical market situations as if they were actual markets. While revealed preference methods value people's values directly from responses by affected parties, for example in surveys. This later approach allows consumer surplus to be estimated, which is important in many environmental contexts. It can also be used to determine willingness to accept compensation for damages. The stated preference method is also called the survey or contingent valuation method (Mitchell et al., 1989).

Quality and quantity aspects.

The drinking, or potable water, is classified as having tolerable levels of quality in terms of its physical, chemical, bacteriological parameters so that it can be safely utilised for drinking and drinking purposes (WHO, 2004). The current research study focuses on assessing the quality of drinking water and quantity of water that meets the minimum daily requirements of the individuals or households in the selected study area, which was the base for problem (e)valuations. This critical phase of the research study was based on (a) stakeholder assessment (include user perceptions), (b) expert judgment.

a. **Stakeholder assessment.** This study analysed the collected empirical data from the concerned authorities or parastatal agencies during the literature review stage regarding quality parameters which included colour, odour, pH values, dissolved solids, hardness, alkalinity, elemental compounds and quantity of drinking water for the select case study area. The empirical data was then compared with the desirable or permissible levels of quality of drinking water. In the case of any gaps in the data that was collected and analysed, detailed focus group discussions were conducted with the key players from the respective authorities and parastatal agencies to fill in the details, though the accuracy of the database remains uncertain, particularly in relation to the errors in estimating the pollution levels, which were nullified using expert judgment.

In terms of quality of drinking water, the consumer's perception of physical and aesthetic parameters of drinking water played a vital role, sometimes exceeding the actual quality of the water as it concerned the quality of drinking water for the user communities (Sheat, 1992; Doria, 2010). Relying on the users' own senses may lead to avoidance of highly turbid or coloured but otherwise safe waters in favour of more aesthetically acceptable but potentially unsafe water sources (WHO, 2004). Therefore, in addition to the discussions with the authorities and parastatal agencies, primary surveys and focus group discussions were carried out to assess the human sensory perceptions of taste, odour and colour (appearance) of drinking water with the representative population size of the study area (WHO, 2012; Doria, 2010).

b. Expert judgement. Further, to authenticate and reinforce the stakeholder assessment, the Rapid Assessment of Drinking Water Quality (RADWQ) methodology that is based in UNICEF's Multiple Indicators Clusters Surveys (MICS) was carried out (Howard et al., 2003; UNICEF, 1995). The methodology uses a cluster sampling approach across the study area for testing the select parameter of drinking water sources. The objective of sampling is to collect a small portion of water, at the source point, transmission point and consumer end point, which can be easily transported to a laboratory, without contamination or deterioration and which should accurately represent the water being supplied and stored.

A cluster sampling method is then carried out. The water sample, from the sources, supplies and storage, selection needs to be geographically close to one another, they need to be in "clusters", and should be representative of all of the water supply technology types (WHO, 2012). The drinking water samples need to include source point, transmission and consumer end. They need to cover locations which are most vulnerable in the supply system.

The study made a comparison of water qualities at the source point, transmission point and consumer end. The analysis of the quality of the drinking water that was stored in the households of the select sample population size of the select study area. The results were then compared with the standards given by the Government of India and the World Health Organisation and then they were further analysed to (e)valuate the health impacts.

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Chapter 3

Research Design and Methods

Chapter 3 | Research Design and Methods

The purpose of this thesis is to investigate the independent variable: What is the decision making process for providing safe and sufficient drinking water to the urban poor population? The scientific or empirical part of the thesis is to investigate the dependent variable: What is the quality and quantity of drinking water of the urban poor population? The current research wishes to demystify the key theoretical concepts, frameworks and arguments in social and environmental sciences which are related to the research study. By doing this, it led to develop a novel approach called "S.I.T.E valuation." This approach includes Social, Institutional, Technical and Economic aspects of the decision making process in order to confront environmental externalities. The current research focused on quality and quantity of drinking water in the case study area which was the slum areas and population in Hyderabad city region, India.

3.1. Philosophical positions

In order to achieve the S.I.T.E valuation mentioned above, the philosophical positions[64] which influenced this research were primarily considered. The philosophical strands in any research which were connected with natural and social sciences, play a significant role in creating a platform for conducting research (Williman, 2006). Different authors in different research studies have used various terminologies[65] for explaining these philosophical ideas and methodologies used. It is necessary to understand the views and issues ranging from the broad ideas to the specific problems. Each idea needs to be considered within the research approaches and methodologies which were used and in the overall research study. In order "to ensure intelligibility" to the current research, broadly, the epistemological positions "positivism or post-positivism", "interpretivism" which focuses on ontological positions "objectivism" and "constructivism" were all taken into consideration (Marsh et al., 2002).

The complex nature of the current research, dealt with a wide range of elements, which required both rational and perceptional discernments. The author's epistemological and ontological assumptions are positioned in "shared criteria" or "collective knowledge" between positivism/post-positivism, objectivism, interpretivism and constructivism. The author took the position of both "interpretist" (primary position) and "positivist" (secondary position) and by switching between these two roles depending on what the

[64] Otherwise known as ideas or assumptions which are the hidden rudiments that are acting as the foundation stone or "basic set of beliefs that guide the action" (Guba, 1990) or "the set of common beliefs and agreements shared between scientists about how problems should be understood and addressed" (Kuhn, 1962)
[65] For instance, ontology (Crotty, 1998); epistemology (Crotty, 1998); paradigms (Lincoln et al., 2000; Mertens, 1998); broadly conceived research methodologies (Neuman, 2000)

situation demanded, in order to meet the requirements optimally and to gain knowledge. The explanations below detail the linkage between philosophical notions and the current research, in different phases of the research.

(Phase 1) Developing a theoretical framework.

The current research initially focused on the ontological position "constructivism" in order to "understand the research gap and identifying the key theories and concepts" in the literature and from the epistemological position "interpretivism" through a literature review. The process, which was purely subjective or interpretive in nature, led to the construction of a theoretical or analytical framework which was for the systematic and integrated decision making process to provide drinking water facilities and services. This was the point of departure for operationalising the research study and for the next phases, as detailed below.

(Phase 2) Analyzing the dependent variables.

During this phase the research focused on the ontological position "constructivism" so that it was able to "understand the quality and quantity levels of drinking water" in the case study area through the epistemological notion "interpretivism". This was carried out by means of questionnaire-based interviews of a representative sample size of the population within the case study area, in order to understand the "perception" of the population in terms of their perceived quality and quantity of their drinking water.

The process, which was purely subjective in nature, led to the construction of facts about the quality and quantity of drinking water through the perceptions of population and the researcher. The research also focused on the ontological position "objectivism" to be able to understand "what were the standards of drinking water" in the case study area, through the epistemological notion "positivism and post-positivism" by collecting the samples of drinking water and conducting laboratory tests to measure the quality parameters.

The study then made a comparative analysis of the current situation of both the quality and quantity of the drinking water in the case study area and took into account the drinking water international and national standards, to identify the gaps and challenges. This process of "collective knowledge" served to validate the findings from both approaches and arrived at reliable conclusions regarding the quality and quantity of drinking water in the case study area.

(Phase 3) Analysing the independent variables.

This phase focused on the ontological position "constructivism" in order to "understanding the decision making processes in providing drinking water facilities and services" in the case study area through the epistemological notion "interpretivism". This was done through questionnaire-based interviews using a representative sample size of the population within the case study which was in order to understand the "perceptions" of the people in terms of decision making processes. The process, which was purely subjective in nature, led to the construction of facts about the decision making processes through the perceptions of population.

The research also focused on the ontological position "constructivism" in order to "understand the decision making process in providing drinking water facilities and services" in the case study area through questionnaire-based interviews directed at the stakeholders at the Institutional level and focus group discussions to understand the decision making processes. The process, which was purely subjective in nature, led to the construction of facts about the existing decision making process. The study then further made a comparative analysis of the current aspects that were considered in the decision making process and the theoretical framework in order to identify the gaps and challenges. The process of "collective knowledge" was used to strengthen the findings from both of the approaches so that it was possible to arrive at reliable conclusions and construction of facts about the Institutions, regarding the decision making process in the case study area.

(Phase 4) Relationship between independent and dependent variables.

Based on the inferences drawn from phase 2 and 3, the research further analysed the relationship between the quality and quantity of drinking water which were the dependent variables and the decision making processes which were the independent variables by identifying the corresponding patterns of analysis and the factors determining the quality and quantity of drinking water in the case study area. The research then was able to confirms and or modify the theoretical framework and was able to provide recommendations to improve the existing decision making processes in order to provide an adequate quality and quantity of safe drinking water facilities and services to the population in the case study area.

This was a novel framework as it integrated the values of social, institutional, technical and economic aspects into the decision making processes. This did not only address the environmental concerns in a new way in various government and non-government agencies but it was also able to contribute to extant knowledge, "S.I.T.E valuation" which was a systematic and integrated approach that was used in tackling externalities that were caused due to environmental problems.

3.2. Research Design

This research study used a new approach for the case study area in order to evaluate the drinking water of the urban poor population and decision making procedures in providing drinking water facilities and services to the urban poor population, it considered a "shared knowledge" of positivism and interpretivism. Marsh et al (2002) argued that any alternations in ontological and epistemological assumptions would unswervingly influence the approaches and methods. From a philosophical position the current research is in its entirety associated with majorly interpretist and partly positivist notions and the study required a mixed methodological approach as a research strategy. Considering the positions of ontology and epistemology discussed in the previous section, they direct the approach to theory and the methods that were required for the current research. Marsh et al (2002) along with Hay (2002) further claimed that epistemology and methodology were very much dependent on each other. However, the links between them were important but were far from determinant (Read et al., 2002).

Qualitative with a hint of Quantitative approach.

According to Kanbur (2003), research studies with mixed approaches typically tend to lean towards either qualitative or quantitative approaches, rather than being concurrently used. However, there were examples of research studies that use both approaches concurrently and they have a distinct dichotomy. The research study has also predominantly considered qualitative analysis that had primarily involved open-ended questionnaire-based interviews, focus group discussions, academic and analysis of policy documents which were related to the subject area, regarding the perceptions of quality and quantity of drinking water and decision making processes.

These were also methods that were used in interpretivism and constructivism notions, whose results were always subjective in nature, with rich descriptions. For the current research, the study of the behaviours and relationships of stakeholders that determined the quality and quantity of drinking water involved an active participation of the researcher in the development of methodologies, review and analysis of relevant literature, participant observations and review of the active involvement of relevant stakeholders through interviews and focus group discussions (Galvin, 1998). In addition, the current research assessed in detail the quality and quantity of drinking water through laboratory tests and perceptions, using suitable techniques. The testing of the quality of drinking water was only done in the identified case study area.

This research study used primarily qualitative methods. The literature and empirical research were simultaneously conducted, in mutually influencing and contributing processes. The literature and empirical data were gathered via a predominantly qualitative process and then triangulated methods were used to collect and analyse the information from the multiple sources. The triangulation method was used in order to strengthen the study and increase the methods’ validity. *The strength of one approach was able to compensate for the weakness of another* by using both methods this was so that they would complement each other, and the cross-data validity checks were used to reconfirm any findings (Read et al., 2002; Patton, 2002). For instance, the qualitative information, which lacked the richness of information in terms of generalisability, was able to be reinforced with the quantitative findings and the quantitative information, which lacked the notions of reliability and validity, which was able to be reinforced by the qualitative findings (Gavin, 1998; Lunt et al., 1996).

The current research study is social sciences based, required a deductive mode of approach in order to gain logical conclusions without diverting from the basic idea (Danermark et al., 2002). In order to test the theoretical framework, the empirical and perceptional analysis was used as and when it was required, which is further outlined in the subsequent descriptions.

Many of the procedures in the study were continuously repeated, there was an interplay of theory and data which either confirmed or revised the ideas in order to achieve the set objects of develop a systematic and integrated decision making process so that it was possible to provide safe and adequate drinking water facilities and services.

Thus, the research was not only a deductive analysis, but it was able to provide a comprehensive understanding and it gave added value to the empirical analysis and outputs (Samantha et al., 2013). The current research did not only use empirical data, which was calculated using scientific methods, it was also rich in information which was qualitative data. The qualitative data analysis required a flexible process, unlike the quantitative data analysis, which was more of a repetitive mechanical process (Srivastava, 2009; Bruce, 2007; Harper, 2003; Mauthner et al., 2003). The iterative approach was a process, which dealt with qualitative information analysis in a systemic, repetitive and successive approach to deduce concrete inferences. The current research followed a retroductive approach in combination with an iterative approach which will be further explained in the following section.

3.3. Research Strategy

Retroductive approach.

The interplay of theories and data or evidence is best described as a retroductive approach, it is a combination of deductive and inductive (Downward et al., 2007; Downward et al., 2006; Tashakkori et al., 2003; Saether, 1998; Ragin, 1994; Samantha et al., 2013). In a retroductive approach, the starting point is to have a theoretical framework (Samantha et al., 2013). However, in the process of constructing ideas or theories and analytical frameworks for the research studies, the knowledge might be a combination of ideas from different fields (Peirce, 1934).

The theories or concepts from the literature were used as a basis which was deduced to an analytical framework. The data from qualitative, quantitative or mixed methods was then used to make a procedure from the inferences. The empirical data analysis in relationship with quantitative data analysis supported each other in order to arrive at these inferences. The interplay between the analytical framework and the inferences resulted in tackling the current research problem.

As mentioned earlier, qualitative analysis is reflexive when compared to quantitative analysis, which is scientific and formula oriented. Patton (2010) argued that qualitative data analysis is like a process of the work of an investigator, it is like, *getting into one's head* (Srivastava, 2009).

Iterative approach.

In order for the qualitative data analysis to arrive at significant and meaningful results, sequential tasks need to be performed multiple times, which is in accordance with an iterative approach (Mills et al., 2010). There have been many studies describing qualitative analysis (Lincoln et al., 1985; Miles et al., 2014; Patton, 2002; Strauss et al., 1998). And others that have effectively used and described the iterative approach (Kock, 2003). The iterative approach is used in order to provide the required flexibility in data collection and analysis in response to the research study. The iterative approach is a process of qualitative analysis which includes data collection and preliminary analysis of this data is carried out like a pilot study. If the method of data collection is found to be at fault if something needs to be changed it allows for the alterations in the analysis improvements were able to be made and new ideas can be generated in order to improve the analysis (Berkowitz, 1997; Srivastava, 2009).

The data collection process was conducted in multiple cycles, which were known as iterative cycles, with sampling frames that were relevant to the study. There was specific information collected that was related to the research study making the analysis robust, reliable and valid (Srivastava, 2009).

Mills et al (2010) argued that information needs to be collected until saturation point. The iterative cycles of qualitative data analysis should be carried out until there is no more information to be found which is related to the research study.

The current research study used both of the retroductive and iterative approaches that acted as the research strategies. The ideas, analytic frames, evidence, data and images acted as building blocks (Hartig, 2011) within the current research which can be visualised on the right side of Figure 7 (Author, 2018). The base model on the left side of Figure 7, was adopted from Ragin (1994) was adjusted by integrating the iterative approach and stating the philosophical positions of the researcher (explained in the earlier section).

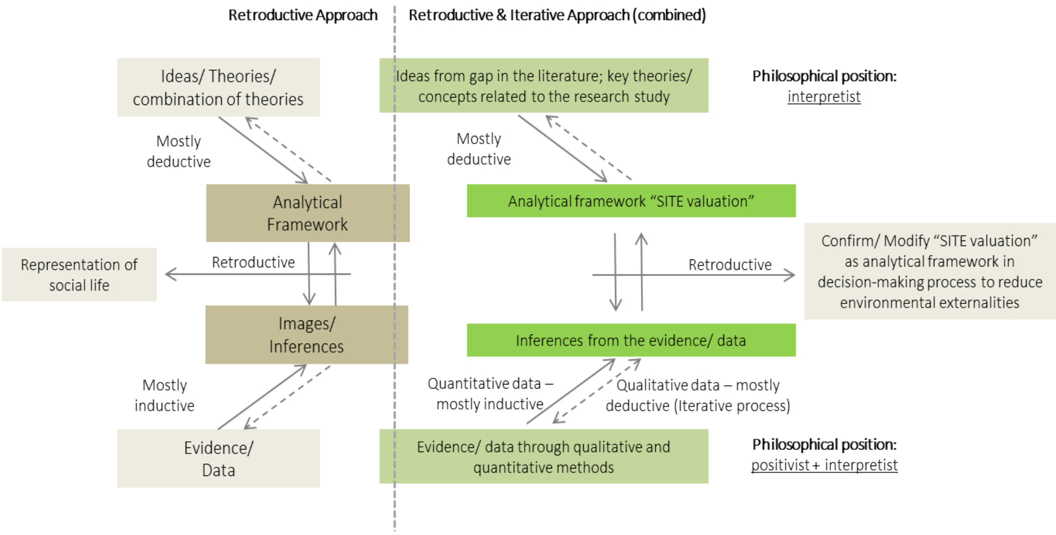

Figure 7: Research strategy

The current research, which is retroductive in nature, primarily focuses on identification of “ideas”[66]. A systematic and integrated “analytical framework” called “S.I.T.E valuation” was developed by combining different proven theories and ideas. The evidence or data was collected which was a mix of qualitative and quantitative data to form the “image” or to understand the actual reality. The iterative process, which primarily dealt with the qualitative analysis, helped comprehend and understand and significantly support building the “image”. The interplay between the analytical framework and the image will led to interpretations (Ragin, 1994). Based on these interpretations “the analytical framework was able to be confirmed, refuted or amended” (Hartig, 2011). Nonetheless, the confirmation, rejection and modifications of analytical frameworks were common in any research field. The introduction of new frameworks is a derivation from the retroductive process (Ayim, 1974).

The current research, through the retroductive process, led to confirmations and modifications of the “S.I.T.E valuation” as a systematic and integrated analytical framework for decision making processes which was used to provide safe and adequate drinking water facilities and services, based on inferences drawn from the qualitative and quantitative analysis.

[66] Gap in the literature and problem formulation through practical findings will be the point of departure for identification of theories and framing the analytical framework

3.4. Research Methods

Case study approach.

Yin (1994, 2003) stated that the selection of the type of strategy or the combination of strategies chosen to complement each other is dependent on definite conditions such as the type of research questions, control of the events and the type of phenomenon[67]. In addition, the type of strategies can be broadly classified into experiments, interviews, archival analysis, history and case studies. Considering the complex nature of the current research study and in order to comply with all the said conditions and achieve the best possible results, it was decided that the combination of case study and interviews was the best fit (Benbasat et al., 1987; Darke et al., 1998; Yin, 1994). The combination of a case study and interviews is illustrated in Figure 8 (Author, 2018).

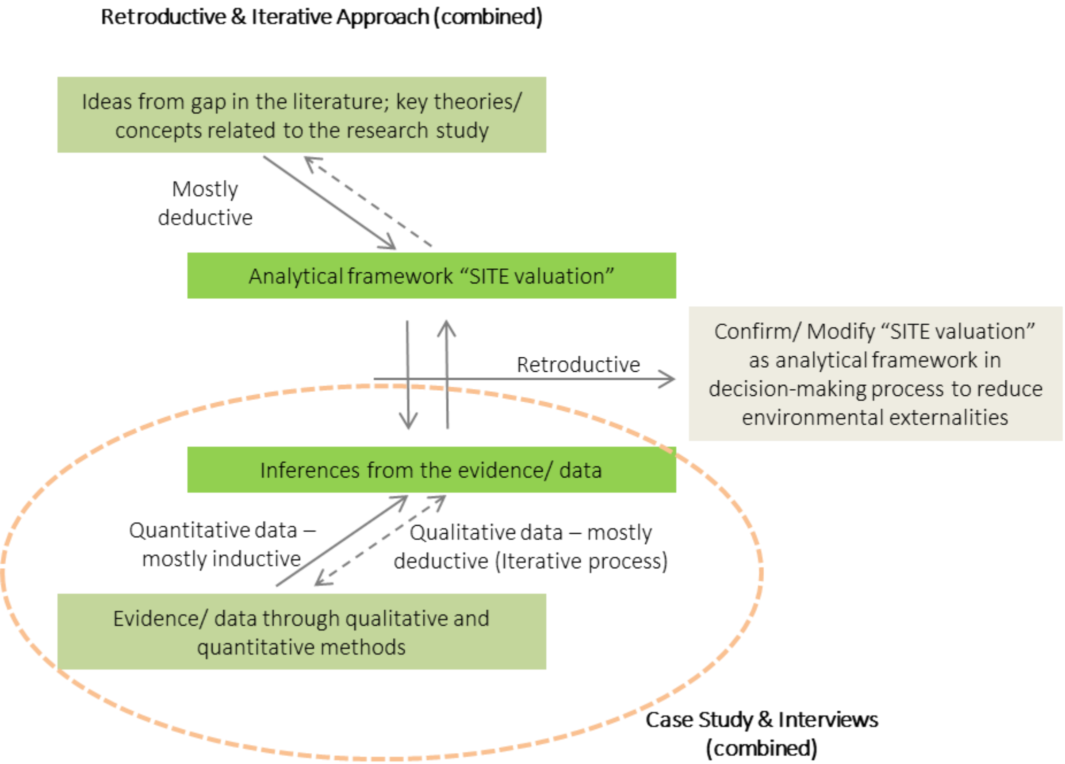

Figure 8: Research methods

[67] Contemporary or historical

The selection of a case by the case study research was the first task (Seawright et al., 2008) and it must be noted that the selection of the case(s) was not in an arbitrary fashion (Yin, 1994). It was important to understand the factors influencing the selection of the case(s) and to justify the selection process for the identified case(s) as an integral part of the selection procedure. Further, in order to increase the quality aspects of the selection process of the case(s), it was important to consider the factors such as (a) "appropriateness" which was related to the purpose of the study and the phenomenon of inquiry that has been defined in the research questions and sub-research questions, data requirements and sources and methods of data collection and (b) "adequacy" that was related to the number of cases that were considered for the study (Kuzel, 1999; Miles et al., 1994; Patton, 1990).

Qualitative Comparison Analysis (QCA).

In order to compliment the qualitative approach and case study approach, the case-oriented qualitative comparison approach was used to accomplish the desired outcomes so that it was possible to better address the current research questions and sub-questions defined in the earlier sections. QCA is comprised of a group of techniques that were of significant importance to cases, configurations, conditions, combinations of factors or variables and contexts or outcomes in any disciplined research. Rihoux et al., (2013) identified cross-case patterns and generalises the phenomenon (Rihoux, 2007; Cairns et al., 2017; Ragin, 1987, 2000; Punton et al., 2016; Sehring et al., 2013).

This signifies that the QCA has the advantages of both a qualitative method which focuses on the cases and a quantitative method which focuses on generalisation (Sehring et al., 2013; Blatter et al., 2007; Lauth et al., 2008; Rihoux, 2003, 2006, 2008a, 2008b). QCA is more complex than the traditional case-centered methods of agreements and disagreements so that it is possible to overcome their disadvantages[68] and transcends many limitations of solely qualitative and quantitative approaches (Ragin and Fiss, 2008; Tierno et al., 2016; Ragin, 1987, 2000, 2008; Vis, 2012; Mill, 1843; Cress and Snow, 2000; Woodside, 2016; Vassinen, 2012; Sehring et al., 2013).

Rather than using the traditional correlation methods and other conventional quantitative methods, the advanced QCA method, which is grounded in Boolean logic and set-theory, was used to establish the casual relationships between cases through systematic comparisons in order to identify cross-case patterns, and to comprehend the variations, similarities and differences, and understand the factors influencing these variations

[68] The disadvantages of traditional qualitative comparative analysis include difficulties in identifying a common difference and determining the cause of phenomenon, non-applicability to all the studies (having both positive and negative results)

Historically, the QCA is used for various purposes and can broadly be classified into (a) case or data summary, (b) exploring case diversity (similarities and differences), (c) evaluate or test existing theories, (d) assess new ideas or propositions, and (e) elaborate or refine theories or develop new theoretical arguments (Schlosser et al., 2009; Marx et al., 2014).

The two key concepts that were associated to QCA, that have been developed in recent times, were consistency and coverage to determine the relevance of cases, diversity of cases and their heterogeneity (Marx et al., 2014; Tierno et al., 2016). There were many advantages associated with QCA such as:

- Providing in-depth focus on cases
- Ability to draw cross case patterns and understand the complex and multiple causations
- Usage of small-N or intermediary-N cases (N: 5 to 50, over 100)69 which need not be a statistically significant sample size in order to carry out quantitative analysis and that can be too large a sample size to carry out quantitative analysis
- Comprehend the important influencing factors and effect of combinations of factors on the outcomes
- Allow results or findings to be tested and/or replicated elsewhere. It allows for generalisation
- Ability to generate lessons and recommendations

However, there were also some disadvantages that were associated with QCA such as 10 cases were required as a practical minimum, in-depth information for each case is required, no missing information pertaining to the factors and variables of the theoretical framework, as it may lead to situations in which important influencing factors may be ignored, a scoring processes involving the researcher's judgement which makes it purely subjective, iterative procedures between findings, analysis, cases and theoretical framework which leads to reformulating factors and new rounds of data collection. This requires excess time and resources to obtain accurate and sufficient data (Rihoux, 2007; Sehring et al., 2013; INTRAC, 2017; Baptist and Befani, 2015; Punton et al., 2016; Ragin, 1984, 2000; Przeworski and Teune, 1968; Schatz and Welle, 2016).

Considering the advantages of QCA, the current research attempted to follow this alternative approach instead of the more conventional qualitative or quantitative methods to understand the relationship between independent; - decision making procedures with social, institutional, technical and economic aspects as sub-factors and dependent; quality and quantity of drinking water facilities and services provided to the urban poor population variables of the research's theoretical framework in the proposed study areas. Particularly,

[69] The number of cases cannot be as low as 10. This will not exhibit the benefits of QCA (Schneider and Wagemann, 2012)

the causations, being able to identify the governing factors in a systematic and integrated decision making framework in order to provide safe and adequate drinking water facilities and services.

It is important to understand the general procedures involved in conducting a QCA. This method initially requires a theory of change which is translated into a theoretical framework with definite independent factors, which were the influencing factors or conditions and dependent factors, which were the outcomes (Punton et al., 2016).

This activity is followed by identifying the cases and units of analysis for which the theory of change is valid. Further, in any QCA study, the case selection cannot be on random basis, rather it needs to follow a theoretical reasoning and knowledge. Once the cases and factors were finalised, it is vital to investigate everything that has to be known about each case and the factors influencing the cases. This involves collecting relevant information through primary and secondary sources for each case and discovering the potential factors. The information collecting methods may include semi-structured interviews, field observations and literature reviews.

In order to bring the collected data for each factor to a common platform, the qualitative and quantitative data is converted into scores using Boolean algebra. For example, crisp-set QCA scores the data using binary factors such as "0" or "1" and fuzzy-set QCA uses values between "0" and "1", for example, "0", "0.33", "0.66", or "1". In turn, the level of presence or absence of all the factors were looked at in each case to further arrive at aggregated scores for each case. These represent as "truth tables" for the research study.

The next step is to analyse the datasets and scan through the scores across the cases to comprehend the patterns and be able to present a combination of factors which includes more than one pathway that appear to be present or absent within the cases. This activity includes summarising the findings, majorly stating asymmetrical relationships such as "necessity" and "sufficiency" that co-exists between conditions and outcomes and representing them in the form of statements or diagrams.

At this point, it is important to note that the defined conditions in the theory of change may not be solely causing the outcomes or completely influencing the outcomes. There can also be external conditions or factors, which were not initially considered, that influence the outcomes. Therefore, as a next step, it is important to have an iterative process also known as a retroductive approach, as opposed to an inductive or deductive approach, of going back and forth between data collection, analytical findings, cases and theory of change, otherwise called the theoretical framework to refine and increase the robustness of the case analysis and the theoretical framework based on the emerging new insights during the analysis (Ragin, 1987, 2000, 2008; Schneider and Wagemann 2012; Schatz and Welle, 2016; INTRAC, 2017; Rihoux and Ragin 2009; Olsen, 2019).

Qualitative data collection using the Likert scale.

The current research, which emphasises conducting investigative research and discovering the perceptions of the end users, analysing the of decision making procedures regarding and the aspects of safe and adequate drinking water in the slum areas, used a unique combination of data capturing methods and analysis in order to provide a better understanding of the research problems. The practical approach to social sciences can include using methods which were best suited to the research objectives without getting into the philosophical debates about which is the best approach. The purpose here is not to showcase that one approach is better than the other and it is not fair to do so, considering their varied approaches, assumptions and contributions (Hoepfl, 1997; Neill, 2007; Firestone, 1987; Siegle, 2002; Gall et al., 1996) and which remain true to their own identity (Salomon, 1991). However, studies may explicitly consider the strengths of qualitative and quantitative methods in a sequential way and in a fashion that they complement each other and overcome the limits of individual approach (Creswell et al., 2004; Barton and Lazarsfeld, 1955; Sale et al., 2002).

This hybrid way of approaching data collection has only included an additional second method to the dominant method so that it is possible to overcome the drawbacks in the dominant method (Boucherf, 2015). The data, either qualitative or quantitative, can be analysed using qualitative or quantitative data analysis techniques. These were popularly known as mixed methods (Creswell, 2009) such as nested designs (Yoshikawa et al., 2008; Rogoff et al., 1975). This involves choosing a main framework and methodology to formulate the research and subsequently adding a technique from another methodology (DePoy and Gitlin, 1993; DePoy and Gitlin, 1998; Creswell, 2009) to arrive at the anticipated results of the current research. These types of mixed methods offer logical and practical alternatives (Burke et al., 2005). For instance, the descriptive data collect can be coded for quantitative analysis and the statistical data gathered using Likert scales can be presented qualitatively (Secrest and Sidani, 1995).

Although there were various pros and cons linked to qualitative, quantitative and mixed research strategies, there were no prescribed rules for combining different strategies. These were determined by factors such as: What would the researcher like to discover?, What were the analytical objectives?, What data collection instruments should be used?, What data should be collected?, What is the geographical distribution of study population? (Bogdan and Biklen, 1998; Silverman, 2000; Borg and Gall, 1989; Cooper and Schindler, 2006; Miles and Huberman, 1994; Krathwohl, 1998; Howe and Eisenhart, 1990). In the commencement phase of the study, the author used structured questionnaires to understand the perceptions of households regarding the quality and quantity of drinking water and decision making procedures followed by the drinking water service provider.

This research, which used qualitative comparative analysis, primarily focused on capturing qualitative data which was initially supported with limited quantitative data. The purpose of qualitative research was to explore a narrow phenomenon in depth and that of quantitative research was to collect the breadth or variations (Hawa and Raman, 2001). Typically, the sample sizes that were used for qualitative analysis were smaller than the sample sizes used for quantitative analysis (Harry and Lipsky, 2014; Thompson, 2011; Babbie, 1989; Bogdan and Biklen, 1989; Yoshikawa et al., 2008; Ritchie et al., 2003). This was because the data obtained for qualitative analysis was very detailed from a small sample size and any increase in sample size than required resulted in diminishing returns of value in contribution of new evidence. Further, the in-depth analysis from a smaller sample size did not require incidences and establish statistical inferences (Ritchie et al., 2003).

However, in order to overcome the criticisms of qualitative data analysis such as a limited applicability or generalisation with regard to the larger population or other settings or contexts or theories which was also known as empirical and theoretical generalisation, smaller geographical distribution of study population, subject to missing on capturing critical aspects (unless an adequate sample is considered) (Daniel, 2017; Haradhan, 2018; Harry and Lipsky, 2014; Thompson, 2011; ACAPS, 2012; Abusabha and Woelfel, 2003; Cohen and Manion, 1989; Chambers, 2007), a large population over a wide geographical area was used as a sample size for data collection and analysis to collect variations among the cases or population.

Ritchie et al (2003) mentions that there should be a distinct definition of possible ways to carry out in-depth qualitative research with a larger sample population. There were certain limitations with qualitative data capturing and analyzing from large sample population such as large quantity of data which is rich in details will have inconsistency in specificity, range, depth and discussion patterns across the sample population, the interviewer could be emotionally involved with people and space, subjective and biased because of unstructured or semi-structured and non-standardized processes of data collection instruments detract from the objectivity of the study, respondents' distinct interpretation (belief) of the world from the reality, respondents' providing different answers to the same questions on the account of socio-economic status, educational and cultural position, emotional status, health conditions, learnings, resource (cost, labor and time) intensiveness, requirement of experienced interviewers to pursue potentially important and unanticipated ideas that arise during interviews, subject to achieve unambiguous interpretations and results, tedious exercise to capture and analyse the data relating to a large population in an inefficient and inconsistent form, etc (Daniel, 2017; Atieno, 2009; Yauch and Steudel, 2003; Bowen, 2006; Rahman, 2017; Tewksbury, 2009; ACAPS, 2012; Karina et al., 2012; Chambers, 2007; Cohen and Manion, 1989; Borg and Gall, 1989; Robson, 1995; Gall et al., 1996; Bogdan and Biklen, 1982; Merton and Kendall, 1946; Flick, 2009; Skager and Weinberg, 1971; Bryman, 2006).

Therefore, qualitative data needs to be transformed into quantitative data in terms of frequencies which can be compared (Flick, 2009). In order to have a more valid and valuable pragmatic approach and to overcome these difficulties associated with handling or capturing data from a statistically large representative sample of the population attitudinal scales, such as the Likert scale, the Thurstone scale and the Guttman scale need to be used.

These scales have advantages in data collection such as improved validity and substantiation of pre-approved (or pre-accepted perceptions and questions of reality), standardized and easy tool to capture data by the interviewers with limited proficiency in interviewing and knowledge about research, gathering standardized and easily comparable information in an efficient and consistent way, avoiding the effects of interviewer's and respondent's conditions, less cost and time to capture and analyze data, minimize variations amongst the interviewers collecting the information, adequately cover all possible options of subject's experiences (Bell, 1996; Penny et al., 2009; Daniel, 2016; Glasow, 2005; Borg and Gall, 1989; Kathwohl, 1993; Oppenheim, 1992; Martin and Bridgmon, 2012; Black, 1999; Balnaves and Caputi, 2001; Singh, 2006; Haradhan, 2018).

Further, to make it easy for the respondents to appreciate the scale used for each of the question in the questionnaire, the labeling of responses and the optimal number of scale points are most critical. Firstly, there can be multiple ways to label the responses, i.e., by using words, numbers and images (Lucian, 2016; Alwin, 1997). The images that can be visually appealing include tick boxes, thumbs up/ down, pictures, etc, allowing relational conjectures (Johnston, 2008; Reichmann, 1964; Kunin, 1998). However, studies signify that using "words" for labeling the responses in the questionnaire are more preferred and comfortable to respondents, easy to understand and answer, fast to answer, better to express feelings, produce more true answers, avoid neutral points, etc. (Derham, 2011; Chrystal, 2008; Krosnick and Berent, 1993; Dickinson and Zellinger, 1980). Secondly, the number of scale points should be equally distributed, continuous, reliable, valid and complete. For better response, the number of scale points for each question can range between two-point and seven-point (Anderson et al., 1998; Krosnick and Presser, 2009; Joshi et al., 2015; Klockars and Yamagishi, 1998; Habibi et al., 2014; DeVellis, 2003; Harry and Deborah, 2012).

One of the major drawbacks associated with attitudinal scales is restricting and forcing the respondents to the scale with defined parameters. This may bias the respondent answers and there is a possibility of missing out on the actual responses that the respondent would intend to convey (Schwarz et al., 1985). To address this situation, the combination of open and closed questions should be considered. In addition to a set of closed substantive options, the researcher may also consider including "other" as open-ended option, wherein, the respondent will have the flexibility to answer beyond the substantive options.

But there is a higher possibility that the respondents will choose an answer only from the substantive options (Schuman and Scott, 1987).

Therefore, in order to overcome this limitation in the current research, the questions along with the set of answer choices in the questionnaire that were used for the study were comprehensive. Prior to conducting the detailed field level interviews of the entire sample case study areas and population, attitudinal scales were defined. They were defined for each of the questions in the data gathering instruments which was based on an extensive literature review and a pre-test.

The pilot pre-test was comprised of preliminary field level interviews and focus group discussions. This was comprised of open ended questions, so that the researcher was able to familiarise himself with the context and ground-level reality. This was carried out until a saturation point was reached in order to recognise the possible range of responses. this occurred when no changes were needed to be made to the questionnaire with any additional information that would be gathered (Locke, 2001; Guest, Bunce, and Johnson, 2006; Aguinis and Solarino, 2019).

The responses collected were then grouped into relatively smaller numbers of categories. These details were further considered and build into the comprehensive questionnaires that were then used. The questionnaires were used to collect the perceptions of slum residents from the entire sample. The questions were regarding the quality and quantity of the residents drinking water as well as which decision making procedures were followed by the government agencies that were providing the drinking water facilities and services in the selected case study areas.

Further, the second phase of the study was limited to stakeholders in an Institution which was responsible to provide drinking water services and facilities in the study area. Therefore, the study administered unstructured questionnaires to collect the stakeholders' perceptions at an Institutional level on decision making procedures to provide drinking water facilities and services. However, the qualitative data that was collected using open-ended questions was converted into a 5-point scale. To aggregate, analyse and synthesize the data and make the best use of unanticipated information and overcome the disadvantages of focus group discussions (Flick, 2009).

A post-coding strategy was then applied whereby data categories were developed in relation to the responses generated aftermath (Aitken and Thomas, 2009). The other procedures of converting qualitative data into measurable quantitative data include first- and second- order coding, hermeneutics and qualitative data programs (Kuckartz, 1995; Mathes and Eckert, 1995). The primarily objective was to uncover key insights and patterns associated with qualitative comparative analysis, in order to compare the independent and dependent variables and their results, that is why they were both brought onto the same scale.

Questionnaire-based interviews and focus group discussions.

As a research strategy, using interviews and focus group discussions in combination with a case study approach, for any research study, was beneficial in capturing the required information from the selected case studies suitable for the research study. This approach primarily involves collecting the data through interacting with the individuals and groups who were assumed to have the anticipated information.

The collection of data was based on a set of questions relating to the research study's variables in the formal or informal formats for questionnaires and checklists. These questionnaires were the only means of gathering first-hand information, thus playing a vital role in any research studies (Oppenheim, 2001). Oppenheim (2001) points out that questionnaires or checklists which can be close-ended and/or open-ended, were the cheapest means of data collection without any bias, there was less cost of processing the data and the best way to cover a wide range of the population and relevant stakeholders within the study area. These were the means taken in estimating the values of challenges and solutions from the research participants. The questionnaires and checklists were used for household interviews and Focus Group Discussions (FGDs) designed to ensure that appropriate information is collected from the required respondents. The information collected using the questionnaires had information that was simple to analyse and correlate with marginal variability of findings.

When using questionnaires for data collection, there was however a possibility of unwillingness and inability of the respondents to provide the required information, human biases and misunderstanding issues were caused due to semantic difficulties. However, the mentioned glitches can be avoided by vigilant framing and phrasing of questions, Systematic and controlled data gathering by trained investigators to retrieve comprehensible reactions and information during the interviews, Cautious interpretations using clear recognition of the limitations of the data, Understanding of what exactly the data represents and looking at facts in relative rather than absolute terms (Hamza, 2014). Creswell (2009) also suggested testing the questionnaires or checklists to refine the questionnaires and determining the feasibility and usage.

Therefore, the pilot questionnaires that were initially designed were given to a sample population to ensure that the questions were clear, concise and straightforward. The questionnaires were then redesigned based on the feedback from the pilot survey which was comprised of a sample population of 35 people which included 5 stakeholders in organisations and 30 residents in the identified slum area.

The redesigned questionnaires were again piloted on a sample population before finalising it. Then the finalised questionnaires were used as an instrument for personal interviews and focus group discussions for which the responses were noted. Considering the population of the current research, despite the availability of different modes of data collections[70], the researcher was solely directly and personally involved without any support from any other investigators in the data collection process. The data collection process included capturing the perceptions of households on quality and quantity aspects of drinking water at all the identified sample case study areas, perceptions of households on decision making processes, drinking water sample collection for laboratory testing of quality aspects and perceptions of stakeholders at the Institutional level on decision making processes.

The objective of the research study was to assess the quality and quantity of drinking water and discover which decision making processes were involved in providing the drinking water facilities and services to the urban poor population. It was only possible to do this research using questionnaires, interviews and focus group discussions. The questionnaires were used for various groups of the population which were comprised of households in the case study area and concerned stakeholders at Institutional level.

The questionnaire formats helped to collect a broad range of required reliable information pertaining to the socio-economic characteristics, physical conditions, perceptions, motivations and attitudes of respondents. The questionnaires and checklists that were designed and used were divided into three categories, primarily to collect information regarding:

- Perceptions of households on:
  - Quality of drinking water,
  - Quantity of drinking water
  - Decision making processes followed by authorities to provide drinking water
  - Sources of drinking water
  - Challenges that were faced due to the drinking water conditions
- Drinking water quality
- Which decision making procedures were followed by the government agencies to provide drinking water facilities and services.

The questionnaires and the checklist prepared are primarily based on the parameters defined in the theoretical framework.

a. **First questionnaire**. ***Questions regarding perceptions of households on the existing quality and quantity of drinking water*** - The questionnaire was partly used to assess the perceptions of households on the existing quality and quantity of drinking water. These questions were closed questions that were based on the 5-point Likert's scale. This was done to collect the perceptions, namely, the satisfaction levels, of households regarding the existing quality and quantity of drinking water

[70] Personal interviews, interviews via the telephone, interviews via hard copy and email correspondence (Dornyei, 2007)

that was supplied to them through different sources. ***Questions regarding drinking water quantity, water sources and facilities*** - Closed and open-ended questions were used to understand the drinking water quantities, existing drinking water sources, other facilities and the challenges faced due to existing drinking water conditions at the household and community levels in the identified case study areas. ***Questions regarding household perception of water authority*** - This questionnaire had open-ended questions with respect to the perception of households on the level of amount of consideration given to the various aspects in the existing decision making processes which were carried out by the institutions to provide safe and adequate drinking water facilities and services. ***Focus Group Discussion (FGD) questions*** - Open ended questions were used in the Focus Group Discussions (FGDs) in order to obtain responses that were relevant, in depth, lengthy and helpful in order to figure out more about the current situation. The detailed questionnaire has been provided in Annex 5A.

b. Second Questionnaire. *Checklist questions to assess the drinking water quality levels* - The checklist to assess the drinking water quality levels was designed with open ended questions to record the drinking water quality values that were deducted during the laboratory tests. The checklist was further designed to identify and compare the quality parameters of drinking water supplied in the case study area with the standard drinking water quality. A detailed checklist has been provided in Annex 5B.

c. Third Questionnaire. *Questions regarding decision-making procedures in Government agency* – Closed and open-ended questions were used to understand the decision making processes followed by the government agencies to provide adequate and safe quality and quantity drinking water to the identified case study areas. The questionnaire was designed to assess the responses of the stakeholders on various aspects of the existing decision making processes which were carried out by the government agency who were responsible for providing drinking water facilities and services. The detailed questionnaire has been provided in Annex 5C.

3.5. Unit of Analysis and Case selection

According to Koepsell (2005), the term "unit of analysis" is defined as an item on which data values are summarized in order to draw inferences or to arrive at generalisation. There are nearly an infinite variety of possible units of analysis and there is no limitation as to what could be studied. Social researchers are able to study just about anything that has a relevance to social life. However, it is vital in any research studies, particularly in the case of a nomothetic study, which refers to qualitative studies or a combination of qualitative and quantitative studies, to have a clear understanding as to what should be studied. The units of analysis are the units of observations in any research study (Rubin et al., 2008). These are also known as the units of observations, dealing with individual entities or aggregates, which needed to be differentiated, in order to determine what observations needed to be made about whom and what.

Contrary to this, from the viewpoint of Dimiter (2016) and Koepsell (2005), the units of analysis and units of observations can be different and must be differentiated. Units of analysis try to find concrete conclusions, whereas units of observations are used in data collection this is relevant for any descriptive analysis. For example, if classes in a school are defined as units of analysis to describe the characteristics of the students, the units of observations are students in those particular classes.

It is difficult to make these kinds of differences between units of analysis and units of observations in the case of exploratory studies or qualitative research (Koepsell, 2005). By making a distinction between these two terms creates more confusion rather than giving us the clarity. It is only essential to ponder upon the concept of units of analysis or observations that we want to describe and analyse, thus in the absence of identification of units of analysis or units of observations, there is a possibility of drawing invalid conclusions as the assertions about one unit of analysis is based on the examination of another. For the purpose of exploring, describing or explaining which unit of analysis is to be generalised, it is primarily important to define and clearly differentiate the units of analysis and anticipate the potential outcomes in the first place. This can be identified using an accurate understanding of the research questions, theoretical framework and methodological explanations.

Researchers in the Social Sciences typically choose individual entities as units of analysis or multiples of them for analysing various parameters pertaining to them and then combine the findings of the respective units of analysis to provide a composite view to represent the whole. This is in order to explore the inter and intra linkages between units of analysis (Rubin et al., 2008).

These units can broadly be classified into micro and aggregate (macro) levels of analysis. The presence of such multiple data and analytical hierarchies or clusters, involving multiple units of analysis, are inevitable in any social or human or biological research (Goldstein, 1999; Snijders and Bosker, 2012; Hox, 2002).

For any research studies, the lowest possible unit of analysis belong is the micro level and combinations of multiple micro level units of analysis for generalisation belong to an aggregate (macro) level of analysis. The generalisation of any research study is based on an aggregate (macro) level of analysis. There are different types of micro level units of analysis, each of which are eventually combined to aggregate (macro) levels for generalisation.

Firstly, these units of analysis in any social research, can be in the form of "individuals" or "people" (William, 2006; Hulme, 1997; Roche, 1999). These were typically defined within certain geographical boundaries, in order to describe the characteristics and explore the social dynamics of any or all of the different kinds of individuals. And by aggregating the findings for any of the groups or societies or geographical areas in order to generalise it.

Secondly, if the study is interested in studying the groups for the research, the unit of analysis can be "groups" (William, 2006; Hulme, 1997; Roche, 1999). These groups can be comprised of the study of smaller units of analysis or sub-units or nested units of analysis defined as per the research variables (Koepsell, 2005). Similar to that of "individuals", when "groups" were treated as units of analysis, the descriptions reveal the characteristics and the explanatory studies reveal the social dynamics of any groups, census blocks, communities, cities and any geographic regions (Rosenberg, 1968; Lofland et al., 2006; William, 2006; Hulme, 1997; Roche, 1999). The findings for these particular set of units of analysis can further be generalised upon in the aggregation of findings from the multiple units of analysis.

Thirdly, other units of analysis can be in the form of "organisations", implying the study of relevant populations and variables in any particular organisation or institution. These organisations can be any units such as public, semi-public, private, non-profit agencies and academic institutions (Rosenberg, 1968; Lofland et al., 2006; Hulme, 1997; Roche, 1999).

Fourthly, the other important units of analysis in any social research can be in the form of "social artefacts", this typically refers to the products of social beings, social behaviours and social interactions. It is important to define the purpose whether one is interested in studying the social artefacts themselves or the "individuals" or "groups" responsible for social artefacts (Babbie, 2001).

This is similar to descriptive analysis that reveals the characteristics of the social artefacts and the explanatory studies revealing the dynamics of these social artefacts. Nevertheless, categorically understanding different possible units of analysis makes the perceptions complicated, but there must be a clarity on what the unit of analysis is for the current research study, to avoid ecological fallacy, individual fallacy and reductionism (Rubin et al., 2008; Robinson, 1950; Alker, 1969; Koepsell, 2005).

The sample size is influenced by the research purpose and population size. Hence, upon finalising the unit of analysis, it is vital to categorically determine the sample size for the research in question. Typically, the number of samples to be investigated for each variable or indicator in the research is largely dependent on the confidence or risk levels[71] (viz. 80%,

[71] Confidence or Risk level, which is based on the Central Limit Theorem, which is when a population is repeatedly sampled, the average value of the attribute obtained by those samples is equal to the true population value. Thus, the values obtained by samples are distributed normally around the

85%, 90%, 95%, 99%, etc.) in information reporting, the precision rates or sampling error (viz. +/-5%) within which the true characteristics of the entire population is assessed and the degree of variability[72] in the characteristics of the given population (Israel, 1992). Another important factor that determines the sample size, i.e. type of data, such as qualitative or quantitative or mix of both qualitative and quantitative data required for the research.

a. **Qualitative data**. The purpose of qualitative data is to have a rich understanding of the population's possible characteristics from a limited sample size, rather than having larger representative sample size.
b. **Quantitative data**. When working with quantitative data, it is desirable to have a large sample size that is representative in nature in order to generalise the outcomes.

Therefore, the requirements for sample size can be determined based on the expected levels such as basic, intermediary and advanced levels of statistical analysis (O'Leary, 2004). The small sample sizes for basic and intermediary analysis lacks representativeness and statistical significance. There were many statistical theories, methods,[73] software and applications[74] which were used to for calculating the required sample size or cases to investigate in order to arrive at valid statistical inferences for any research studies in social and behavioural sciences (Woodward, 2005; Kirkwood and Sterne, 2006; O'Leary, 2004; Israel, 1992).

By applying the equation(s) to the total slum of the population or the number of households and the number of areas in the Hyderabad city region, the case study city, (refer section 1.3), the sampling size for the current research study was able to be calculated. Unfortunately, it was not possible to conduct household interviews, focus group discussions, stakeholder consultations and drinking water sample collections in all

true value of the population, with some samples having a higher value and some samples having a lower value than the true value of the population. The risk of a selection of samples that are obtained which do not represent the true population value will be dependent on the confidence levels. The risk is reduced at higher (99%) confidence levels and increased at lower (95%) confidence levels.

[72] Proportion of 50% specifies extreme variability; the characteristics of the population can be heterogeneous or homogenous. The more the variability or more heterogeneous, the higher the sample size required; the lower the variability or more homogenous, the smaller the sample size required for the research study.

[73] Methods/ Theories/ Models cities in Mace (1964), Kraemer and Thiemann (1987), Cohen (1988), Desu and Raghavarao (1990), Lipsey (1990), Shuster (1990), Odeh and Fox (1991), Freiman et al (1986), Thornley and Adams (1998), Wheeler (1975)

[74] Software/ applications citied in Elashoff (2000), Hintze (2000), Borenstein et al (1997), Lenth (2000)

of the identified case study areas, which was a statistically significant sample size, with the available resources namely: labour, money and time.

The sample size can also be based on the researcher's judgement levels on how many cases need to be investigated and whether the inaccuracy levels that can be tolerated. The sample size can also be as random as possible to defend accusations of bias, but it should also be feasible and representative in nature. The representative sample size should be large enough to make statistical inferences, but at the same time, should not be too small, which might give the results a lack of precision (Israel, 1992).

It is vital to have a credibility in the methodological considerations as well as the practicalities in conducting the research. There were many studies which claim that 10% of the population size is a good maximum sample size to give accurate characteristics to the entire population and study area, as long as it does not exceed 1,000 samples and the minimum sample size as 100. For instance, in a population of 6,000, 10% would be 600. And, in a population of 300,000, 10% would be 3,000. This is exceeding the limit of 1,000. In the latter case, the maximum sample size only needs to be 1,000. In both the cases, the minimum sample size is 100. However, choosing the maximum sample size will have the advantage of producing more accurate results, collect the variations in the population and subdivide the sample size in multiple groups (Alreck and Settle, 2004; Conroy, 2016).

Once the sample size for different units of analysis has been determined, it is also imperative to decide on the appropriate sampling procedures, to gather the data. Whether it should be either random or non-random or a combination of both, to avoid any sampling errors. The researcher can choose any sampling procedures or combination of sampling procedures, in order to obtain a representative sample size that is spread across the study area without excluding any pockets in the sampling area, representing the entire study area and subsequently the inferences and outcomes were able to be generalized into the entire study area, without any prejudice.

The vast literature mentions numerous advantages of random sampling procedures in order to incorporate an entire study area, without any bias and enabling the population to have equal chances of selection and allowing for accurate representation. These random sampling procedures include simple random sampling, systematic random sampling, stratified random sampling, cluster random sampling, multistage random sampling, etc.

To overcome the shortcomings of random sampling procedures, such as inability to pick and choose the samples, coverage error, non-responsive bias, known and accessible population, etc.), non-random sampling procedures, such as handpicked sampling, snowball sampling, volunteer sampling, selection or shortlisting criteria, etc. can be used as sampling procedures (O'Leary, 2004; Levy and Lemeshow, 1999; Lohr, 1998; Thompson, 2002; Tortu et al., 2001; Wainer, 2000). In order to take advantage of random and non-random sampling procedures and overcome the shortfalls of anyone sampling procedure, the current research intends to use combination of sampling procedures.

Considering the above stated arguments and the research interest, which was defined in the earlier sections, the main unit of analysis for the current research was "slum area" to collect the perceptions of households on existing quality and quantity of drinking water and on the decision making processes. However, there were three sub-units which were analysed: (a) water samples, (b) households in slum areas, (c) stakeholders in organisations pertaining to the main unit of analysis (i.e., slum area). In order to analyse the main unit in this current research, a detailed selection criterion was considered for shortlisting the case studies (slum areas).

A statistically representative sample of 10% of the shortlisted case studies based on "simple random sampling" procedure and "spatially balanced sampling" procedure was adopted to identify the sample case studies (slum areas). Within each of the identified sample case studies (slum areas), a statistically representative sample of 10% of the total slum households were selected by adopting a "simple random sampling" procedure for conducting interviews and focus group discussions (refer section 3.5.2).

Considering the resource constraints, in terms of labour, time and money, for the current research study, the drinking water samples collection and testing was limited to one water sample from different sources of drinking water from only 50% of the identified sample case studies (slum areas). The selection of 50% of the identified sample case studies adopted a "spatially balanced sampling" procedure and a "simple random sampling" procedure for water sample collection and testing within each of the identified sample case study areas (slum area) (refer section 3.5.3).

The current research study also focused on analysing the decision making processes in providing drinking water facilities and services to the identified slum areas. The government institution responsible for this was identified as the Hyderabad Metropolitan Water Supply and Sewerage Board (HMWSSB). However, in the case of selecting the stakeholders in the identified institution, the sampling procedure that was adopted was "stratified random sampling" wherein the complete list of stakeholders was grouped based on their relevant characteristic known as strata and then the participants or stakeholders were selected within these groups.

Within each of the identified groups, a statistically representative sample of 10% of the total number of stakeholders were selected by adopting a "simple random sampling" procedure for conducting interviews and focus group discussions (refer section 3.5.4). Table 6 summarises the units of analysis, sample size and the sampling procedures that were applied for the current research study.

Table 6: Summary of units of analysis, sample size and sampling procedures of the current research study

Variables	Indicators	Main Unit of Analysis	Sampling Procedures/ Sample Size	Sub-Unit of Analysis	Sampling Procedure/ Sample Size
Drinking water	Quality	Slum areas	Shortlisting of slum area based on selection criteria -> (10% of the shortlisted slum areas) Spatially balanced sampling and Simple random sampling	Slum households	Simple random sampling; 10% of the total slum population / households from each slum area
		Slum areas	Shortlisting of slum area based on Selection Criteria -> (5% of the shortlisted slum areas) Spatially balanced sampling and Simple random sampling	Drinking water samples	Simple random sampling; 1 sample from each source of drinking water from each slum area
	Quantity	Slum areas	Shortlisting of slum area based on Selection Criteria -> (10% of the shortlisted slum areas) Spatially balanced sampling and Simple random sampling	Slum households	Simple random sampling; 10% of the total slum population / households from each slum area
Decision making process	Socio-Health	Slum areas	Shortlisting of slum area based on Selection Criteria -> (10% of the shortlisted slum areas) Spatially balanced sampling and Simple random sampling	Slum households	Simple random sampling; 10% of the total slum population / households from each slum area
		HMWSSB	None	Institution's Stakeholders	Stratified random sampling; 10% of the total number of stakeholders from each group
	Institutional	Slum areas	Shortlisting of slum area based on Selection Criteria -> (10% of the shortlisted slum areas) Spatially balanced sampling and Simple random sampling	Slum households	Simple random sampling; 10% of the total slum population / households from each slum area
		HMWSSB	-	Institution's Stakeholders	Stratified random sampling; 10% of the total number of stakeholders from each group
	Technical	Slum areas	Shortlisting of slum area based on Selection Criteria -> (10% of the shortlisted slum areas) Spatially	Slum households	Simple random sampling; 10% of the total slum population /

Variables	Indicators	Main Unit of Analysis	Sampling Procedures/ Sample Size	Sub-Unit of Analysis	Sampling Procedure/ Sample Size
			balanced sampling and Simple random sampling		households from each slum area
		HMWSSB	-	Institution's Stakeholders	Stratified random sampling; 10% of the total number of stakeholders from each group
	Economic	Slum areas	Shortlisting of slum area based on Selection Criteria -> (10% of the shortlisted slum areas) Spatially balanced sampling and Simple random sampling	Slum households	Simple random sampling; 10% of the total slum population / households from each slum area
		HMWSSB	-	Institution's Stakeholders	Stratified random sampling; 10% of the total number of stakeholders from each group

The following sections provide an in-depth detail description of the units of analysis, sample size and the sampling procedures that were applied in the current research study.

3.5.1. Main Unit of Analysis - Sample case studies (Slum areas)

The theoretical concept of the current research study and the presence of a large number of slum areas, also known as informal settlements, in the Hyderabad region, motivated the researcher to develop selection criteria in order to choose the sample case studies. These were chosen from a complete list of slum areas in the Hyderabad region. They were selected to be able to make an in-depth and comprehensive research study which was based on select parameters, which were chosen to evaluate the quality and quantity of drinking water in the slum areas and the decision making procedures to provide drinking water facilities and services to the slum areas, the following parameters were used:

- Slum areas in Hyderabad city region
- Status of slum areas as notified slum area
- Agency responsible for providing drinking water facilities and services
- Availability of public and local representatives
- Tenable status
- Availability of different drinking water facilities and services
- Characteristics of population or households

By incorporating these parameters, an analysis was carried using the available secondary statistical information from all of the slums with respect to demography, housing and infrastructure conditions. The collated secondary data was then analysed to classify the slums according to the selected criteria. The following section describes the selection criteria more in depth and the sequential process that was followed in shortlisting the case studies for the current research study.

a. Selection Criteria

i. Criteria 1 - Status of areas as "Slum"

The government agencies in Hyderabad metropolitan region have analysed and recognise slum areas along with the details pertaining to demography and basic infrastructure conditions (CDP, 2011; GHMC, 2013; GHMC, 2016). In addition, the Census of India (2011) also enumerated the slum population in Hyderabad.

The government agencies of India had an unfair approach to categorising areas as "slums" and inaccurate methods of collecting information regarding slums, unfortunately Hyderabad city is no exception. The designation of different areas in Hyderabad as "slums" follows a techno-bureaucratic approach and publications of statistics related to slums were inconsistent, inaccurate and underestimated. There were substantial differences in the information published by different agencies pertaining to slums in the Hyderabad city region and what is the accurate reality (Risbud, 2010). The same conclusions were drawn from the survey results of a study carried out by the Centre for Good Governance on slum areas and population to validate with the available statistics at GHMC (CGG, 2008). Nevertheless, the current research did not intend to establish the rationale, analyse the approaches used for defining slum areas in the Hyderabad city region and validate the sources of information; it was more interested in using the available secondary data from authentic sources.

The latest available statistical information from GHCM (2013) and ToI (2012) pertaining to slums notes that Hyderabad is currently a land to a total slum population of 1,951,207, which is about 28.65% of the total Greater Hyderabad Municipal Corporation[75] area population. This total slum population is spatially spread all over the city region into different pockets. There were about 1,476 slum areas covering a total area of 80.45 km^2, which is about 12% of the total Greater Hyderabad Municipal Corporation (GHMC) area. However, according to the latest statistics available at GHMC, there were about 1,466 slum areas (GHMC, 2016). The variation in the number of slums over a period of 3 years was due

[75] Included the core area, (Municipal Corporation of Hyderabad region) and surrounding 12 municipalities

to the denotification of slum areas and at the same time an increase in number of slums in certain locations.

The Hyderabad government has split the Hyderabad area up into a number of circles. The maximum number of slum areas were located in circle no. 4 and the least number of slum areas were located in circle no. 13. Further, the Central zone of the GHMC area is having the maximum share of the total number of slum areas, i.e., 35.8%, followed by the South zone with 24.2% and the North zone with 19.7%. The East zone is land to 10.9% of the total number of slum areas whereas the West zone is with the least share of number of slum areas, with 9.4%. A closer analysis reveals that the core area, also known as the Municipal Corporation of Hyderabad (MCH) area, has the maximum number of slums 57% and the remaining 43% were spread across the surrounding municipalities, which were merged with the MCH which led to the formation of GHMC area.

Although there were areas outside of the Greater Hyderabad Municipal Corporation (GHMC) boundary and within the limits of the Hyderabad Metropolitan Development Authority (HMDA[76]) boundary that were meeting the criteria defined for slum areas, the authorised agencies treated them as hamlets or villages and not as slum areas. The GHMC area accounts for a substantial share, more than 75%, of the total population and accounts for the total slum population, 100% of the slums, of the HMDA area. The areas that were identified as slums, both notified and non-notified, were only in the GHMC area and therefore, the current research focused on these.

Thus, the criteria for selection of case studies was applied to the list of 1,466 slums that were located in GHMC region only. The table in the Annex 2 illustrates the spatial distribution of slum areas across the zones[77] and circles[78] of GHMC region. The total number of slum areas pertaining across zones and circles of GHMC region are provided in Annex 1A.

ii. Criteria 2 – Slum area status as "Notified"

The analysis of statistical information that was provided in the Slum free city action plan showed that there were about 1,476 slum areas, of which about 79.6%, 1,176 were notified and the remaining 20.4% were non-notified slums (GHMC, 2013). However, as per the latest information available by the GHMC, there were 1,466 slum areas, of which about 78.8%, 1,155 were notified and the remaining 21.2% were non-notified slums. The

[76] Municipal area and its surrounding 55 peri-urban areas

[77] The city of Hyderabad (GHMC area) is divided into five zones, namely, (a) North zone, (b) South zone, (c) East zone, (d) West zone, (e) Central zone;

[78] These zones are divided into 18 circles (administrative boundaries) and further into 150 circles (administrative boundaries) for government agency's planning and development purposes

maximum number of notified slum areas were located in circle no. 4 and the least number of notified slum areas were located in circle no. 13.

When the same analysis was done for non-notified slums, the maximum number of non-notified slum areas were located in circle no. 10 and the least number of non-notified slum areas were located in circle no. 15. It was also observed that the central zone of the GHMC area had the maximum share of the total number of notified slum areas, which had 33.5%, followed by South zone with 25.8% and the North zone with 23%. The East zone had 10.9% of the total number of notified slum areas whereas the West zone had the least amount of notified slum areas, 6.6%. The central zone of the GHMC area had the maximum share of the total number of non-notified slum areas, 44%, followed by the West zone with 19.9% and the South zone with 18%. The East zone had 10.6% of total number of non-notified slums whereas the North zone had the least share of number of non-notified slum areas, 7.4%.

The core area, also known as the Municipal Corporation of Hyderabad (MCH) area had the maximum number of notified slums 56% and the remaining 44% were spread across the surrounding municipalities within the GHMC boundary. Similarly, the maximum number of non-notified slums 60% were in the core area and the remaining 40% were found in the surrounding municipalities within the GHMC boundary.

Within the current research, which primarily focused on the government's decision making processes, it was important to study the slum areas where there was an active involvement of the government agencies in providing the required infrastructure facilities and services to the slum areas.

According to GHMC (2013) there was a political notion in notifying the slums and the challenges in infrastructure provision by the government agencies on a sustainable basis to the non-notified slum areas. Due to this the current research only focused on the notified slums. Therefore, one of the criteria for the selection of case studies was "notified slums" which had a sample size of 1,155 out of a total of 1,466 slum areas which were spread across different circles. The table in the Annex 1B and Annex 2 illustrates the spatial distribution of these notified and non-notified slums across the zones and circles of GHMC area.

iii. Criteria 3 - Agency responsible for providing infrastructure facilities and services

The provision of physical infrastructure facilities and services such as water supply, sewerage, drainage and roads in the city of Hyderabad is the responsibility of Greater Hyderabad Municipal Corporation (GHMC) and the Hyderabad Metropolitan Water Supply and Sewerage Board (HMWSSB). The analysis of statistical information that was provided by GHMC (2013), in the Slum free city action plan showed that GHMC and HMWSSB were the agencies responsible for providing the physical infrastructure facilities and services in all the "notified" slum areas.

Within the current research, which primarily focused on the government's decision making processes, it was important to study the areas where there was involvement of government agencies in providing the requirement infrastructure facilities and services to the slum areas. Therefore, one of the criteria for selection of case studies was "agencies responsible for providing infrastructure facilities and services" resulting in the sample size number as 1,155 out of a total of 1,155 notified slum areas that were spread across different circles. The table in Annex 1C illustrates the spatial distribution of the number of slums according to the agencies responsible for providing the required infrastructure facilities and services.

iv. Criteria 4 - Availability of public and local representatives

The GHMC region is administratively divided into different zones, circles and wards for its planning and development purposes. These administrative boundaries were demarcated depending on the natural boundaries, geographical features, contiguity of the area, important junctions or lanes and survey numbers. Within every circle there is an elected public representative who acts as a point of contact for the public who can approach him/her to put forth their concerns. In addition to these public representatives, different communities within these circles have elected and un-elected local representatives. All the people in these communities, in general, go to these local representatives to put forth their concerns that were brought up in their communities. The analysis of statistical information provided in the GHMC (2013) slum free city action plan showed that all of the "notified" slum areas had access to public and local representatives.

In the current research, which primarily focused on the government's decision making processes, it was important to study the areas where there was involvement of public and local representatives in the decision making process. Therefore, one of the criteria for selection within the case studies was the "availability of the public and local representatives." This resulted in a sample size number as 1,155 out of a total of 1,155 notified slum areas which was spread across all of the different circles. The table in Annex 1D illustrates the spatial distribution of the number of slums with the availability of public and local representatives.

v. Criteria 5 - Tenable slums

The slum areas in the GHMC region were located on various land types which can broadly be categorised into hazardous and non-hazardous conditions. According to GHMC (2013), the non-hazardous conditions were treated as tenable and semi-tenable for slum developments. These were the sites suitable for human habitation and the other land (sites) were not set aside for any major public facilities or any residential uses as per the Master Plan as they were hazardous.

The hazardous land was treated as non-tenable for any slum development activities. These un-tenable conditions included environmentally hazardous[79] and ecologically sensitive[80] sites. Further, these were the sites reserved for public utilities and services like major roads, railway tracks and trunk infrastructure. The analysis of statistical information provided by GHMC (2013) in the slum free city action plan showed that there were about 1,155 notified slum areas, of which about 99.5%, 1,150 were tenable slums and the remaining 0.5% were un-tenable slums.

The maximum number of tenable slums areas were in circle no. 4 and the least number of tenable slum areas were in circle no. 13. Further, it was also observed that the central zone of the GHMC area had a maximum share of the total number of tenable slum areas, 33.6% followed by the South zone with 25.7% and the North zone with 22.9%. The East zone had 11.04% of total number of tenable slum areas whereas the West zone had the least share of number of tenable slum areas 6.6%. A closer analysis revealed that the core area, also known as the MCH area, had the maximum number of notified slum 56% and the remaining 44% were spread across the surrounding municipalities within the GHMC boundary.

The current research focused on analysing the slums which were "tenable", because the aspects of concerns pertaining to infrastructure provision on a sustainable basis in un-tenable slum areas is a difficulty for any government agency and there were undesirable conditions for the people to reside in these un-tenable slum areas. Therefore, based on these criteria for selection for the case studies, namely the "tenable slums", the sample size number was 1,150 out of a total of 1,155 notified slum areas which were spread across different circles and zones. The table in Annex 1E illustrates the spatial distribution of these tenable slums across the zones and circles of GHMC area.

vi. Criteria 6 - Availability of all water infrastructure facilities and services

The slum areas in the GHMC region had different sources of water supply, namely, underground and raw water. The sources of municipal water included individual water supplied through household taps, public taps, municipal tankers, tanks, ponds, rivers, canals, lakes and springs. Similarly, the underground water sources included open wells, tube wells, hand pumps and bore wells. Since the current research focused on analysing the decision making processes and the quality and quantity of drinking water from various sources in slum areas, it was important to understand the existing conditions of drinking water from all possible sources. Therefore, for the current research, the slum areas that had all sources of water were considered. However, the statistical information and

[79] Sites such as catchment areas rivers, ponds, sea, ocean, hilly or marshy terrains.

[80] Sites such as mangroves, national parks and sanctuaries.

stakeholder consultations pertaining to sources of drinking water revealed that the direct usage of drinking water from tanks, ponds, rivers, canals, lakes and springs was no longer the potential options for the residents in Hyderabad region. According to the Pollution control board (GHMC, 2013), the pollution levels in these sources of water were beyond the threshold limits and were not able to be used for consumption purposes without treatment.

Statistical information reported during the preparation of the GHMC (2013) Slum free city action plan noted that there were about 1,150 slum areas, both notified and tenable, of which about 93%, 1,069 slum areas, had access to individual tap connections. Further, these statistics also reveal that about 80% of the slum areas, both notified and tenable, 918 slum areas, had access to public or community taps in order to fetch water. The other potential sources of drinking water were water tankers and bottled water.

According to GHMC (2013) about 46% of the slum areas, both notified and tenable in nature, were facilitated with the supply of water through water tankers and bottles. The other source of water in these slum areas is through under-ground water. About 324 slum areas, 28% of the total 1,150 slum areas had access to open wells and about 1014 slum areas, 88% of the total 1,150 slum areas, had access to tube wells, hand pumps and bore wells. The table in Annex 1F illustrates the spatial distribution of the notified and tenable slum areas with access to different sources of water.

Since the current research focused on analysing the quality and quantity parameters of all possible sources of water in the selected case study areas, slum areas were considered that had both municipal water, which is classified as: drinking water in from taps in houses, public taps, water tankers, bottled water and underground water which includes: open wells, tube wells, hand pumps and bore wells as sources of water. The current research by no means sought to establish the rationale for the non-availability of the infrastructure facilities, especially all the sources of water in slum areas. The study only wished to analyse the parameters pertaining to the quality of the decision making processes that were involved in providing an adequate quantity and quality of drinking water to slum areas in the Hyderabad region.

In order to achieve this, it was important to consider all of the slum areas that had the required facilities pertaining to drinking water. The statistical information that was provided by GHMC (2013) in the Slum free city action plan showed that about 35% of the total number of slums, both notified and tenable, had all sources of drinking water. The table in Annex 1G illustrates the spatial distribution of the notified and tenable slum areas with access to all sources of drinking water.

The most slum areas with all of the sources of drinking water were located in circle no. 4 and the least number of slums with such facilities were located in circle no. 11. Further, the South zone of the GHMC area contained the greatest number of slum areas with all sources of water, 36%, followed by North zone with 29% and the Central zone with 23%. 9% of the total number of slum areas was found in the East zone and the West zone had the least share of number of slum areas with such facilities 3.5%.

The core area, also known as the MCH area, had the maximum number of slums with these facilities 53% and the remaining 47% were spread across the surrounding municipalities within the GHMC boundary. Based on these criteria for the selection of case studies, "having all the sources of drinking water", the sample size number was 401 out of the total of 1,150 notified and tenable slum areas that were spread across different circles and zones as given in Annex 1G.

vii. Criteria 7 - Characteristics of population or households

Income levels.

The majority of income levels of the population or households in the slum areas of the Hyderabad region were Below the Poverty Line (BPL). According to GHMC (2013), the average monthly income of slum households was approximately INR 4,000 (60 USD) per month. The studies conducted by the GHMC and allied agencies also noted that about 85% of the slum population within the GHMC region had monthly incomes under the Below Poverty Line and the remaining 15% Above Poverty Line (APL). In addition, the monthly expenditures of these slum population exceeded their monthly incomes (GHMC, 2013).

As the current research study focused on understanding the monetary values pertaining to challenges caused due to insufficient and unsafe drinking water, the majority of the selected of case studies focused on slum areas whose population or households earned Below the Poverty Line. However, this selection of slum areas did not include 100% of the BPL population.

To understand the dynamics and co-relation between BPL population and APL population in any selected slum area, the selection of slum areas had "more than and equal to 60%" and "less than and equal to 90%" of BPL population. The statistical information was taken from the GHMC (2013) Slum free city action plan which noted that there were about 86% of the total number of slums, both notified and tenable with access to all sources of drinking water facilities and services had "less than and equal to 90%" of BPL population.

The maximum number of slum areas with a BPL population ranging between 60% and 90% were located in circle no. 5 and the least number of slums with such facilities were located in circle no. 11. Further, the South zone of the GHMC area had the maximum share of the total number of slum areas with BPL population, which ranged between 60% and 90%, thus 33%, followed by North zone which had 29% and the Central zone which had 26%. The East zone is a land to 9% of the total number of slum areas whereas and the West zone had the least share of the number of slum areas with such facilities, 3%. A closer analysis revealed that the core area, otherwise known as the Municipal Corporation of Hyderabad (MCH) area, had the maximum number of slums with these facilities 52% and the remaining 48% were spread across the surrounding municipalities within GHMC boundary.

Based on these criteria for the selection of case studies, "having a BPL population ranging between 60% and 90%", the sample size number was 344 out of a total of 401 notified and tenable slum areas which had access to all sources of water spread across different circles and zones. The table in Annex 1H illustrates the spatial distribution of the shortlisted slum areas with the above-mentioned criteria.

Population or Households.

The population and the households were the primary units of analysis in the current research study. According to the statistical records provided by GHMC (2017) and the GMC (2013) Slum free city action plan, the total slum population was 1.95 million which was spread across 1,466 slum areas in Hyderabad region.

Based on the above shortlisting criteria, the number of slum areas under consideration for the current research study was 344. The population and households in all these 344 slum areas in Hyderabad region widely ranged between as low as 68 households from a 278 population size and as high as 3,705 households from a 17,916 population size.

In order to comprehend the population dynamics and its association with parameters pertaining to drinking water, it was vital to include in the analysis the maximum possible population or households from each of the selected slum areas. Therefore, the selection of slum areas that was chosen had a "population and households with above the average population". The statistical information provided by GHMC (2013) in the Slum free city action plan showed that about 57% of the total number of slum areas with the criteria "both notified and tenable slum areas with access to all sources of drinking water facilities and services and with BPL population ranging between 60% and 90%", from the 344 slum areas were shortlisted with the previously mentioned criteria.

The maximum number of slum areas with the population and households above the average limits were located in circle no. 15 and the least number of slums with these criteria were located in circle no. 2. Further, it can also be observed that the North zone of the GHMC area had the maximum share of the total number of slum areas with a population and households above the average limits, 37%, followed by the Central zone with 23.5% and the South zone with 22%. The East zone had 13% and the West zone had 4%, the least number of slums with these shortlisting criteria. A closer analysis revealed that the core area, known as the Municipal Corporation of Hyderabad (MCH) area, had the minimum number of slum areas with the above-mentioned shortlisting criteria, 40% and the remaining 60% were spread across the surrounding municipalities within the GHMC boundary.

Based on these criteria for selection of case studies, "having a population and households above average", the sample size number was 196 out of a total of 344 notified and tenable slum areas which had access to all the sources of water and with a BPL population ranging between 60% and 90% spread across different circles and zones. The table in Annex 1I illustrates the spatial distribution of the shortlisted slum areas with the above-mentioned criteria.

b. Sample case study areas (slum areas)

In order to conduct a comprehensive analysis for the parameters defined in the theoretical framework, in the current study city, the Hyderabad Metropolitan Region, the sample size of slums was selected as follows. As the Hyderabad Metropolitan Region had 1,466 slums as per the records and various sources, strictly following the sample sizes established by confidence levels or intervals was not feasible with the existing resources of both manpower and finances. Therefore, 2 slums were selected within each of the 18 Municipal Circles, also known as administrative boundaries, in the Central, North, South, East and West Zones of the Hyderabad Metropolitan Region, special emphasis and due weightage was given to the above mentioned selection criteria:

- Notified slums
- Agency responsible for providing infrastructure facilities and services
- Availability of public and local representatives
- Tenability
- Availability of water facilities and services
- Characteristics of population or households.

Based on the above-mentioned shortlisting criteria, the sample size for the current research study was 34 slum areas. The table in Annex 1J illustrates the population and household details in the selected slum areas and the sample size for conducting the household level semi-structured interviews. Further, a naming convention was used for the slum areas consisting of Circle and its number, type of area regarding the slum and identification number to assign a unique name to each sample slum area. For example, Circle 1 signifies the Circle named "Kapra" and Slum A signifies the Slum named "Sairam nagar" and the sample slum area would be Circle 1 _ Slum A, Circle 1 _ Slum B, Circle 2 _ Slum C, Circle 2 _ Slum D, Circle 3 _ Slum E and so on. The table in Annex 1K illustrates the complete list of slum names selected or identified for the current research study, along with the codes that were used. Further, the detail profiling of each of the slum areas selected for the current research study were provided in Annex 3.

3.5.2. Sub-Unit of Analysis - Slum households

Under the main unit of analysis, the slum population or households was the sub-unit of analysis for the current research study. The following Table 7 illustrates the number and name of the selected slum areas, which were identified after applying the selection criteria, along with the total number of households and population and the sample size, which was 10% of the total households, that were required for the current research study.

Table 7: Selected slum areas with sample size

Circle No.	Circle Name	Total No. of Slums	No. of selected slum areas	Name of selected slum areas	Total Households	Total Population	Sample size = 10% of total households
East Zone							
1	Kapra	5	2	1. Sairam Nagar	555	2103	56
				2. B.J.R. Colony	359	1439	36
2	Uppal	10	2	3. Manikesav Nagar (O U Campus)	525	2141	53
				4. Gandhi Nagar	495	1967	50
3	L.B. Nagar	11	2	5. Rajiv Gandhi Nagar	404	1774	40
				6. Dr. Ambedkar Nagar	398	1777	40
South Zone							
4	Charminar (Erstwhile Circle – I)	17	2	7. Shivaji Nagar	528	2252	53
				8. Sai Baba Nagar	422	1793	42
5	Charminar (Erstwhile Circle – II)	15	2	9. Fatima Nagar	302	1405	30
				10. Farooq Nagar	208	1133	21
6	Rajendra Nagar	11	2	11. Wadi - E – Mahamood	474	2479	47
				12. Indira Nagar	542	2851	54
Central Zone							
7	Khairatabad (Erstwhile Circle – IV)	12	2	13. Vivekananda Nagar	527	2197	53
				14. Indira Nagar (13-6) (Gudimalkapur)	329	1353	33
8	Abids (Erstwhile Circle – VI)	4	2	15. Pool Bhaugh	664	2329	66
				16. Band Line	258	1042	26

Circle No.	Circle Name	Total No. of Slums	No. of selected slum areas	Name of selected slum areas	Total Households	Total Population	Sample size = 10% of total households
9	Abids (Erstwhile Circle – III)	19	2	17. Indira Nagar-I	478	2259	48
				18. Bapu Nagar (Amberpet)	680	3400	68
10	Khairatabad (Erstwhile Circle – V)	11	2	19. Devarakonda Basti	307	1347	31
				20. Ambedkar Nagar	350	1756	35
West Zone							
11	Sherilingampally (S)	2	2	21. Prem Nagar	2399	9699	240
				22. Marthanda Nagar	1586	6418	159
12	Sherilingampally (N)	3	2	23. Izzatnagar Weaker Section	619	2658	62
				24. Maktha Mahaboobpet	427	1574	43
13	Ramachandra puram and Patan Chervu	-	-	There were no notified slums in this Circle	-	-	-
14	Kukatpally	3	2	25. Rajiv Ghandhi Nagar (Allapur)	927	4203	93
				26. Yellamma Banda	2129	8775	213
North Zone							
15	Quthbullapur	39	2	27. Shiridi Saibaba Nagar	1755	6900	176
				28. Kaiser Nagar	437	1951	44
16	Alwal	9	2	29. Turkapally Bollaram	334	1246	33
				30. Bharat Nagar	305	1209	31
17	Malkajgiri	15	2	31. I N Nagar	1396	5366	140
				32. B J R Nagar	677	2809	68
18	Secunderabad	9	2	33. Hamal Basthi Phase-I	400	1624	40
				34. Hamalbasthi P-II	566	2386	57
	Total	**196**	**34**	-	**22762**	-	**2281**

The household level interviews were conducted to collect the perceptions of the slum residents regarding the quality and quantity of drinking water and the decision making procedures followed by the service provider used this sub-unit. Due to the limited availability of time and money, which were the resources for the current study, only 10% of the total households were taken into consideration from each of the selected slum areas in order to conduct household level interviews, as defined in the research design, strategy and methods.

3.5.3. Sub-Unit of Analysis - Drinking water samples

Under the main unit of analysis, the drinking water was another sub-unit of analysis for the current research study. The following Table 8 illustrates the number and name of the selected slum areas which were identified after applying selection criteria, including the source of drinking water and the samples that were collected and tested for the current research study.

Table 8: Selected slum areas with drinking water sample size

Circle No.	Circle Name	Name of selected slum areas	Drinking water samples collected and tested		
			Individual/ public taps	B.wells/ H.pumps	Water tankers
East Zone					
1	Kapra	1. Sairam Nagar	-	-	-
		2. B.J.R. Colony	1	1	1
2	Uppal	3. Manikesav Nagar (O U Campus)	1	1	1
		4. Gandhi Nagar	-	-	-
3	L.B. Nagar	5. Rajiv Gandhi Nagar	1	1	1
		6. Dr.Ambedkar Nagar	-	-	-
South Zone					
4	Charminar (Erstwhile Circle – I)	7. Shivaji Nagar	-	-	-
		8. Sai Baba Nagar	1	1	1
5	Charminar (Erstwhile Circle – II)	9. Fatima Nagar	-	-	-
		10. Farooq Nagar	1	1	1
6	Rajendra Nagar	11. Wadi - E – Mahamood	1	1	1
		12. Indira Nagar	-	-	-
Central Zone					
7	Khairatabad (Erstwhile Circle – IV)	13. Vivekananda Nagar	1	1	1
		14. Indira Nagar (13-6) (Gudimalkapur)	-	-	-
8	Abids (Erstwhile Circle – VI)	15. Pool Bhaugh	1	1	1
		16. Band Line	-	-	-
9	Abids (Erstwhile Circle – III)	17. Indira Nagar-I	1	1	1
		18. Bapu Nagar (Amberpet)	-	-	-
10	Khairatabad (Erstwhile Circle – V)	19. Devarakonda Basti	1	1	1
		20. Ambedkar Nagar	-	-	-

Circle No.	Circle Name	Name of selected slum areas	Drinking water samples collected and tested		
			Individual/ public taps	B.wells/ H.pumps	Water tankers
West Zone					
11	Sherilingampally (S)	21. Prem Nagar	1	1	1
		22. Marthanda Nagar			
12	Sherilingampally (N)	23. Izzatnagar Weaker Section	1	1	1
		24. Maktha Mahaboobpet	-	-	-
14	Kukatpally	25. Rajiv Ghandhi Nagar (Allapur)	-	-	-
		26. Yellamma Banda	1	1	1
		North Zone			
15	Quthbullapur	27. Shiridi Saibaba Nagar	1	1	1
		28. Kaiser Nagar	-	-	-
16	Alwal	29. Turkapally Bollaram	-	-	-
		30. Bharat Nagar	1	1	1
17	Malkajgiri	31. I N Nagar	1	1	1
		32. B J R Nagar	-	-	-
18	Secunderabad	33. Hamal Basthi Phase-I	1	1	1
		34. Hamalbasthi P-II	-	-	-
	Total	-	**18**	**18**	**18**
	Grand Total		**54**		

The drinking water samples were collected and tested from the selected slum areas to assess the quality of drinking water from different sources of drinking water such as municipal water which was supplied through individual tap connections, public tap connections, ground water which was through bore wells or hand pumps and municipal water which was supplied with water tankers. Taking into account the limited availability of time and money, as the resources for the current study, water samples from the different sources of drinking water from only 50% of the identified sample case studies in the slum areas were collected, as defined in research design, strategy and methods. The slum areas from which the samples were collected are highlighted in the table above.

The drinking water samples collected were submitted to a renowned water quality testing laboratory in Hyderabad, India, namely The Institute of Health Systems. Although there were many water quality testing laboratories in Hyderabad, that were both government and privately owned, the Institute of Health Systems was selected for the current study due to cost and time. The Institute of Health Systems promised to provide their services at a discounted price and in less time, compared to other water quality testing laboratories in Hyderabad. Other important reasons that they were chosen was because of trust and transparency.

After submitting the drinking water samples, The Institute of Health Systems allowed the researcher to shadow the laboratory technicians while conducting the water quality tests.

This was done primarily to monitor and confirm that the test results were not tampered with during the process. In addition, The Institute of Health Systems also provided a complete guidance and toolkits for drinking water sample collection and submission. All the required precautions were taken into consideration while collecting the drinking water samples from the different sources, as per the rules and regulations defined by the testing laboratory. All of the drinking water samples collected were submitted to the selected testing laboratory in order to be analysed according to the quality parameters, such as the physical, chemical and biological parameters.

3.5.4. Sub-Unit of Analysis - Institution Stakeholders

Under the main unit of analysis, the Institution was considered as another sub-unit of analysis for the current research study. The following Table 9 illustrates the list of stakeholders consulted and interviewed at the Hyderabad Water Supply and Sewerage Board (HMWSSB), the government agency responsible for taking decisions in providing drinking water facilities to the selected slum areas in Hyderabad, for the current research study.

Table 9: List of stakeholders

S.No.	Stakeholders	Interviewed/ Consulted
1.	Honourable Minister for Ministry of Administration and Urban Development (MA&UD Dept.)	-
2.	City Commissioner	Yes
3.	Special Chief Secretary, MA&UD Dept.	-
4.	Director of Health	-
5.	Managing Director, HMWSSB	Yes
6.	Director-Finance, HMWSSB	Yes
7.	Director-Technical, HMWSSB	Yes
8.	Director (Operations), HMWSSB	Yes
9.	Executive Director, HMWSSB	Yes
10.	Public Relations Officer, HMWSSB	Yes
11.	Asst.PRO, HMWSSB	-
12.	Director Revenue and UFW, HMWSSB	Yes
13.	General Manager, UFW Division, HMWSSB	Yes
14.	Single Window Cell, HMWSSB	Yes
15.	Quality Control and Vigilance Division, HMWSSB	Yes
16.	Medical Officer	Yes
17.	Station House Officer	-
18.	GM(E) and I/c Principal, Metro Staff Training College, HMWSSB	Yes
19.	Director (Personnel and Administration), HMWSSB	Yes
20.	Standing Counsel, HMWSSB	-
21.	Legal Officer, HMWSSB	Yes
22.	Engineering division, General Manager, HMWSSB	Yes
23.	Director Projects, HMWSSB	Yes

S.No.	Stakeholders	Interviewed/ Consulted
24.	Central Store Division, HMWSSB	-
25.	General Manager for select case study area, Operation and Maintenance, HMWSSB	Yes
26.	Public representatives for the selected slum areas	Yes
27.	Engineers Association, HMWSSB	-
28.	Union Association, HMWSSB	-
29.	Local/ Community level associations of the selected slum areas	Yes
30.	Faculty/ Research scholars	Yes
31.	Consultants/ Experts/ NGOs	Yes

The stakeholders were interviewed to collect the decision making procedures that were followed and to discover what factors were considered during the decision making procedures to provide drinking water facilities and services to the selected slum areas in the Hyderabad city region. Due to the limited availability of time and money, as resources for the current study, only the relevant stakeholders who were responsible and part of decision making procedures were interviewed.

3.6. Operationalisation of Independent and Dependent Variables

The theoretical or conceptual framework discussed in the previous chapter provides the basis for conducting this study and guides the choice of the research strategy and methods. Consequently, the research strategy employs different approaches due to the complex nature of the current research.

Considering the purpose of the research and the core variables pertaining to decision making process and dependent variables in order to provide quality and quantity drinking water and the detailed research methodology, the following Table 10 illustrates the indicators and sub-indicators of analysis which were operationalised for measurement, attributes, types of data, sources, methods and units or sub-units of analysis.

Table 10: Operationalization of Independent and Dependent variables

Variables	Indicators	Sub-Indicators	Attributes/ Description	Type of data	Data Source	Methods	Units/ Sub-units
Drinking water (Dependent Variable)	Quality	*Quality (Q1)*	Assessment of quality perceptions, Drinking water sources, Microbiological parameters, Chemical parameters, Physical parameters, Seasonal variations, standards.	Qualitative, Quantitative	Slum residents' perceptions, Water sample testing (Experts' assessment)	Personal Interviews, FGDs, Sample collection	Slum area/ Slum residents, Water samples
	Quantity	*Quantity (Q2)*	Assessment of quantity perceptions, drinking water sources, Average household size, Frequency of drinking water supply/ availability, Quantity of drinking water collected/ stored, No. of days of storage, LPCD values, Seasonal variations, standards.	Qualitative, Quantitative	Slum residents' perceptions, Experts' assessment	Personal Interviews, FGDs	Slum areas/ Slum residents
Decision making process (Independent Variable)	Socio-Health	*Socio-economic (S1)*	Consideration of the household size, population, income levels, expenditure patterns, households with employment, type of occupation and type of expenditures during the decision making processes	Qualitative	Slum residents and Stakeholders perceptions	Personal Interviews, FGDs	Slum areas/ Slum residents, Institutions' stakeholders
		Health (S2)	Consideration of the type of illness, duration and frequency of illness and seasonal variations of illness during the decision making processes	Qualitative	Slum residents and Stakeholders perceptions	Personal Interviews, FGDs	Slum areas/ Slum residents, Institutions' stakeholders

Variables	Indicators	Sub-Indicators	Attributes/ Description	Type of data	Data Source	Methods	Units/ Sub-units
		Slum residents' voice (S3)	Consideration of Household perceptions of existing drinking water facilities and services, Service needs and impacts assessment, (based on users' feedback/ requirements/ concerns) during decision making processes	Qualitative	Slum residents and Stakeholders perceptions	Personal Interviews, FGDs	Slum areas/ Slum residents, Institutions' stakeholders
	Institutional	*Policies, regulatory frameworks and procedures (i1)*	Consideration of Existing functions, vision statements, objectives, policies, strategies, regulations and procedures (in practice) during decision making processes	Qualitative	Slum residents and Stakeholders perceptions	Personal Interviews, FGDs	Slum areas/ Slum residents, Institutions' stakeholders
		Internal and External Stakeholders' Involvement (i2)	Consideration of Roles and responsibilities, Involvement of management units/ teams, operational units/ teams, local associations, public representatives, consultants/ experts during decision making processes	Qualitative	Slum residents and Stakeholders perceptions	Personal Interviews, FGDs	Slum areas/ Slum residents, Institutions' stakeholders
		Capacities and Enforcements (i3)	Consideration of stakeholders' capacities, implementation frameworks, monitoring frameworks and procurement guidelines, during decision making process	Qualitative	Slum residents and Stakeholders perceptions	Personal Interviews, FGDs	Slum areas/ Slum residents, Institutions' stakeholders
	Technical	*Resource analysis and planning (T1)*	Consideration of natural resources, man-made infrastructure facilities and services, manpower, financial resources availability to provide drinking water facilities and	Qualitative	Slum residents and Stakeholders perceptions	Personal Interviews, FGDs	Slum areas/ Slum residents, Institutions' stakeholders

Variables	Indicators	Sub-Indicators	Attributes/ Description	Type of data	Data Source	Methods	Units/ Sub-units
			services, during decision making processes				
		Requirements analysis and planning (T2)	Consideration of service needs assessment during decision making process	Qualitative	Slum residents and Stakeholders perceptions	Personal Interviews, FGDs	Slum areas/ Slum residents, Institutions' stakeholders
		Engineering and Innovation (T3)	Consideration of Existing local conditions, Technical feasibilities, Engineering drawings, different problems, challenges, solutions, best practices, innovative ideas, viable alternatives, technology usage, etc. during decision making process	Qualitative	Slum residents and Stakeholders perceptions	Personal Interviews, FGDs	Slum areas/ Slum residents, Institutions' stakeholders
	Economic	*Damage costs (E1)*	Consideration of Loss of productivity, Medical expenses, and expenditure on extra drinking water during decision making processes	Qualitative	Slum residents and Stakeholders perceptions	Personal Interviews, FGDs	Slum areas/ Slum residents, Institutions' stakeholders
		Preventive costs (E2)	Consideration of expenditure on filtering mechanisms during decision making process	Qualitative	Slum residents and Stakeholders perceptions	Personal Interviews, FGDs	Slum areas/ Slum residents, Institutions' stakeholders
		Willingness to accept/ pay (E3)	Consideration of Willingness to accept/ pay for specific set of options pertaining to drinking water facilities and services during the decision making process	Qualitative	Slum residents and Stakeholders perceptions	Personal Interviews, FGDs	Slum areas/ Slum residents, Institutions' stakeholders

Chapter 4

Analysis of Drinking water Quality and Quantity

Chapter 4 | Analysis of Drinking water Quality and Quantity

This section of the research study primarily discusses the perceptions of slum households on the quality and quantity of drinking water facilities and services in their respective slum areas. It attempted to understand the quality and quantity of drinking water from various sources of drinking water such as individual tap connections, public tap connections, bore wells, hand pumps and water tankers.

The households' perception of quantity parameters of drinking water led to understand the perception of what the adequacy of drinking water for them was. It was also imperative for the researcher to authenticate and reinforce the perceptions of what the quantity of drinking water was adequate and compare it with the standards that were applied in order to identify the tangible gaps.

The study also focused on analysing the drinking water quality by capturing relevant measurable information and drinking water quality through laboratory water quality testing. Further, a comparative assessment was carried out between the perception analysis and experts' judgement analysis to arrive at the overall conditions of the drinking water quality and quantity in the selected slum areas in Hyderabad city region. This section also focused on providing key insights on various consequences that were caused due to the poor quality and quantity of drinking water in these selected slum areas.

4.1. Slum households' Perception of Quality and Quantity of Drinking water

The consumers play an important role and their perceptions matter the most when it comes to assessing the services that they were availing. An Individuals perception of drinking water is usually based on the physical and aesthetic parameters of the drinking water. This information was accumulated via household level interviews and the interview responses were then validated by the interviewer based on expert judgements through physical verifications.

This section of analysis was able to reveal the perceptions of the quality and quantity of drinking water from various sources that were available in the selected slum areas of the Hyderabad city region.

4.1.1. Drinking water sources

The slum population in the Hyderabad city region have access to different water sources for household (or domestic) usage. These include (a) household individual taps, (b) public taps, (c) community tube-wells, (d) hand pumps, (e) bore wells, (f) open wells, (g) water tankers and (h) bottled water.

In this section, the analysis of access to water infrastructure or facilities was unable to confirm the availability of quality and quantity drinking water services. In fact, the population in the slum areas had access to multiple sources of drinking water due to the low standards of quality and quantity of drinking water that was available to the slum population.

The primary source of drinking water in the slum areas were household level individual taps. 1,448 out of 2,281 households, 63% of the total slum population received their main supply of drinking water from household level individual taps. The other significant sources of drinking water were water tankers and public taps. 877 out of 2,281 households, 38% of the total slum population received their supply of drinking water from water tankers. 710 out of 2,281 households, 31% of the total slum population received their supply of drinking water from community level public taps. Further, there is significant share of population or households having access to drinking water through tube-wells, hand pumps, or bore wells. There are 622 out of 2,281 households, 27% of the total slum households received their supply of drinking water from tube-wells, hand pumps and bore wells. 120 out of 2,281 households, about 5% of the total slum population or households received their supply of drinking water from bottled water.

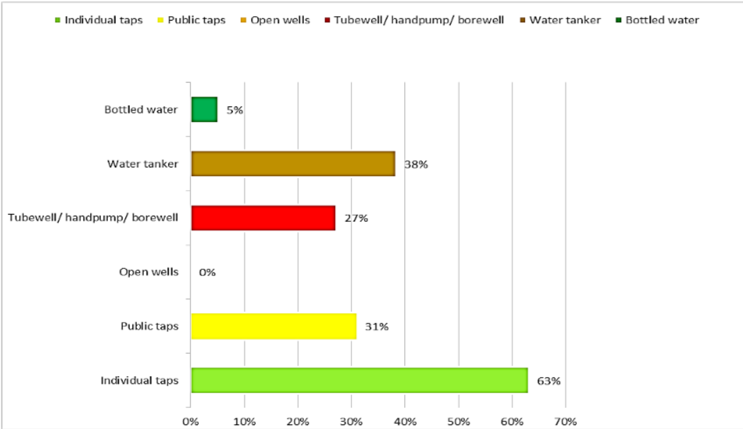

Figure 9: Graph showing the % distribution of slum households with different sources of drinking water

The following photographs show the various sources of drinking water used by the slum residents in the Hyderabad city region. They were taken during the field study. Presented in the order, from left to right, individual or household municipal water tap, community or public tap, water tankers, community level hand-pump and bottled mineral water.

Figure 10: Different sources of drinking water in the slum areas of Hyderabad city region

The slum population had access to all of these various sources of drinking water and drinking water taps in the households, in order to meet their daily requirements. This showed that the slum households had access to multiple sources of drinking water infrastructure facilities. The need to have various drinking water facilities and not only one because there was not a single infrastructure facility that was provided to cater for the requirements of all of the households in the notified slum areas of Hyderabad city region.

The problems regarding the drinking water from the different water facilities in the slum areas of the Hyderabad city region can largely categorised into the following: (a) Quality which include (i) colour variation, (ii) turbidity, (iii) unnatural taste, (iv) unnatural odour, (v) traces of coliform, (vi) traces of algae and (b) Low Quantity.

Some of slum households had single or multiple concerns with respect to the quality and quantity of drinking water from the different source of drinking water. Even though there was a significantly low or near to zero percentage of slum dwellers that claimed to have algae and coliforms in their drinking water from the various infrastructure facilities when the various sources of water were tested in the laboratory there was actually a large amount of algae and coliforms found in the drinking water from many of the infrastructure facilities. This could be because it is very difficult to see algae and coliform with the naked eye.

Thus, not only were the perceptions of the slum dwellers recorded but a rapid household and community level drinking water assessment was also carried out, which also gave an expert's opinion of the quality and quantity of drinking water from the different infrastructure facilities (refer section 4.2).

a. Individual tap connections

One of the significantly used sources of drinking water in the slum areas of Hyderabad city region were running water tap connections that were found in the individual households. This section is the subset of the analysis carried out in the section 5.3.1 on sources of drinking water. As mentioned earlier, the perceptions of households on quality and quantity of drinking water is presented for a sample of 1,448 out of 2,281 households, 63% of the households or population that had access to running water through a tap connection in the houses of the slum areas of Hyderabad city regions.

Perception levels on quality and quantity of drinking water from Individual tap connections.

155 out of 1,448 households, 11% of the total slum population who had access to a running water tap in their households were strongly satisfied with the quality and quantity of drinking water from this source. 500 out of 1,448 households, 35% of the total slum population who had access to individual water tap connections were satisfied with the quality and quantity of drinking water from this source. 55 out 1,448 households, 4% of

the total slum population who had access to individual water tap were moderately satisfied or unsatisfied with the quality and quantity of drinking water from this source. 253 out of 1448, 17% of the total slum population who had access to individual water tap were unsatisfied with the quality and quantity of drinking water from this source. 284 out of 1448, 20% of the total slum population who had access to individual water tap in their households were strongly unsatisfied with the quality and quantity of drinking water from this source.

Translating the household analysis into the area level analysis: 16 out of 34 slum areas, 47% of the total slum areas in the Hyderabad city region were satisfied with standard quality and quantity of drinking water supplied through individual tap connections. 2 out of 34 slum areas, 6% of the total slum areas were partially satisfied. 13 out 34 slum areas, 38% of the total slum areas did not have a standard quality and quantity of drinking water that was supplied through individual taps compared to the other areas. 3 out 34 selected slum areas, 9% of the total slum areas in the Hyderabad city region did not have fresh running water from taps inside of the houses.

"Quantity" concerns.

100% of the households with individual tap connections residing in slum areas no. 2, 8, 10, 13, 23, 27, 28, 29, 30 and 31 had concerns regarding the quantity of the drinking water. 78% of the households with an individual tap connection who were residing in slum area no. 9 also had the same concerns. 30-34% of the households with an individual tap connection residing in slum areas no. 18 and 26 expressed concerns about the inadequate quantity of drinking water. 2-25% of the households with an individual tap connection who were residing in slum areas no. 16, 19 and 20 expressed their concern as to the low quantity of drinking water which was available from the individual tap connections. 0% of the households with an individual tap connection from slum areas no. 3, 4, 5, 6, 7, 12, 14, 17, 21, 22, 24, 25, 32, 33 and 34 had no concerns pertaining to the quantity of drinking water from individual tap connections. The following table 11 illustrates the slum areas and the satisfactory levels of quantity of drinking water from individual tap connections.

Table 11: Satisfactory levels of quantity of drinking water from Individual tap connections

Level	Slum Area number
Satisfactory	16, 19, 20, 3, 4, 5, 6, 7, 12, 14, 17, 21, 22, 24, 25, 32, 33, 34
Partial Satisfactory	18, 26
Unsatisfactory	2, 8, 10, 13, 23, 27, 28, 29, 30, 31, 9
None	1, 11, 15

18 out of 34 selected slum areas, 53% of the total slum areas in Hyderabad city region were satisfied with the drinking water quantity that was supplied through individual tap connections. 2 out of 34 selected slum areas, 6% of the total slum areas in Hyderabad city

region were partially satisfied with the drinking water quantity that was supplied through individual tap connections. 11 out of 34 selected slum areas, 32% of the total slum areas in Hyderabad city region were unsatisfied with the drinking water quantity that was supplied through individual tap connections. 3 out of 34 selected slum areas, 9% were not using or did not have access to drinking water from a tap inside of their house.

"Quality" concerns.

100% of the households with individual tap connections residing in slum no. 22 and 30 had concerns pertaining to the quality of drinking water. 83-87% of the households with individual tap connections residing in slum no. 13 and 29 had concerns pertaining to the quality of drinking water. 66% of the households with individual tap connections residing in slum no. 10 had concerns pertaining to the quality of drinking water. 26-43% of the households with individual tap connections residing in slum no. 2, 8, 9, 20, 26, 27 and 31 had concerns pertaining to the quality of drinking water. 2-10% of the households with individual tap connections residing in slum no. 4, 5, 6, 7, 12, 16, 18, 19, 33 and 34 had concerns pertaining to the quality of drinking water. 0% of the households with individual tap connections from slum no. 3, 14, 17, 21, 23, 24, 25, 28 and 32 have no concerns pertaining to the quality of drinking water from individual tap connections. The following table 12 illustrates the slum areas and the satisfactory levels of quality of drinking water from individual tap connections.

Table 12: Satisfactory levels of quality of drinking water from Individual tap connections

Level	Slum Area number
Satisfactory	4, 5, 6, 7, 12, 16, 18, 19, 33, 34, 3, 14, 17, 21, 23, 24, 25, 28, 32
Partial Satisfactory	2, 8, 9, 20, 26, 27, 31
Unsatisfactory	22, 30, 13, 29, 10
None	1, 11, 15

19 out of 34 selected slum areas, 56% of the total slum areas in Hyderabad city region were satisfied with the drinking water quality supplied through individual tap connections. 7 out of 34 selected slum areas, 21% of the total slum areas in Hyderabad city region were satisfied with the drinking water quality supplied through individual tap connections. 5 out of 34 selected slum areas, 15% of the total slum areas in Hyderabad city region were satisfied with the drinking water quality supplied through individual tap connections. 3 out of 34 selected slum areas, 9% were not using or were unable to access drinking water from a tap inside of their house. The following box 2 illustrates the type of drinking water quality concerns from individual tap connections raised by the slum residents.

Box 2: Type of quality concerns of Individual tap connections

Type of quality concerns. 377 out of 1,448 households, 26% of the total number of slum households with running water through a tap in their own house did not have clear water, most of the time the drinking water had a colour. 172 out of 1,448 households, 12% of total slum households claimed that the water was turbid. 159 out of 1,448 households, 6% of total slum households claimed that the drinking water had issues pertaining to the "taste". 81 out of 1,448 households, 6% of households fetching claimed that the drinking water had an unpleasant "odour".

b. Public tap connections

The other important source of drinking water in the slum areas of Hyderabad city region is community or public tap drinking water connections. This section provides the perception analysis of slum residents and the challenges encountered by them from the public tap drinking water sources. The analysis in this section is the subset of the analysis carried out in the section 4.4.1 on sources of drinking water. In this section, the perceptions of households on quality and quantity of drinking water was taken from a sample of 710 out of 2,281 households, 31% of the households/ population had access to public tap connections at community level in the slum areas of the Hyderabad city region.

Perception levels on quality and quantity of drinking water from public tap connections.

22 out of 710 households, 3% of the slum population with access to public tap connections were "strongly satisfied" with the quality and quantity of drinking water from public tap connections available in their communities. 99 out of 710 households, 14% of total slum households with access to public tap connections were satisfied with the quality and quantity of drinking water fetched from public tap connection. 63 out of 710 households, 9% of total slum households with access to public tap connections were moderately satisfied/unsatisfied with the quality and quantity of drinking water fetched from public tap connection. 472 out of 710, 67% of total slum households with access to public tap connections were unsatisfied with the quality and quantity of drinking water fetched from public tap connection. 53 out of 710, 7% of total slum households with access to public tap connections were strongly unsatisfied with the quality and quantity of drinking water fetched from public tap connection.

Translating the household analysis into the area level analysis: 11 out of 34, 32% selected slum areas in the Hyderabad city region were satisfied with quality and quantity of drinking water supplied through public tap connections. 3 out of 34, 9% selected slum areas in the Hyderabad city region were satisfied with the quality and quantity of drinking water supplied through public tap connections. 5 out of 34, 15% selected slum areas of the total slum areas did not use public tap connections as a sources of drinking water.

Quantity" concerns.

100% of the households with access to public tap connections residing in slum areas no. 1, 2, 9, 11, 13, 15, 16, 17, 18, 20, 21, 22, 23, 26, 27, 29 and 31 had concerns regarding the quantity of drinking water. 80% of the households with access to public tap connections residing in slum area no. 10 had concerns regarding the quantity of drinking water. 0% of the households with access to public tap connections from slum areas no. 3, 4, 7, 8, 12, 14, 19, 24, 25, 33 and 34 had no concerns pertaining to the quantity of drinking water from the public tap connections. The following table 13 illustrates the slum areas and the satisfactory levels of quantity of drinking water from public tap connections.

Table 13: Satisfactory levels of quantity of drinking water from Public tap connections

Level	Slum Area number
Satisfactory	3, 4, 7, 8, 12, 14, 19, 24, 25, 33, 34
Partial Satisfactory	None
Unsatisfactory	1, 2, 9, 11, 13, 15, 16, 17, 18, 20, 21, 22, 23, 26, 27, 29, 31, 10
None	5, 6, 28, 30, 32

11 out of 34, 32% of the selected slum areas in Hyderabad city region were satisfied with drinking water quantity supplied through public tap connections. 18 out of 34, 53% of the selected slum areas were unsatisfied with quantity of drinking water through public tap connections. The remaining, 5 out of 34 selected slum areas were not using or accessing drinking water through public tap connections.

"Quality" concerns.

100% households with public tap connections residing in slum areas no. 8, 15, 17 and 27 had concerns regarding to the quality of drinking water. 83% households with access to public tap connections residing in slum no. 18 had concerns regarding to the quality of drinking water. 53-75% households with access to public tap connections residing in slum no. 2, 9, 10, 11, 16, 20, 22, 26, 29 and 31 had concerns regarding the quality of drinking water. 50% households with public tap connections residing in slum area no. 13 had concerns regarding the quality of drinking water. 0% of the households with public tap connections from slum areas no. 1, 3, 4, 7, 12, 14, 19, 21, 23, 24, 25, 33 and 34 had no concerns regarding the quantity of drinking water from public tap connections. The following table 14 illustrates the slum areas and the satisfactory levels of quality of drinking water from public tap connections.

Table 14: Satisfactory levels of quality of drinking water from Public tap connections

Level	Slum Area number
Satisfactory	1, 3, 4, 7, 12, 14, 19, 21, 23, 24, 25, 33, 34
Partial Satisfactory	13
Unsatisfactory	8, 15, 17, 27, 18, 2, 9, 10, 11, 16, 20, 22, 26, 29, 31
None	5, 6, 28, 30, 32

13 out of 34, 38% of the selected slum areas in the Hyderabad city region were satisfied with drinking water quality supplied through public tap connections. 1 out 34, 3% of the selected slum areas in the Hyderabad city region were partially satisfied with drinking water quality supplied through public tap connections. 15 out of 34, 44% of the selected slum areas in the Hyderabad city region were unsatisfied with drinking water quality supplied through public tap connections. 5 out of 34, 15% of the selected slum areas did not use or have access to drinking water from public tap connections. The following box 3 illustrates the type of drinking water quality concerns from public tap connections raised by the slum residents.

Box 3: Type of quality concerns of public tap connections

Type of quality concerns. 252 out of 710 households, 36% of the total slum households that had access to drinking water from public tap connections observed colour variations in the drinking water. 99 out of 710 households, 14% of the total slum households that had access to public tap connections claimed that they had a significant amount of turbid drinking water. 235 out of 710 households, 33% of total slum households that had access to public tap connections expressed concerns pertaining to the taste of the drinking water. 14 out of 710 households, 2% of the slum households that had access to public tap connections encountered issues of an unpleasant odour.

c. Borewells, Handpumps or Tubewells

The other important source of drinking water for the slum dwellers within the Hyderabad city region were bore wells, tube wells and hand pumps at household and community level. This section provides a perception analysis of the slum residents and it includes the challenges that they encountered from the bore wells and hand pumps as a drinking water source. This section is the subset of the analysis carried out in section 4.4.1 on sources of drinking water. In this section, the perceptions of the households regarding the quality and quantity of drinking water was measured with a sample of 622 out of 2,281 households, 27% of the households or population had access to bore wells/ hand pumps/ tube-wells in the slum areas of the Hyderabad city region.

Perception levels on quality and quantity of drinking water from borewells/ handpumps.

27 out of 622 households, 4% of the total number of slum households used bore wells, hand pumps or tube wells were "strongly satisfied" with quality and quantity of drinking water. 84 out of 622 households, 14% of the total number of slum households used bore wells, hand pumps or tube wells were satisfied with quality and quantity of drinking water. 320 out of 622 households, 51% of the total number of slum households used bore wells, hand pumps or tube wells were moderately satisfied/unsatisfied with quality and quantity of drinking water. 157 out of 622 households, 25% of the total number of slum households used bore wells, hand pumps or tube wells were unsatisfied with quality and quantity of

drinking water. 33 out of 622 households, 5% of the total number of slum households used bore wells, hand pumps or tube wells were strongly unsatisfied with quality and quantity of drinking water.

Translating the household analysis into the area level analysis, 9 out of 34 26% of the total slum areas were satisfied with quality and quantity of drinking water supplied through bore wells, hand pumps or tube wells. 14 out of 34, 41% of the total slum areas were satisfied with quality and quantity of drinking water supplied through bore wells, hand pumps or tube wells. 8 out of 34, 24% of the total slum areas were satisfied with quality and quantity of drinking water supplied through bore wells, hand pumps or tube wells. 3 out of 34, 9% of the total slum areas were satisfied with quality and quantity of drinking water supplied through bore wells, hand pumps or tube wells.

"Quantity" concerns.

100% of households in slum areas no. 1, 2, 4, 5, 9, 10, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 26, 27, 28, 31 and 32 had concerns pertaining to the quantity of drinking water. The drinking water that was fetched from bore wells, hand pumps and tube-wells was not sufficient for their drinking and other domestic purposes. 61% of households in slum area no. 3 had concerns pertaining to the quantity of drinking water. The drinking water that was fetched from bore wells, hand pumps and tube-wells was not sufficient for their drinking and other domestic purposes. 36-38% of households in slum areas no. 7 and 8 had concerns pertaining to the quantity of drinking water. The drinking water that was fetched from bore wells, hand pumps and tube-wells was not sufficient for their drinking and other domestic purposes. 0% households in slum areas no. 6, 12, 13, 24, 25, 33 and 34 had no concerns pertaining to the quantity of drinking water from bore wells, hand pumps and tube-wells. The following table 15 illustrates the satisfactory levels of quantity of drinking water from borewells, handpumps and tubewells.

Table 15: Satisfactory levels of quantity of drinking water from borewells, handpumps and tubewells

Level	Slum Area number
Satisfactory	6, 12, 13, 24, 25, 33, 34
Partial Satisfactory	7, 8
Unsatisfactory	1, 2, 3, 4, 5, 9, 10, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 26, 27, 28, 31, 32
None	11, 29, 30

7 out of 34, 21% of total slum areas in Hyderabad city region were satisfied with drinking water quantity supplied through bore wells, hand pumps and tube-wells. 2 out of 34, 6% of total slum areas in Hyderabad city region were satisfied with drinking water quantity supplied through bore wells, hand pumps and tube-wells. 22 out of 34, 65% of total slum areas in Hyderabad city region were satisfied with drinking water quantity supplied through bore wells, hand pumps and tube-wells. 3 out of 34, 9% of total slum areas in Hyderabad

city region were satisfied with drinking water quantity supplied through bore wells, hand pumps and tube-wells.

"Quality" concerns.

100% of the slum residing in slum areas no. 9, 15, 18, 19, 20, 21, 23, 27, 28 and 34 had concerns about the quality of drinking water from bore wells, hand pumps, or tube-wells. The drinking water that was fetched from these sources was perceived as unsafe to drink and not fit for other domestic purposes. 95% of the slum households in slum area no. 22 had concerns about the quality of drinking water from bore wells, hand pumps, or tube-wells. The drinking water that was fetched from these sources was perceived as unsafe to drink and not fit for other domestic purposes. 63-75% of the households residing in slum areas no. 7, 12, 14, 17 and 25 had concerns about the quality of drinking water from bore wells, hand pumps, or tube-wells. The drinking water that was fetched from these sources was perceived as unsafe to drink and not fit for other domestic purposes.

44-50% of the households residing in slum areas no. 1, 3, 24 and 31 had concerns about the quality of drinking water from bore wells, hand pumps, or tube-wells. The drinking water that was fetched from these sources was perceived as unsafe to drink and not fit for other domestic purposes. 0% of the households in slum areas no. 2, 4, 5, 6, 8, 10, 13, 16, 26, 32 and 33 had no concerns regarding the quality of drinking water from bore wells, hand pumps or tube-wells. The following table 16 illustrates the satisfactory levels of quality of drinking water from borewells, handpumps and tubewells.

Table 16: Satisfactory levels of quality of drinking water from borewells, handpumps and tubewells

Level	Slum Area number
Satisfactory	2, 4, 5, 6, 8, 10, 13, 16, 26, 32, 33
Partial Satisfactory	1, 3, 24, 31
Unsatisfactory	9, 15, 18, 19, 20, 21, 23, 27, 28, 34, 22, 7, 12, 14, 17, 25
None	11, 29, 30

11 out of 34, 32% of the total slum areas in Hyderabad city region were satisfied with drinking water quality supplied through bore wells, hand pumps or tube-wells. 4 out 34, 12% of the total slum areas in Hyderabad city region were partially satisfied with drinking water quality supplied through bore wells, hand pumps or tube-wells.

16 out of 34, 47% of the total slum areas in Hyderabad city region were unsatisfied with drinking water quality supplied through bore wells, hand pumps or tube-wells. 3 out of 34, 9% of total slum areas were not using or had no access to drinking water from through bore wells, hand pumps or tube-wells. The following box 4 illustrates the type of quality concerns of drinking water from borewells, handpumps and tubewells.

Box 4: Type of quality concerns of Borewells or handpumps

Type of quality concerns. 288 out of 622 households, 46% of the total slum households with access to bore wells, hand pumps or tube-wells claimed that the drinking water that they had fetched from these sources of drinking water noted that the water was "coloured". No households with access to these sources claimed that they encountered a concern regarding the turbidity of the drinking water. 360 out of 622 households, 58% of total slum households claimed that the drinking water that they had fetched from the bore wells, hand pumps or tube-wells had issues regarding the "taste" of the drinking water. 323 out of 622 households, 52% of total slum households with bore wells, hand pumps or tube-wells stated that the water that they had fetched had an unpleasant "odour".

d. Water tankers

The other important source of drinking water amongst in the slum areas of the Hyderabad city region are water tankers. Similar to the analysis that was carried out with the other sources of drinking water in the previous sections, the following section provides the perception analysis of slum residents and the challenges encountered by them from water tanker drinking water sources. This section is the subset of the analysis carried out in section 4.4.1 on sources of drinking water. In this section, the perceptions of households on quality and quantity of drinking water was carried out with using a sample of 877 out of 2,281 households, about 38% of the households or population who had access to water tankers in the slum areas of the Hyderabad city region.

Perception levels on quality and quantity of drinking water from Water tankers.

22 out of 877 households, 2% of the total slum households that got their drinking water from tankers claim that they were strongly satisfied with the quality and quantity of drinking water from water tankers. 310 out of 877 households, 35% of the total slum households that got their drinking water from tankers claim that they were satisfied with the quality and quantity of drinking water from water tankers. 395 out of 877 households, 45% of the total slum households that got their drinking water from tankers claim that they were moderately satisfied / unsatisfied with the quality and quantity of drinking water from water tankers. 142 out of 877 households, 16% of the total slum households that got their drinking water from tankers claim that they were unsatisfied with the quality and quantity of drinking water from water tankers. 9 out of 877 households, 1% of the total slum households that got their drinking water from tankers claim that they were strongly unsatisfied with the quality and quantity of drinking water from water tankers. Translating the household analysis into the area level analysis.

Translating the household analysis into the area level analysis, 20 out of 34 slum areas, 59% of total slum areas in the Hyderabad city region were satisfied with the quality and quantity of drinking water supplied through water tankers. 12 out of 34 selected slum areas, 35%

of total slum areas in the Hyderabad city region were partially satisfied with the quality and quantity of drinking water supplied through water tankers. 2 out of 34 slum areas, 6% of total slum areas in the Hyderabad city region were not satisfied with quality and quantity of drinking water supplied through water tankers.

"Quantity" concerns.

100% of the households with access to water tankers residing in slum areas no. 1, 2, 8, 9, 10, 22, 23, 26, 27, 28, 29, 30 and 31 had concerns about the quantity of drinking water from water tankers. 95% of the households with access to water tankers residing in slum area no. 11 had concerns about the quantity of drinking water from water tankers. 73% of the households with access to water tankers in slum area no. 15 had concerns about the quantity of drinking water from water tankers. 40-47% of the households with access to water tankers in slum areas no. 16, 20 and 32 had concerns about the quantity of drinking water from water tankers. 29% of the households with access to water tankers in slum area no. 19 had concerns about the quantity of drinking water from water tankers. 6-9% of the households residing in slum area no. 17 and had concerns about the quantity of drinking water from water tankers. 0% of the households had access to water tankers from slum areas no. 3, 4, 5, 6, 7, 12, 13, 14, 18, 24, 25, 33 and 34 had no concerns about the quantity of drinking water from water tankers. The following table 17 illustrates the satisfactory levels of quantity of drinking water from water tankers.

Table 17: Satisfactory levels of drinking water from water tankers

Level	Slum Area number
Satisfactory	17, 21, 3, 4, 5, 6, 7, 12, 13, 14, 18, 24, 25, 33, 34
Partial Satisfactory	16, 20, 32, 19
Unsatisfactory	1, 2, 8, 9, 10, 22, 23, 26, 27, 28, 29, 30, 31, 11, 15
None	-

15 out of 34, 44% of total slum areas in Hyderabad city region were satisfied with drinking water quantity supplied through water tankers. 4 out 34, 12% of total slum areas were partially satisfied with quantity of drinking water supplied through water tankers. 15 out of 34, 44% of total slum areas were unsatisfied with drinking water quantity supplied through water tankers.

"Quality" concerns.

100% of the slum households with water tankers residing in slum no. 9 and 15 had concerns about the quality of drinking water from water tankers. 80-95% of the slum households with access to water tankers residing in slum areas no. 2, 22 and 27 had concerns about the quality of drinking water from water tankers. 57-71% of the slum households with access to water tankers residing in slum areas no. 8, 11, 19, 29, 31 had concerns about the quality of drinking water from water tankers. 40-45% of the slum households with water tankers residing in slum areas no. 17, 18, 20, 28, 30 had concerns about the quality of drinking water from water tankers. 16% of the households with access to water tankers residing in slum area no. 1 had concerns about the quality of drinking water from water tankers. 0% of the households with water tankers from slum areas no. 3, 4, 5, 6, 7, 10, 12, 13, 14, 16, 21, 23, 24, 25, 26, 32, 33 and 34 had no concerns pertaining to the quantity of drinking water from water tankers. The following table 18 illustrates the satisfactory levels of quality of drinking water from water tankers.

Table 18: Satisfactory levels of quality of drinking water from water tankers

Level	Slum Area number
Satisfactory	1, 3, 4, 5, 6, 7, 10, 12, 13, 14, 16, 21, 23, 24, 25, 26, 32, 33, 34
Partial Satisfactory	17, 18, 20, 28, 30
Unsatisfactory	8, 11, 19, 29, 31, 9, 15, 2, 22, 27
None	-

19 out of 34, 56% of the total amount of slum areas in Hyderabad city region were satisfied with drinking water quality from water tankers. 5 out 34, 15% of the total slum areas were partially satisfied with quality of drinking water from water tankers. 10 out of 34, 29% of the total slum areas were unsatisfied with drinking water quality from water tankers. The following box 5 illustrates the type of quality concerns of drinking water from water tankers.

Box 5: Type of quality concerns of Water tankers

Type of quality concerns. 306 out of 877 households, 35% of total slum households with access to water tankers claimed that the drinking water from these sources had “colour”. No slum households with access to water from this source claimed that they had any concerns regarding the turbidity of the drinking water. 205 out of 877 households, 23% claimed that they had issues regarding the “taste” of the drinking water. 146 out of 877 households, 17% of slum households claimed that the drinking water from the water tankers had an unpleasant “odour”.

4.1.2. Slum households’ perceptions’ analysis summary

This section further discusses the indicators of drinking water in slum areas by comparatively analysing the quality and quantity patterns across the slum areas and the level of satisfaction for each indicator namely, quality and quantity, from different sources of drinking water.

In order to perform this exercise, the following table 19 has been developed by mapping the indicators and sub-indicators discussed in the theoretical framework regarding drinking water and by analysing to what extent or level of satisfaction the indicators and sub-indicators of drinking water across all the selected slum areas complied with the assessment criteria. This analysis included the distribution of slum areas based on the varying perceptions of slum households with respect to quality and quantity of drinking water from each of the different sources of drinking water, as discussed in the previous sections.

Not only have the satisfaction levels of quality and quantity of drinking water from different sources been evaluated, but the overall scores regarding the drinking water quality and quantity for the selected slum areas were derived by considering the satisfaction levels of the drinking water from the different sources. The overall scores for quality and quantity of drinking water for each of the selected slum areas were classified as either satisfactory or non-satisfactory or partially satisfied.

The aggregate score for quality and quantity of drinking water was classed as "satisfactory" when at least 2 out of 3 major sources of drinking water were classified as satisfactory. The aggregate score for quality and quantity of drinking water was classed as "non-satisfactory" when at least 2 out 3 major sources of drinking water were classified as partially and non-satisfactory. The aggregate score for quality and quantity of drinking water was classed as "partial satisfactory" when at least 1 out 3 major sources of drinking water were classified as satisfactory.

The major sources of water that were used as drinking water and for domestic purposes included fresh water from a tap in a home, public or community tap connections and water tankers. The water fetched from bore wells and hand pumps was mainly used for domestic purposes and only occasionally used for drinking purposes.

Table 19: Distribution of slum areas with varying perceptions of quality and quantity of drinking water

Sources		Individual taps		Public taps		B.Well/ H.Pump		Water tankers		**Overall Score**	
Indicator		Qty.	Qly.	Qty.	Qly.	Qty.	Qly.	Qty.	Qly.	**Qty.**	**Qly.**
Slum code	**#**										
C 1-S A	1	N/A	N/A	N	Y	N	P	N	Y	N	N
C 1-S B	2	N	P	N	N	N	Y	N	N	N	N
C 2-S A	3	Y	Y	Y	Y	N	P	Y	Y	Y	Y
C 2-S B	4	Y	Y	Y	Y	N	Y	Y	Y	Y	Y
C 3-S A	5	Y	Y	N/A	N/A	N	Y	Y	Y	Y	Y
C 3-S B	6	Y	Y	N/A	N/A	Y	Y	Y	Y	Y	Y
C 4-S A	7	Y	Y	Y	Y	P	N	Y	Y	Y	Y
C 4-S B	8	N	P	Y	N	P	Y	N	N	N	N
C 5-S A	9	N	P	N	N	N	N	N	N	N	N
C 5-S B	10	N	N	N	N	N	Y	N	Y	N	P
C 6-S A	11	N/A	N/A	N	N	N/A	N/A	N	N	N	N
C 6-S B	12	Y	Y	Y	Y	Y	N	Y	Y	Y	Y
C 7-S A	13	N	N	N	P	Y	Y	Y	Y	Y	P
C 7-S B	14	Y	Y	Y	Y	N	N	Y	Y	Y	Y
C 8-S A	15	N/A	N/A	N	N	N	N	N	N	N	N
C 8-S B	16	Y	Y	N	N	N	Y	Y	Y	Y	Y
C 9-S A	17	Y	Y	N	N	N	N	Y	P	Y	P
C 9-S B	18	P	Y	N	N	N	N	Y	P	P	P
C 10-S A	19	Y	Y	Y	Y	N	N	Y	N	Y	Y
C 10-S B	20	Y	P	N	N	N	N	Y	P	Y	P
C 11-S A	21	Y	Y	N	Y	N	N	Y	Y	Y	Y
C 11-S B	22	Y	N	N	N	N	N	N	N	N	N
C 12-S A	23	N	Y	N	Y	N	N	N	Y	N	Y
C 12-S B	24	Y	Y	Y	Y	Y	P	Y	Y	Y	Y
C 14-S A	27	Y	Y	Y	Y	Y	N	Y	Y	Y	Y
C 14-S B	28	P	P	N	N	N	Y	N	Y	N	N

Sources		Individual taps		Public taps		B.Well/ H.Pump		Water tankers		Overall Score	
Indicator		Qty.	Qly.	Qty.	Qly.	Qty.	Qly.	Qty.	Qly.	Qty.	Qly.
Slum code	#										
C 15-S A	29	N	P	N	N	N	N	N	N	N	N
C 15-S B	30	N	Y	N/A	N/A	N	N	N	P	N	P
C 16-S A	31	N	N	N	N	N/A	N/A	N	N	N	N
C 16-S B	32	N	N	N/A	N/A	N/A	N/A	N	P	N	N
C 17-S A	33	N	P	N	N	N	P	N	N	N	N
C 17-S B	34	Y	Y	N/A	N/A	N	Y	Y	Y	Y	Y
C 18-S A	35	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
C 18-S B	36	Y	Y	Y	Y	Y	N	Y	Y	Y	Y

Legend: Y (Compliant), P (Partially compliant), N (Non-compliant), N/A – Not Applicable (was not used as a source of drinking water)

Variations in quality and quantity of drinking water from different sources within the slum areas.

There are certain slum areas for which the quality and quantity of drinking water from different sources have satisfaction levels, and certain slum areas for which the drinking water quality and quantity from different sources have non-satisfaction levels. The patterns of satisfaction levels in certain slum areas and non-satisfaction levels in certain slum areas was observed even with the prominent sources of drinking water such as individual tap connections and public tap connections. Similar satisfaction and non-satisfaction levels were observed for drinking water from borewells, handpumps, tubewells and water tankers.

Positive corresponding patterns between quality and quantity of drinking water from different sources.

The slum areas where the drinking water quantity had positive satisfaction levels also had positive satisfactory levels of drinking water quality from all of the other sources of drinking water. In the case of drinking water from individual tap connection, when the quantity of drinking water was satisfactory, they were also satisfied with the quality aspects of the water too. In the slum areas where the quantity of drinking water was non-satisfactory the slum dwellers also claimed to not be satisfied with the quality of the drinking water.

Similar patterns were also observed for drinking water from public tap connections and water tankers. The slum areas in which the quantity of drinking water from the public taps and water tankers was satisfactory, they were also satisfied with the quality aspects of the drinking water from these sources. This also applied to when the quantity of drinking was not satisfactory then the quality was also perceived as non-satisfactory.

However, the positive corresponding patterns between the quality and quantity of drinking water from bore wells, tube wells and hand pumps were not observed. Even in the slum areas where they were satisfied with the quantity of drinking water from bore wells, tube wells and hand pumps, they perceived quality as being not satisfactory. The slum areas where the quantity of drinking water from bore wells, tube wells and hand pumps were not satisfactory, the corresponding quality aspects of the drinking water from these sources was perceived as satisfactory. There were significantly low numbers of slum areas for which the quantity of drinking water from bore wells, tube wells and hand pumps was perceived as satisfactory that also had satisfactory levels regarding the quality of the drinking water from these sources.

Positive corresponding patterns of satisfaction levels between different drinking water sources.

The households that were satisfied with one source of drinking water were also satisfied with at least one other source of drinking water. The pattern analysis observed in the summary table above showed that the households that were satisfied with the quality and quantity aspects of the drinking water from the taps that were found in the individual households were also satisfied with the quality and quantity aspects of drinking water from the water tankers. Thus, there was a positive corresponding pattern of perceived satisfaction levels of quality and quantity aspects of drinking water from individual tap connections and water tankers as sources of drinking water.

The households that were satisfied with the quality and quantity aspects of drinking water from individual household taps and water tankers also expressed a certain satisfactory level regarding the quality and quantity aspects of drinking water from public or community level tap connections. This showed partial corresponding patterns of the satisfaction levels of the quality and quantity aspects of drinking water from individual tap connections, water tankers and public or community level tap connections as sources of drinking water.

The analysis of the corresponding patterns of the satisfaction levels between different sources of drinking water sources that is presented in the above summary table revealed that there were no corresponding patterns of satisfaction levels that were observed between sources of drinking water like the individual tap connections, water tankers and public tap connections and the sources of drinking water like bore wells, tube wells and hand pumps.

The household satisfaction levels on quality and quantity of drinking water from bore wells and hand pumps were significantly low and did not show any corresponding relationship with the satisfaction levels regarding the quality and quantity of drinking water from the other available sources of drinking water.

In summary, the overall corresponding pattern analysis significantly showed that there were variations amongst the slum areas in terms of accessibility or availability of safe quality and adequate quantity drinking water from different sources of drinking water in the Hyderabad city region. Further, the pattern analysis also significantly showed that the slum areas for which the quantity of drinking water was satisfactory from any source of drinking water they were also satisfied with the quality aspects from the same source of drinking water.

In addition, the corresponding pattern analysis also showed that if there were satisfactory levels of one source of drinking water then there would also be satisfaction levels for at least one other source of drinking water. The current research performed an in-depth expert judgement analysis to validate and reinforce the findings of slum households' perception analysis and then further analysed it and arrived at key conclusions regarding the quality and quantity aspects of drinking water from the different sources that were used by the slum households in the Hyderabad city region.

4.2. Experts' Judgement on Quantity and Quality of Drinking water

The stakeholders' perceptions of drinking water quality and quantity parameters in the slum areas of Hyderabad city region had significant variations and there were confronting challenges for the slum households that perceived that they had unsafe quality and insufficient quantity of drinking water from the various sources. Although the consumers' perception of the physical and aesthetic parameters of the drinking water played a vital role with respect to the quality and quantity of drinking water, when they were only able to rely on their own senses they were unable to detect other issues and therefor were not able to assess the actual quantity and quality aspects of the drinking water.

In addition to the assessment of the human sensory perceptions of the quantity, taste, odour, colour, appearance and other parameters of the drinking water, in the current research study a Rapid Assessment of Drinking Water Quality (RADWQ) and Quantity was carried out to assess scientifically the quantity and quality parameters and to reinforce the stakeholders' perception assessment of the drinking water quality and quantity.

The following section of the analysis firstly investigates the quantity of drinking water that was made available for drinking and other domestic purposes to the households in the slum areas in the Hyderabad city region. The later sections of the chapter cover the aspects of the quality of the drinking water.

4.2.1. Quantity of drinking water

The population in slum areas in the Hyderabad city region having access to multiple sources of drinking water, the permissible quantity of drinking water in general for a population is 150-200 litres per person per day. However, households from lower income groups, the economically weaker sections of the society, only have access to 135 litres of water per person per house per day (CPCB, 2013).

In order to understand the perceptions of the households regarding the quantity of drinking water and to be able to estimate the ***number of litres per person per day*** *(*Litres Per Capita per Day - *LPCD)* that was available to the households or population from the various sources of drinking water combined, it was imperative to firstly work out the following:

- Average number of households
- Number of litres of water fetched by the households per day
- What were the days that the water is made available,
    - The frequency of drinking water supply
    - The availability of the drinking water

- The number of days for which the collected water is stored.

In order to estimate the number of liters per head per day, the following is the formula to be used.

Quantity of drinking water (in LPCD) = (Total number of litres of water collected by the households) / (Total number of days for which the water collected is stored) / (Average household size in the slum areas).

Equation 1: Formula to estimate the quantity of drinking water in liters per capita per day

Average household size.

The housing structures within the slum areas of the Hyderabad city region provided shelter for a minimum of 2 households and a maximum of 12 households. These households were made up of individuals of all age groups and of both the genders.

The primary objective of any residential development is to accommodate the lowest possible number of households to moderate the burden on the limited resources that were available for example in terms of land and water. Therefore, rules and regulations were made based on standards in order to control household sizes. However, considering various factors in the development of slums, such as:

- Fewer income levels to avail better services
- High land prices
- Low availability of land
- Proximity to the workplace
- Plot area or built-up area of the housing unit

The population density of the slum areas was higher than the rest of the residential areas in the city region. This meant that the average household size was higher in these slum areas compared to rest of the city's household sizes.

This is a common feature of slum areas that were found in urban cities. Due to the variations in household sizes, the infrastructure facilities and service requirements also differed. The requirements of and the burden on the physical infrastructure facilities and services such as water, drainage, sewerage and solid waste, were dependent on the household sizes. The higher the number of households in the building structure, the higher is the requirements of and the burden on infrastructure facilities and services. For instance, the amount of solid waste generated from a building structure with a high number of households is higher than the amount of solid waste generated from a building structure with a lower number of households. Similarly, is the case with the requirements for water infrastructure facilities and services. The higher the number of households, the higher the water requirements and consumption.

1,489 out of 2,281, 66% of the households claimed that their family size was between 4 to 5 people. 456 out of 2,281, 20% of the households claimed that their household size was between 6 to 8 people. 245 out of 2,281, 11% of the households claimed that their family size was between 2 to 3. 70 out of 2,281, 3% of the households that claimed to have a family size ranging between 9 and 12. In summary, the weighted average of household sizes in the selected slum areas of the Hyderabad city region is 4.88 (rounded off to 5) households per housing unit.

Average frequency of drinking water supply or availability.

The frequency of the availability of drinking water in the slum areas in the Hyderabad city region varies. The availability of the drinking water has an effect on:

- The numbers of days the water has to be stored in the family unit,
- The usage patterns of the water
- The quality of the stored drinking water

The major sources of drinking water in the slum areas in the Hyderabad city region include the municipal water supplied through either household tap connections, public tap connections, water tankers, ground water supplied through household and community level bore wells, tube wells and hand pumps.

The slum households in Hyderabad city region need to fetch the water for drinking and other domestic purposes depending on the availability of the water, which can be daily to once in 10 days. The frequency, in number of days, of drinking water that is available to the majority of the slum households is very low, the gap in terms of the number of days between the supplies or availability of drinking water is high. This is why the figures for the quantity of drinking water that is available was low.

None of the households had a daily supply of drinking water. 1,362 out of 2,281, 60% of the households had access to drinking water every 2 days. The sources of drinking water from which the slum households or population fetched the drinking water on every alternative day varied, either from individual tap connections, public tap connections, or water tankers. In the slum areas of Hyderabad city region, there were a significant share of the households or population with the frequency of availability of drinking water was every 2 days.

121 out of 2281, 5% of the households had access to drinking water every 3 days. 666 out of 2,281, 29% of the households had access to drinking water every 7 days 127 out of 2281, 6% of the households had access to drinking water every 10 days. In summary, the weighted average of the frequency of the number of days on which the drinking water is available to the households/ population in the slum areas of the city, was about 3.90 (rounded off to 4) days.

Average quantity of drinking water collected.

The selected slum areas in the Hyderabad city region had a lower quantity of drinking water that was available for drinking and other domestic purposes than the required standard. Typically, these slum households collect drinking water from different sources such as individual tap connections, public tap connections, water tankers, bore wells, tube wells and hand pumps. The slum households used different carrying and storage containers such as household vessels, overhead tanks and underground sumps. However, the drinking water quantity collected was primarily dependent on factors such as frequency of supply, duration of supply and pressure of supply, which were controlled and monitored by the HWMSS.

The total quantity of drinking water that was collected by the slum households and which was taken into consideration within this analysis section was taken from all of the combined potential sources of drinking water used by the slum population. Further, the analysis that has been provided in this section refers to the total amount of storage equipment in which the water is collected. Although the storage equipment did not have accurate units of measuring the quantity of drinking water collected, an estimate of the total quantity of drinking water was able to be estimated by considering the total capacity of the storage equipment. In order to estimate the total quantity in number of litres and have a common unit for measuring the quantity of drinking water collected, the capacity of the storage unit or equipment considered for the current analysis in this section ranged between 80-100 litres (average was 90 litres). When the analysis description specified the drinking water collected in storage units was ranging between 2 to 3 means that the total quantity of drinking water collected was between 180 to 270 litres.

80 out of 2,281, 4% of the total slum households collected between 13-15 storage units of drinking water from various sources. 249 out of 2,281, 11% of the total slum households collected between 9-12 storage units of drinking water from different sources. 921 out of 2,281, 40% of the total slum households collected between 6-8 storage units of drinking water from different sources. 756 out of 2,281, 33% of the total slum households collected between 4-5 storage units. of drinking water from different sources. 278 out of 2,281, 12% of total slum households collected between 2-3 storage units of drinking water from different sources. In summary, the weighted average of the number of storage units filled with drinking water, collected from different sources by the households, was about 6.40 (rounded off to 6) storage units of drinking water. Considering the average capacity of the storage unit was 90 litres, the average quantity of drinking water collected is 575.69 (rounded off to 576) litres per household.

Average number of days for which the collected water is stored.

The number of days for which the water collected was stored in the households was dependent on the frequency of drinking water that was available. The lower the frequency, in number of days of availability of drinking water, the lower the number of days for which the water needed to be stored. It was observed that the average number of days for which the drinking water collected was stored within the households was equal or more than the frequency of the average number of days for which the drinking water was available.

1,283 out of 2281, 56% of total slum households stored the collected drinking water between 2-3 days within their household premises. Further, 797 out of 2,281, 35% of total slum households stored the collected drinking water between 4-5 days within their household premises. 195 out of 2,281, 9% of total slum households stored the collected drinking water between 6-8 days within their household premises.

Slum area wise drinking water quantity.

This section provides a summary of the key findings regarding the quantity of drinking water that was available to the slum households for drinking and other domestic purposes. The quantity of the drinking water that was available was only estimated for facilities and services that were provided by the HMWSSB in the selected slum areas in the Hyderabad city region. This did not include the drinking water facilities and services procured by the slum households by any other means.

Further, in order to estimate the existing quantity of drinking water, the following equation is applied:

> ***Quantity of drinking water (lpcd) = (Total number of litres of water collected by the households)/ (Total number of days for which the water collected is stored)/ (Average household size in the slum areas)***.

Equation 2: Estimation of existing quantity of drinking water

This equation has been applied to all of the selected slum areas to arrive at an existing quantity (LPCD) and was compared with the quantity standards (LPCD) applicable to slum households to understand the % variations between existing and standard quantity of drinking and compliance levels. This has been illustrated in the analysis summary Table 20.

Based on the slum area level analysis regarding the number of days of storage of collected drinking water, the table (refer Table 20) provides the slum area wise weighted average of the number of storage days of drinking water collected from different sources by the households in the Hyderabad city region. The household analysis of the number of days of storage of collected drinking water in slum areas in the Hyderabad city region discloses in summary that the weighted average of the number of days of storage of drinking water at household level in the slum areas of the city is about 3.65 (rounded off to 4) days. This signifies that the average number of days of storage is equal to the frequency of the average number of days on which the drinking water is available for collection.

Table 20: Analysis summary showing the existing quantity of drinking water and compliance levels compared to standard quantity drinking water

Parameters		Quantity of water collected (in liters)	Frequency of supply (in days)	No. of Days water stored (in days)	Average HH size (in no.)	Existing Quantity (LPCD)	Quantity standards (lpcd)	%	Compliance (Y/N)	Compliance in relative terms (more than average) (Y/N)
Slum code	#									
C 1-S A	1	596.70	7.00	4.80	5.81	21.40	135	15.85%	N	N
C 1-S B	2	594.90	4.80	6.45	4.33	21.30	135	15.78%	N	N
C 2-S A	3	643.50	2.00	2.94	5.43	40.31	135	29.86%	N	Y
C 2-S B	4	575.10	2.00	2.74	4.84	43.37	135	32.12%	N	Y
C 3-S A	5	639.00	2.00	2.74	5.74	40.63	135	30.10%	N	Y
C 3-S B	6	542.70	2.00	2.60	4.92	42.42	135	31.43%	N	Y
C 4-S A	7	806.40	2.00	2.50	5.01	64.38	135	47.69%	N	Y
C 4-S B	8	325.80	2.00	2.50	4.72	27.61	135	20.45%	N	N
C 5-S A	9	434.70	7.00	4.34	5.45	18.38	135	13.61%	N	N
C 5-S B	10	793.80	8.26	5.85	6.41	21.17	135	15.68%	N	N
C 6-S A	11	463.50	7.78	5.40	4.81	17.84	135	13.22%	N	N
C 6-S B	12	639.00	2.00	2.50	5.14	49.73	135	36.84%	N	Y
C 7-S A	13	614.70	2.00	2.50	5.04	48.79	135	36.14%	N	Y
C 7-S B	14	567.00	2.00	2.50	4.42	51.31	135	38.01%	N	Y
C 8-S A	15	235.80	2.00	2.50	4.42	21.34	135	15.81%	N	N
C 8-S B	16	484.20	2.00	2.66	4.50	40.45	135	29.96%	N	Y
C 9-S A	17	690.30	2.22	3.62	4.67	40.83	135	30.25%	N	Y
C 9-S B	18	621.00	2.00	2.90	4.55	47.06	135	34.86%	N	Y
C 10-S A	19	782.10	2.00	3.26	4.34	55.28	135	40.95%	N	Y
C 10-S B	20	603.00	2.00	2.50	5.18	46.56	135	34.49%	N	Y
C 11-S A	21	686.70	2.00	2.58	6.17	43.14	135	31.95%	N	Y
C 11-S B	22	553.50	2.00	3.02	4.95	37.03	135	27.43%	N	Y

Parameters		Quantity of water collected (in liters)	Frequency of supply (in days)	No. of Days water stored (in days)	Average HH size (in no.)	Existing Quantity (LPCD)	Quantity standards (lpcd)	%	Compliance (Y/N)	Compliance in relative terms (more than average) (Y/N)
Slum code	#									
C 12-S A	23	376.20	3.58	3.22	4.41	26.49	135	19.62%	N	N
C 12-S B	24	831.60	2.00	3.42	4.48	54.28	135	40.20%	N	Y
C 14-S A	27	643.50	2.00	2.78	5.70	40.61	135	30.08%	N	Y
C 14-S B	28	567.00	7.36	4.80	4.45	26.54	135	19.66%	N	N
C 15-S A	29	307.80	5.96	3.98	4.33	17.86	135	13.23%	N	N
C 15-S B	30	477.00	9.46	6.05	4.50	17.52	135	12.98%	N	N
C 16-S A	31	365.40	7.98	6.10	4.14	14.47	135	10.72%	N	N
C 16-S B	32	387.00	8.50	5.88	4.01	16.41	135	12.16%	N	N
C 17-S A	33	358.20	5.64	4.00	4.44	20.17	135	14.94%	N	N
C 17-S B	34	888.30	7.00	5.15	4.92	35.06	135	25.97%	N	Y
C 18-S A	35	787.50	2.00	3.02	4.58	56.93	135	42.17%	N	Y
C 18-S B	36	768.60	2.00	2.82	5.10	53.44	135	39.59%	N	Y
Average Values		**575.69**	**3.90**	**3.65**	**4.88**	**35.63**	**135**	**26.40%**	**N**	-

Further, it also signifies that the estimations of quantity of drinking water that were available were lower than the standard requirements for a person per day for drinking and other domestic purposes. However, in order to estimate the average quantity of drinking water in number of litres per day per person, the following were considered, namely,

- The average household size,
- The average quantity of drinking water collected by the household from different sources, and
- The average number of days for which the collected water is stored by the household

The following equation may be considered to estimate the required number of days:

Quantity of drinking water = (Average number of litres of water collected by the households)/ (Average number of days for which the water collected is stored)/ (Average household size in the slum areas).

Equation 3: Estimate of required number of days needed to store water

Based on the above, the following are the results from the other sections:

a. Average number of litres of water collected by the households = 575.69 litres
b. Average number of days for which the water collected is stored by household = 3.65 days
c. Average household size in the slum areas = 4.88 individuals/ household

The quantity of drinking water per day per person is about 35.63 (round off to 36) LPCD (or LPHD). The results show that the average quantity of drinking water per person per day consumption or available for drinking and other domestic purposes is 73% lower than the standard requirements for a person per day for drinking and other domestic purposes, which is 135 LPCD (or LPHD). However, referring to the slum area level analysis (refer the table 20) on the quantity of drinking water per day per person it also disclosed varied results, there was a certain number of slum areas that had higher quantity, in relative terms, of drinking water compared to other slum areas in the Hyderabad city region. This also explained the varied perceptions of slum households regarding the quantity of drinking water as observed in section 4.1.

4.2.2. Quality of drinking water

The population in the slum areas in the Hyderabad city region that had access to multiple sources if drinking water had acceptable quality levels for (a) Microbiological parameters, (b) Chemical parameters and (c) Physical parameters which were in accordance with the Bureau of Indian Standard Drinking water specifications (IS 10500-1991). In this section, the analysis pertaining to a laboratory tests-based quality assessment of drinking water from different sources has been presented and compared to the Indian standard specifications for drinking water to identify the gaps.

The quality assessment of drinking water analysed in this section was for 51 drinking water samples. They were collected from various sources from 17 selected slum areas spread across the Hyderabad city region. A laboratory test analysis which included various quality indicators was carried out on all of the samples.

17 samples were collected from individual or household taps, 17 samples were collected from ground water sources such as bore wells, tube wells and hand pumps and 17 samples were collected from various water tankers that supplied drinking water to the slum areas in the Hyderabad city region.

This section proceeds further to summarise the key findings regarding the quality aspects of drinking water by presenting the compliance with standard acceptable limits for all the quality, microbiological, chemical and physical parameters in the drinking water from the various sources across all of the slum areas. In order to perform this exercise, a summary table was made by mapping the quality, microbiological, chemical and physical parameters showing the compliance with standards for all of the selected slum areas and different sources of drinking water.

This analysis included the distribution of slum areas based on the varying quality compliance with standards regarding the quality aspects of drinking water from different sources of drinking water, as presented in the Annex 4. Overall scores on drinking water quality for selected slum areas were calculated. The overall scores for quality of drinking water for each drinking water sources for each of the selected slum areas was defined as being either "compliant" or "non-compliant". The aggregate score for the quality of drinking water from each drinking water source was said to be "compliant" when all the quality, microbiological, chemical and physical parameters had standard acceptable levels. Similarly, the aggregate score for quality of drinking water from each drinking water source is said to be "non-compliant" when at least one of the parameters was not within the standard acceptable limits.

Microbiological parameters.

There were a variety of micro-organisms which were pathogenic and non-pathogenic in nature that affected the quality of drinking water. The problems that pertain to the taste and odour of drinking water were primarily caused due to the presence of non-pathogenic micro-organisms. This influenced the perception of the households in terms of what is safe quality drinking water and in selecting the water sources for consumption purposes.

The primary concerns for microbial quality was the presence of pathogenic micro-organisms such as viruses, bacteria, protozoa, helminth eggs or larvae in the drinking water which can lead to the most common widespread infectious diseases. In order to maintain the safe quality of drinking water, it is imperative to analyse and monitor the microbiological quality of the drinking water. Considering the microbial indicators that were recommended to assess the quality of the drinking water within the RADWQ framework, the current research study, which primarily focused on drinking water quality in the selected slum areas in the Hyderabad city region, decided to test using laboratory test analysis for the presence of the following indicators in all of the drinking water samples that were collected from the various sources: (i) Thermo tolerant coliforms, (ii) Turbidity, (iii) pH, (iv) Chlorine residuals, (v) Escherichia Coli (E-Coli) and (vi) Total coliforms.

There was a significant presence of microbiological organisms in the drinking water from different sources, especially from household tap connections, public or community level tap connections, bore wells, tube wells and hand pumps and there were also variations in the availability of unsafe drinking water caused due to microbiological organisms within the slum areas. However, there was no presence of microbiological organisms in the drinking water supplied through water tankers throughout all of the slum areas.

Analysing the drinking water quality from the household and community level tap connections presented in the summary table 21, showed that there were certain slum areas for which the presence of microbiological organisms such as thermo coliforms, total coliforms and e-coli were negatively affecting the drinking water quality.

However, there were certain slum areas for which the presence of these microbiological organisms was at acceptable levels. It can also be seen in the summary table that the microbiological parameters such as turbidity and pH levels were within the permissible limits in the drinking water supplied through individual tap connections and community level tap connections.

Despite this, due to the presence of coliforms and E-coli which exceeded the permissible limits and the non-presence of residual chlorine which is a parameter that is desired in drinking water from individual or public tap connections, in certain slum areas as it is lacking, it gave a result of an unsafe quality of drinking water in these slum areas. It was also observed that there were positive corresponding patterns between the presence of thermo coliforms and total coliforms. The drinking water supplied through household or public tap connections in certain slum areas where thermo coliforms were observed, there was also a presence of total coliforms. However, there was no corresponding patterns observed with the presence of coliforms and E-coli.

Analysing the drinking water quality from bore wells, tube wells and hand pumps connections and water tankers as presented in the summary table below, there were certain slum areas whereby the presence of microbiological organisms such as thermo coliforms, total coliforms and e-coli negatively affected the drinking water quality. However, there were also some slum areas that had the microbiological organisms in the drinking water, but their presence was within acceptable limits.

It can also be seen in the summary table that the microbiological parameters such as turbidity and pH levels were within the permissible limits for the drinking water supplied through bore wells, tube wells and hand pumps. Despite this, due to the presence of coliforms and E-coli exceeding the permissible limits in the drinking water from the bore wells, tube wells, hand pumps and water tankers in certain slum areas it resulted in an unsafe quality of drinking water in these slum areas.

It was also observed that there were positive corresponding patterns between the presence of coliforms and E-coli. In the drinking water supplied through bore wells, tube wells, hand pumps and water tankers in certain slum areas for which coliforms were found, there was also a presence of E-coli in the drinking water in these slum areas.

In summary, there were certain slum areas for which the drinking water supplied through individual tap connections, public tap connections, bore wells, tube wells, hand pumps and water tankers were compliant with acceptable quality limits of microbiological parameters and certain slum areas were non-compliant with unacceptable amounts of microbiological organisms.

Table 21: Distribution of slum areas with drinking water from different sources and compliance with standard and acceptable levels of microbiological parameters

Parameters		Therm. Coliforms			Turbidity			pH			Residual Chlorine			Tot. Coliforms			E.coli			**Overall Score**		
Sources		I/PT	BW	WT	I/PT	BW	WT	I/PT	BW	WT	I/PT	BW	WT	I/PT	BW	WT	I/PT	BW	WT	**I/PT**	**BW**	**WT**
Slum Code	**#**																					
C 1-S A	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C 1-S B	2	N	Y	Y	Y	Y	Y	Y	Y	Y	N	NA	NA	N	Y	Y	N	Y	Y	N	Y	Y
C 2-S A	3	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	NA	NA	Y	Y	Y	Y	Y	Y	Y	Y	Y
C 2-S B	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C 3-S A	5	Y	N	Y	Y	Y	Y	Y	Y	Y	N	NA	NA	Y	N	Y	Y	N	Y	Y	N	Y
C 3-S B	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C 4-S A	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C 4-S B	8	Y	N	Y	Y	Y	Y	Y	Y	Y	N	NA	NA	N	N	Y	Y	N	Y	N	N	Y
C 5-S A	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C 5-S B	10	N	Y	Y	Y	Y	Y	Y	Y	Y	N	NA	NA	N	Y	Y	Y	Y	Y	N	Y	Y
C 6-S A	11	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	NA	NA	Y	Y	Y	Y	Y	Y	Y	Y	Y
C 6-S B	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C 7-S A	13	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	NA	NA	Y	Y	Y	Y	Y	Y	Y	Y	Y
C 7-S B	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C 8-S A	15	Y	N	Y	Y	Y	Y	Y	Y	Y	N	NA	NA	N	N	Y	Y	Y	Y	N	N	Y
C 8-S B	16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C 9-S A	17	N	Y	Y	Y	Y	Y	Y	Y	Y	N	NA	NA	N	Y	Y	Y	Y	Y	N	Y	Y
C 9-S B	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C 10-S A	19	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	NA	NA	Y	N	Y	Y	Y	Y	Y	N	Y
C 10-S B	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C 11-S A	21	N	Y	Y	Y	Y	Y	Y	Y	Y	N	NA	NA	N	Y	Y	Y	Y	Y	N	Y	Y

"S.I.T.E" Valuation of Drinking Water

Parameters		Therm. Coliforms			Turbidity			pH			Residual Chlorine			Tot. Coliforms			E.coli			**Overall Score**		
Sources		I/PT	BW	WT	I/PT	BW	WT	I/PT	BW	WT	I/PT	BW	WT	I/PT	BW	WT	I/PT	BW	WT	**I/PT**	**BW**	**WT**
Slum Code	**#**																					
C 11-S B	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C 12-S A	23	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	NA	NA	N	N	Y	Y	Y	Y	N	N	Y
C 12-S B	24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C 14-S A	27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C 14-S B	28	N	N	Y	Y	Y	Y	Y	Y	Y	N	NA	NA	N	N	Y	N	N	Y	N	N	Y
C 15-S A	29	N	Y	Y	Y	Y	Y	Y	Y	Y	N	NA	NA	N	Y	Y	Y	Y	Y	N	Y	Y
C 15-S B	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C 16-S A	31	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C 16-S B	32	Y	N	N	Y	Y	Y	Y	Y	Y	N	NA	NA	Y	N	N	Y	N	N	Y	N	N
C 17-S A	33	N	N	Y	Y	Y	Y	Y	Y	Y	N	NA	NA	N	N	Y	N	N	Y	N	N	Y
C 17-S B	34	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C 18-S A	35	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	NA	NA	N	Y	Y	Y	Y	Y	N	Y	Y
C 18-S B	36	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Legend: Y: Compliant, N: Non-compliant, NA: Not Applicable, -: Samples not collected, I/PT: Individual/ Public Tap connections; BW: Borewell and Handpumps, WT: Water tankers

Chemical parameters.

There were a wide range of chemical elements that have natural and anthropogenic sources which can affect the quality of drinking water and in turn they were able to influence the customers' acceptability of drinking water, they can be harmful to the public health and can also be harmful to the services' operational performance. Standards and guidelines define the desirable and permissible amounts that can be present in the drinking water for all the potential chemical elements.

In terms of time and cost, it was impractical and unnecessary to carry out laboratory tests for all of the chemical parameters in the drinking water samples. Therefore, priorities were set and a selection of chemical parameters for assessment were made with regard to water quality for the selected slum areas in Hyderabad city region. The chemical indicators that were recommended in order to assess the quality of drinking water that were mentioned in the RADWQ framework were used.

The drinking water samples collected from the various sources of drinking water throughout the slum areas in the Hyderabad city region were tested for the following chemicals: (i) phenolphthalein, (ii) Total Alkalinity, (iii) Carbonates, (iv) Hydroxides, (v) Calcium, (vi) Ammonia, (vii) Sulphates, (viii) Iron, (ix) Manganese, (x) Total hardness, (xi) Magnesium, (xii) Nitrite, (xiii) Nitrate, (xiv) Nitrogen and (xv) Fluorides. The following section provides the key findings and analysis of the laboratory test results from the above stated chemicals for the samples collected in the selected slum areas in the Hyderabad city region.

> Limited presence of chemical parameters in the drinking water from different sources and variations in availability of unsafe drinking water caused due to presence of chemical parameters amongst the slum areas.

Bore wells, tube wells and hand pumps.

The analysis of the drinking water quality from the bore wells, tube wells and hand pumps connections as presented in the summary table, shows that there were only a few slum areas where there was a presence of chemicals such as nitrite, nitrate, nitrogen and fluoride which negatively affected the drinking water quality. However, there was a significant number of slum areas where there was a presence of these chemicals, but it was counted as negligible.

It was also observed from the summary table that the other chemical parameters were within the permissible limits in the drinking water from bore wells, tube wells and hand pumps connections for these limited number of slum areas for which there was a presence of nitrite, nitrate, nitrogen and fluoride were at an unacceptable level. There was a significant number of slum areas for which the presence of all chemical parameters was negligible.

There was a positive corresponding pattern observed between the presence of nitrate and nitrogen. The drinking water available from bore wells, tube wells and hand pumps in certain slum areas where there were nitrates found, there was also a presence of nitrogen. However, there was no corresponding patterns observed in the presence of nitrite and fluoride and other chemical parameters such as nitrates and nitrogen.

Household and community level tap connections

Analysing the drinking water quality from household and community level tap connections (see summary table below) it can be seen that there was a significantly low number of slum areas for which the presence of chemicals such as total hardness, nitrogen and nitrate were negatively affecting the drinking water quality. However, there was a significant number of slum areas for which there was no presence of any chemical parameters apart from the permissible limits. Thus, the drinking water from household tap connections and public or community level tap connections had a negligible amount of harmful chemicals in it. There were positive corresponding patterns observed between the presence of nitrate and nitrogen. The drinking water supplied through individual tap connections and public tap connections in one of the sample case study areas for which nitrates were observed, there was also a presence of nitrogen. However, there was no corresponding patterns observed regarding the presence of total hardness of the water and other chemicals such as nitrates and nitrogen.

Water tankers

The analysis of the drinking water quality from the water tankers as presented in the summary table 22, shows that there was a significantly low number of slum areas for which there was a presence of chemicals such as magnesium that negatively affected the drinking water quality.

There was a significant number of slum areas for which there was no presence of any chemicals that were tested beyond the permissible limits. Thus, the drinking water from the water tankers were generally safe and did not contain any harmful chemicals. Further, there was no corresponding patterns observed between any chemical parameters from the drinking water from water tankers.

In summary, there were only a limited number of slum areas for which the drinking water supplied through individual tap connections, public tap connections, bore wells, tube wells, hand pumps and water tankers were not-compliant with the acceptable Indian quality standards of chemical parameters and a significant number of slum areas were compliant with having acceptable quality limits of chemicals within their drinking water.

Table 22: Distribution of slum areas with drinking water from different sources and compliance with standard and acceptable levels of chemical parameters

Parameters		Elements*			Total Hardness			Magnesium			Nitrite			Nitrate			Nitrogen			Fluorides			Overall Score		
Sources		I/PT	BW	WT	I/PT	BW	WT	I/PT	BW	WT	I/PT	BW	WT	I/PT	BW	WT	I/PT	BW	WT	I/PT	BW	WT	I/PT	BW	WT
Slum Code	#.																								
C 1-S A	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C 1-S B	2	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	N	Y
C 2-S A	3	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
C 2-S B	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C 3-S A	5	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
C 3-S B	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C 4-S A	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C 4-S B	8	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	N	Y
C 5-S A	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C 5-S B	10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
C 6-S A	11	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
C 6-S B	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C 7-S A	13	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
C 7-S B	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C 8-S A	15	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
C 8-S B	16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C 9-S A	17	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
C 9-S B	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C 10-S A	19	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
C 10-S B	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Parameters		Elements*			Total Hardness			Magnesium			Nitrite			Nitrate			Nitrogen			Fluorides			Overall Score		
Sources		I/P T	B W	W T	I/P T	B W	W T	I/P T	B W	W T	I/P T	B W	W T	I/P T	B W	W T	I/P T	B W	W T	I/P T	B W	W T	I/P T	B W	W T
Slum Code	#.																								
C 11-S A	21	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	N	Y	N	Y	Y	N	Y	Y	Y	Y	Y	N	N	Y
C 11-S B	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C 12-S A	23	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	N	Y	Y	N	Y	Y	N	Y
C 12-S B	24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C 14-S A	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C 14-S B	26	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	N	Y	Y	Y	Y	Y	N	Y
C 15-S A	27	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
C 15-S B	28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C 16-S A	29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C 16-S B	30	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	N	Y
C 17-S A	31	Y	Y	Y	Y	N	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N
C 17-S B	32	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C 18-S A	33	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Parameters		Elements*			Total Hardness			Magnesium			Nitrite			Nitrate			Nitrogen			Fluorides			Overall Score		
Sources		I/PT	BW	WT	I/PT	BW	WT	I/PT	BW	WT	I/PT	BW	WT	I/PT	BW	WT	I/PT	BW	WT	I/PT	BW	WT	I/PT	BW	WT
Slum Code	#.																								
C 18-SB	34	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Legend: Y: Compliant, N: Non-compliant, NA: Not Applicable, -: Samples not collected, I/PT: Individual/ Public Tap connections; BW: Borewell and Handpumps, WT: Water tankers, *Phenolphthalein (P), Total Alkalinity (T), Carbonates, Hydroxides, Calcium, Ammonia, Chlorides, Sulfates, Iron, and Manganese

Physical parameters.

In addition to microbiological and chemical parameters, certain physical characteristics of the water such as color, odor, electric conductivity, and total dissolved solids should also be included in assessment of water quality, as they are critical indicators of change in quality and are often cited by consumers as reasons for rejecting a source. The consumers of drinking water, at the outset, observe these physical parameters and determine the quality aspects. Considering the physical parameters recommended for assessment of quality of drinking water in RADWQ framework (Howard et al., 2003), the current research study which is primarily focusing on drinking water quality and quantity in the selected slum areas in the Hyderabad city region details on the laboratory test analysis for the observation of the above stated physical parameters in all the drinking water samples collected from various sources of drinking water.

Limited presence of physical parameters in the drinking water from different sources and variations in availability of unsafe drinking water caused due to presence of physical parameters int the slum areas.

The drinking water quality from the household tap connections, public tap connections, bore wells, tube wells and hand pumps connections was analysed and is presented in the summary table 23, it was noted that there were only a limited number of slum areas for which there was a presence of physical parameters such as odour and electrical conductivity that negatively affected the drinking water quality. There were a significant number of slum areas where the odour and electrical conductivity was negligible.

As seen in the summary table the colour and Total Dissolved Solids (TDS) were within the permissible limits for drinking water from household level individual tap connections, community level public tap connections, bore well, tube wells and hand-pump connections. The presence of an odour and electrical conductivity were at unacceptable levels for drinking water from household level individual tap connections, community level public tap connections, bore well, tube wells and hand-pump connections. Although in a significant number of slum areas the presence or observation of all physical parameters was negligible. There were no corresponding patterns observed for the presence of all of the physical parameters such as colour, odour, electrical conductivity and Total Dissolved Solids (TDS) in the drinking water from any of the different sources within the slum areas.

In summary, there were only a limited number of slum areas in which the drinking water supplied through individual tap connections, public tap connection, bore wells, tube wells and hand pumps had a significant level of non-compliance with acceptable quality limits of the physical parameters. There was a significant number of slum areas that were compliant with acceptable quality limits of the physical parameters. The drinking water that was supplied from water tankers from all of the slum areas was compliant with acceptable quality limits of all of the physical parameters.

Table 23: Distribution of slum areas with drinking water from different sources and compliance with the standards and acceptable levels of the physical parameters

Indicators		Color			Odor			EC			TDS			Overall Score		
Sub Indicators		IT	BW	WT	IT	BW	WT	IT	BW	WT	IT	BW	WT	IT	BW	WT
Slum Code	#															
C 1-S A	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C 1-S B	2	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
C 2-S A	3	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	N	Y
C 2-S B	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C 3-S A	5	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	N	Y
C 3-S B	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C 4-S A	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C 4-S B	8	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
C 5-S A	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C 5-S B	10	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
C 6-S A	11	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
C 6-S B	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C 7-S A	13	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
C 7-S B	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C 8-S A	15	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
C 8-S B	16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C 9-S A	17	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
C 9-S B	18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C 10-S A	19	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
C 10-S B	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C 11-S A	21	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	N	Y
C 11-S B	22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C 12-S A	23	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
C 12-S B	24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C 14-S A	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Indicators		Color			Odor			EC			TDS			Overall Score		
Sub Indicators		IT	BW	WT	IT	BW	WT	IT	BW	WT	IT	BW	WT	IT	BW	WT
Slum Code	#															
C 14-S B	26	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
C 15-S A	27	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
C 15-S B	28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C 16-S A	29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C 16-S B	30	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	N	Y
C 17-S A	31	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y
C 17-S B	32	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C 18-S A	33	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
C 18-S B	34	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Legend: Y: Compliant, N: Non-compliant, NA: Not Applicable, -: Samples not collected, I/PT: Individual/ Public Tap connections; BW: Borewell and Handpumps, WT: Water tankers, TDS: Total Dissolved Solids, EC: Electrical Conductivity.

Overall Drinking water quality.

Based on the laboratory test analysis discussed in the previous section on various parameters in understanding the existing drinking water quality conditions in the selected slum areas of the Hyderabad city region, the following proceeds to summarize the key findings on microbiological, chemical and physical quality aspects of drinking water by presenting the compliance with acceptable limits for all the parameters for the drinking water from different sources across all the slum areas.

In order to perform this exercise, the following table was developed by:

- Mapping the microbiological, chemical and physical parameters and showing whether they were compliant with the Indian standards for all the selected slum areas and for all of the different sources of drinking water. This analysis includes the distribution of slum areas based on the varying quality compliance with standards on quality aspects of drinking water from different sources of drinking water, as discussed in the previous sections.
- Aggregating the scores for each source of drinking water and the overall score for all of the drinking water sources which were derived for each of the sample slum areas.
- Aggregating the scores for the quality of drinking water from each source for all the sample slum areas and the overall scores for the quality of drinking water in each of the sample slum areas was classified as being either as "compliant" or "non-compliant".

The aggregate scores for the quality of drinking water from each of the drinking water sources for each of the selected slum areas was classified as being "compliant" when all the of the microbiological, chemical and physical parameters had standard acceptable levels. Similarly, the aggregate scores for quality of drinking water was classified as being "non-compliant" when at least one of the microbiological, chemical or physical parameters were not within the standard acceptable limits.

The overall scores for quality of drinking water for each of the selected slum areas was classified as "compliant" when the quality of the drinking water from all of the sources complied to Indian standard acceptable levels. Similarly, the overall scores for of quality of drinking water for each of the selected slum areas was classified as being "non-compliant" when at least one of the drinking water sources quality was not within the standard acceptable limits.

Table 24: Analysis summary on existing quality of drinking water and compliance levels to standard quality of drinking water

Parameters		Microbiological			Chemical			Physical			Aggregate			Overall
DW Sources		I/PT	BW	WT	I/PT	BW	WT	I/PT	BW	WT	I/PT	BW	WT	All
Slum Code	#													
C 1-S A	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C 1-S B	2	N	Y	Y	Y	N	Y	Y	Y	Y	N	N	Y	N
C 2-S A	3	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	N	Y	Y
C 2-S B	4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C 3-S A	5	Y	N	Y	Y	Y	Y	Y	N	Y	Y	N	Y	Y
C 3-S B	6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C 4-S A	7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C 4-S B	8	N	N	Y	Y	N	Y	Y	Y	Y	N	N	Y	N
C 5-S A	9	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C 5-S B	10	N	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	N
C 6-S A	11	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
C 6-S B	12	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C 7-S A	13	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
C 7-S B	14	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C 8-S A	15	N	N	Y	Y	Y	Y	Y	Y	Y	N	N	Y	N
C 8-S B	16	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C 9-S A	17	N	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	N
C 9-S B	18	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C 10-S A	19	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y
C 10-S B	20	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C 11-S A	21	N	Y	Y	N	N	Y	Y	N	Y	N	N	Y	N
C 11-S B	22	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C 12-S A	23	N	N	Y	Y	N	Y	Y	Y	Y	N	N	Y	N
C 12-S B	24	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Parameters		Microbiological			Chemical			Physical			Aggregate			Overall
DW Sources		I/PT	BW	WT	I/PT	BW	WT	I/PT	BW	WT	I/PT	BW	WT	All
Slum Code	#													
C 14-S A	25	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C 14-S B	26	N	N	Y	Y	N	Y	Y	Y	Y	N	N	Y	N
C 15-S A	27	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
C 15-S B	28	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C 16-S A	29	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C 16-S B	30	Y	N	N	Y	N	Y	Y	N	Y	Y	N	N	N
C 17-S A	31	N	N	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y
C 17-S B	32	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C 18-S A	33	N	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	N
C 18-S B	34	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Legend: Y: Compliant, N: Non-compliant, NA: Not Applicable/ Samples not collected, I/PT: Individual/ Public Tap connections, BW: Borewell and Handpumps, WT: Water tankers

Variations in quality of drinking water from different sources amongst the slum areas.

There were certain slum areas where the quality of drinking water from all of the different sources was compliant with the Indian quality standards and certain slum areas where the drinking water quality from different sources was non-compliant with the quality standards.

There were certain slum areas for which the laboratory test analysis pertaining to drinking water quality supplied through individual or household level tap connections and public or community level tap connections are compliance with the standard quality, and certain slum areas for which the laboratory test results are non-compliance with standard quality drinking water supplied through these sources. Similar patterns were observed for drinking water quality from borewells or handpumps and water tankers.

The summary table 24 shows that there were certain number of slum areas for which the quality of drinking water from borewells and handpumps were having good quality, and certain slum areas for which the laboratory test results were non-compliance with standard quality. Further, it can also be observed from the summary table that there were a significantly low number of slum areas for which the quality of drinking water supplied through water tankers was non-compliant with the standard quality and a significantly high number of slum areas where the laboratory test results were compliant with standard quality.

In summary, the overall corresponding pattern analysis showed that there were variations amongst the sample case studies, informal settlements, in terms of access or availability to safe quality drinking water from different sources of drinking water in the Hyderabad city region.

4.3. Comparative analysis

This section of the study has been developed by mapping the quality and quantity aspects of drinking water from the various available sources in the selected slum areas and assessing to what extent these aspects comply with the people's expectations and the applicable standards. The compliance levels were identified based on the household perceptions' analysis and expert's judgement. The table 27 illustrates the comparative analysis between these two sets of results.

The overall analysis of the household perceptions and the expert's judgement revealed trifling unalike corresponding patterns regarding the quality and quantity of drinking water in the selected slum areas.

The table 25 below tried to identify the extent of compliance levels. There were certain slum areas where the quality and quantity of drinking water were non-compliant and there were other slum areas where the quality and quantity of drinking water were compliant.

The perception analysis and expert's judgement analysis showed similar results for these aspects across all of the selected slum areas in the Hyderabad city region. A closer comparison of the analysis of the independent variables revealed the following variations and similarities which have been presented in the table 25 below.

Table 25: Comparison of the analysis of independent variables

Indicators	Perception analysis of Households at Slum area level (A)	Expert's judgement analysis (B)	Variations between (A) and (B)
Quantity (Qty)	Quantity of drinking water is compliant in certain slum areas and non-compliant in others	Quantity of drinking water is compliant in certain slum areas and non-compliant in others	None
Quality (Qly)	Quality of drinking water is compliant in certain slum areas and non-compliant in others	Quality of drinking water is compliant in certain slum areas and non-compliant others	None

Considering that there were limited differences in the findings between the perception analysis and expert's judgement regarding the quality and quantity of drinking water in all of the selected slum areas, it was necessary to combine these results to arrive at a congruence. In order to combine the results from these two information sources, both of the tables (refer table no. 19, 21) have been grouped according to the overlapping scales in the table 26 below:

Table 26: Stakeholders perception analysis compliance levels

Stakeholders/ Perception analysis compliance levels	Stakeholders/ Perception analysis compliance levels	Combined compliance levels
Compliance (Y)	Compliance (Y)	Compliance (Y)
Compliance (Y)	Partial Compliance (P)	Partial Compliance (P)
Compliance (Y)	Non-Compliance (N)	Partial Compliance (P)
Partial Compliance (P)	Compliance (Y)	Partial Compliance (P)
Partial Compliance (P)	Partial Compliance (P)	Partial Compliance (P)
Partial Compliance (P)	Non-Compliance (N)	Partial Compliance (P)
Non-Compliance (N)	Compliance (Y)	Partial Compliance (P)
Non-Compliance (N)	Partial Compliance (P)	Partial Compliance (P)
Non-Compliance (N)	Non-Compliance (N)	Non-Compliance (N)

The level of compliance from the perception analysis was combined with the level of compliance from expert’s judgement analysis for the corresponding quality and quantity results of the drinking water in the selected slum areas in order to consolidate the results. Based on this exercise, the table no. 66 in chapter 6 was generated which provided consolidated results regarding the level of compliance of drinking water quality and quantity in order to analyse the patterns across the slum areas.

Table 27: Comparative analysis of the quality and quantity aspects of drinking water

Sources		Individual tap				Public tap				Borewells				Water tanker				Overall Score			
Indicators		Qty.		Qly.		Qty.		Qly.		Qty.		Qly.		Qty.		Qly.		Qty.		Qly.	
Analysis source		A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Slum areas	#																				
C 1-S A	1	NA	-	NA	NA	N	-	Y	NA	N	-	P	NA	N	-	Y	NA	N	N	N	-
C 1-S B	2	N	-	P	N	N	-	N	N	N	-	Y	N	N	-	N	Y	N	N	N	N
C 2-S A	3	Y	-	Y	Y	Y	-	Y	Y	N	-	P	N	Y	-	Y	Y	Y	Y	Y	Y
C 2-S B	4	Y	-	Y	NA	Y	-	Y	NA	N	-	Y	NA	Y	-	Y	NA	Y	Y	Y	-
C 3-S A	5	Y	-	Y	Y	NA	-	NA	Y	N	-	Y	N	Y	-	Y	Y	Y	Y	Y	Y
C 3-S B	6	Y	-	Y	NA	NA	-	NA	NA	Y	-	Y	NA	Y	-	Y	NA	Y	Y	Y	-
C 4-S A	7	Y	-	Y	NA	Y	-	Y	NA	P	-	N	NA	Y	-	Y	NA	Y	Y	Y	-
C 4-S B	8	N	-	P	N	Y	-	N	N	P	-	Y	N	N	-	N	Y	N	N	N	N
C 5-S A	9	N	-	P	NA	N	-	N	NA	N	-	N	NA	N	-	N	NA	N	N	N	-
C 5-S B	10	N	-	N	N	N	-	N	N	N	-	Y	Y	N	-	Y	Y	N	N	P	N
C 6-S A	11	NA	-	NA	Y	N	-	N	Y	NA	-	NA	Y	N	-	N	Y	N	N	N	Y
C 6-S B	12	Y	-	Y	NA	Y	-	Y	NA	Y	-	N	NA	Y	-	Y	NA	Y	Y	Y	-
C 7-S A	13	N	-	N	Y	N	-	P	Y	Y	-	Y	Y	Y	-	Y	Y	Y	Y	P	Y
C 7-S B	14	Y	-	Y	NA	Y	-	Y	NA	N	-	N	NA	Y	-	Y	NA	Y	Y	Y	-
C 8-S A	15	NA	-	NA	N	N	-	N	N	N	-	N	N	N	-	N	Y	N	N	N	N
C 8-S B	16	Y	-	Y	NA	N	-	N	NA	N	-	Y	NA	Y	-	Y	NA	Y	Y	Y	-
C 9-S A	17	Y	-	Y	N	N	-	N	N	N	-	N	Y	Y	-	P	Y	Y	Y	P	N
C 9-S B	18	P	-	Y	NA	N	-	N	NA	N	-	N	NA	Y	-	P	NA	P	Y	P	-
C 10-S A	19	Y	-	Y	Y	Y	-	Y	Y	N	-	N	N	Y	-	N	Y	Y	Y	Y	Y
C 10-S B	20	Y	-	P	NA	N	-	N	NA	N	-	N	NA	Y	-	P	NA	Y	Y	P	-
C 11-S A	21	Y	-	Y	N	N	-	Y	N	N	-	N	N	Y	-	Y	Y	Y	Y	Y	N
C 11-S B	22	Y	-	N	NA	N	-	N	NA	N	-	N	NA	N	-	N	NA	N	Y	N	-
C 12-S A	23	N	-	Y	N	N	-	Y	N	N	-	N	N	N	-	Y	Y	N	N	Y	N
C 12-S B	24	Y	-	Y	NA	Y	-	Y	NA	Y	-	P	NA	Y	-	Y	NA	Y	Y	Y	-
C 14-S A	27	Y	-	Y	NA	Y	-	Y	NA	Y	-	N	NA	Y	-	Y	NA	Y	Y	Y	-

“S.I.T.E” Valuation of Drinking Water

Sources		Individual tap				Public tap				Borewells				Water tanker				Overall Score			
Indicators		Qty.		Qly.		Qty.		Qly.		Qty.		Qly.		Qty.		Qly.		Qty.		Qly.	
C 14-S B	28	P	-	P	N	N	-	N	N	N	-	Y	N	N	-	Y	Y	N	N	N	N
C 15-S A	29	N	-	P	Y	N	-	N	Y	N	-	N	Y	N	-	N	Y	N	N	N	Y
C 15-S B	30	N	-	Y	NA	NA	-	NA	NA	N	-	N	NA	N	-	P	NA	N	N	P	-
C 16-S A	31	N	-	N	NA	N	-	N	NA	NA	-	NA	NA	N	-	N	NA	N	N	N	-
C 16-S B	32	N	-	N	Y	NA	-	NA	Y	NA	-	NA	N	N	-	P	N	N	N	N	N
C 17-S A	33	N	-	P	Y	N	-	N	Y	N	-	P	Y	N	-	N	Y	N	N	N	Y
C 17-S B	34	Y	-	Y	NA	NA	-	NA	NA	N	-	Y	NA	Y	-	Y	NA	Y	Y	Y	-
C 18-S A	35	Y	-	Y	N	Y	-	Y	N	Y	-	Y	Y	Y	-	Y	Y	Y	Y	Y	N
C 18-S B	36	Y	-	Y	NA	Y	-	Y	NA	Y	-	N	NA	Y	-	Y	NA	Y	Y	Y	-

Legend: A: Slum residents’ perception analysis; B: Expert’s judgement analysis; Y: Compliant; P: Partial compliant; N: Not compliant; NA/-: Not Applicable; Qty: Quantity; Qly: Quality

4.4. Consequences of poor quality and quantity of Drinking water

The previous sections have pointed out the challenges the poor communities face with the quality and quantity of drinking water facilities and services in the selected slum areas in the Hyderabad city region. Under these circumstances, the slum residents, either accept or try and do something about the conditions.

The major consequences that were observed during the field surveys, that were caused due to poor quality and quantity of drinking water facilities and services in these selected slum areas, included:

- Missing the opportunity to collect drinking water when it was available,
- Loss of work or loss of productivity due to the unpredictable timings to fetch drinking water,
- Medical expenses incurred due to ill-health caused due to poor quality of drinking water,
- Additional expenditure on drinking water due to the dependency on additional sources of drinking water in order to solve the drinking water quantity needs,
- Additional expenditure on preventive measures, such as purifying the water before consumption, to solve the drinking water quality needs.

The following sections expand on the identified consequences.

4.4.1. Missing on fetching drinking water or working schedules

There were a significant number of slum households or members of the slum population, that either missed collecting the drinking water on time or were unable to keep to their work schedules, they were often unable to go to work, due to poor availability of drinking water in the selected slum areas. This was primarily due to the inconsistency of available drinking water and the time and efforts that were taken to fetch drinking water from alternative sources which consequently interfered with work schedules.

In order to comprehend the patterns associated with missing the opportunity to fetch drinking water or missing work due to the inconsistent schedules, it is imperative to understand the influencing factors such as the average number of working days and hours, the consistency levels regarding the availability of the drinking water and the time taken to fetch the drinking water from different sources. The box 6 below illustrates the challenges in terms of availability of drinking water faced by the slum residents.

Box 6: Availability of drinking water

Inconsistency in availability of drinking water.

The household analysis signifies that there are certain share of households falling under the category of effected households due to inconsistency in the availability of drinking water. About 397 out of 2281 households, i.e. about 17% of the total households, states that the timings for the availability of drinking water from different sources are not consistent. The timings in the availability or supply of the drinking water is very erratic and are resulting in long waiting hours on the days of supply or availability of water. The households also claim that there is no consistency in the frequency (in days) of the supply or availability of drinking water from major sources of drinking water.

Time to fetch drinking water.

163 out of 2,281, 7% of the total households took up to 30 minutes to access their different sources of drinking water. 1,055 out of 2,281, 46% of the slum households, of the total households took between 31-60 minutes to access their different sources of drinking water. 229 out of 2,281, 10% of the total households took up to 120 minutes to access their different sources of drinking water. 218 out of 2,281, 10% of the total households took more than 120 minutes to access their different sources of drinking water.

In summary, the weighted average of the time consumption for the slum households to fetch drinking water from different sources of drinking water was about 45.11 (rounded off to 45) minutes.

Missing on collecting the drinking water.

563 out of 2,281, 25% of the households claimed that due to the inconsistency in the availability of the drinking water and the distance to travel in order to collect the drinking water resulted in missing the collection of drinking water. Due to this, the slum population or households incurred additional expenditures on procuring drinking water from other sources (refer section 4.4.3).

1,636 out of 2,281, 72% of the households claimed that they did not miss the correct times to fetch the drinking water despite the inconsistencies in the supply or availability of the drinking in the slum areas of Hyderabad city region. There is a possibility that this portion of population that did not miss collecting drinking water missed going to work while waiting for the drinking water, which resulted in loss of productivity.

Missing on working schedules.

224 out of 2,281, 10% of the households claimed that they missed going to their workplace 1 day per week in order to collect drinking water. 202 out of 2,281, 9% of the households

claimed that they missed going to their workplace 2 days per week in order to collect drinking water. 142 out of 2,281, 6%of the households claimed that they missed going to their workplace 3 days per week in order to collect drinking water. 55 out of 2,281, 2% of the households claimed that they missed going to their workplace more than 3 days per week in order to collect drinking water.

Box 7: Household level income and expenditure

Average number of working days.

1,914 out of 2,281, 84% of the people that were working in the households claimed that they worked between 5 to 6 days a week. 310 out of 2,281, 14% of the people that were working in the households claimed that they worked 7 days a week. 57 out of 2,281, 2% of the people that were working in the households claimed that they worked between 3 to 4 days a week. In summary, the weighted average of number of working days in a week for the slum households or population with employment is about 5.71 (rounding off to 6) days, i.e., about 22.82 (rounding off to 23) days in a month.

Average number of working hours.

1201 out of 2,281, 53% of the people in the households were working between 6-8 hours per day. 972 out of 2,281, 43% of the people in the households were working between 9-12 hours per day. 105 out of 2,281, 5% of the people in the households were working between 12-15 hours per day. 5 out of 2,281, Less than 1% of the people in the households were working between 4-5 hours per day. In summary, the weighted average of number of working hours on a working day for the slum households or population is about 8.9 (rounded off to 9) hours per day.

Average household level income.

82% of the slum households or population with working family members were employed for skilled work and the remaining 18% of the slum population worked as daily wageworkers. On average, the monthly household income (in Rs.) levels for skilled employment was Rs. 9,320 (123 US Dollars/month) and unskilled employment was Rs. 2507 (33 US Dollars/month[81]). The weighted average of the household monthly incomes (in Rs.) in the slum areas of the Hyderabad city region was about 8,094 (107 US Dollars/month). Thus, the average annual per capita income (in Rs.) in the slum areas of the Hyderabad city region was about 97,124 (1,286 US Dollars/year). This proves the hypothesis that the average household monthly income (in Rs.) in slum areas of Hyderabad city region is "higher" than Rs. 8,000 (106 US Dollars/month) and the average annual per capita income (in Rs.) is "higher" than Rs. 96,000 (1,271 US Dollars/year). Further, in order to estimate the per person monthly income (in Rs.) it is imperative to consider the average household sizes.

Average household level expenditure.

[81] Conversion of Indian Rupees to US Dollars was per 01 June 2020 taken from: https://www.xe.com/currencyconverter/convert/?Amount=1&From=INR&To=USD

The majority of money that is spent in the slum households or population in the Hyderabad city region includes the following: (a) house rentals, (b) food and beverages, (c) education, (d) clothing, (e) travel or fuel, (f) electricity charges, (g) household gas or fuel, (h) entertainment activities, (i) water charges, (j) medical or health, (k) debt repayments. The study revealed that the majority of the household's income was spent on the above mentioned categories and nothing is left over for any saving purposes. The following table 28 provides a summary of the household income levels and expenditure patterns per month per household in the slum areas of Hyderabad city region.

Table 28: Summary of monthly household income and expenditure patterns

Category	Amount (in INR)	Amount (in US$)	% of (A)
Total Income (A) per month	8094	107	-
Total Expenditure (B) per month	6759	89	84%
House rental	637	8	8%
Food & Beverages	1130	15	14%
Clothing	104	1	1%
Education	100	1	1%
Travel	340	5	4%
Gas or Fuel	761	10	9%
Electricity	761	10	9%
Entertainment or Miscellaneous	705	9	9%
Loans/Debt	2221	29	27%
Total Balance (A-B) per month	1335	18	16%

The inconsistency in the amount of time and effort it took to fetch drinking water highly affected the working schedules of the employees in the slum areas of Hyderabad city region, which resulted in loss of income.

On an average, the monthly income of the slum households is about Rs. 8,094 (107 US Dollars/month), which is equal to the daily income, taking 23 days as working days in a month, of about Rs. 351.91/day (4.67 US Dollars/day). Out of which, 84% is spend on household level expenditure items such as housing rent, food, drinks, clothing, education, travel, gas or fuel, electricity, entertainment, debt repayments and other miscellaneous items. Thus, there is only a balance 16% of the household level income left to meet the needs of infrastructure facilities and services and to make savings if at all possible. This analysis indicates that there is no or little scope for the working households in the slum areas in the Hyderabad city region to take a day off from work which would result in a loss of income. The following table 29 is a summary of household level loss of income per month per household in the slum areas of Hyderabad city region.

Table 29: Loss of productivity due to collection of drinking water per month per household

Category	Income loss	Amount (in INR)	Amount (in US$)	% of (A)
Total Income (A) per month	-	8094	107	-
Total Expenditure (B) per month	-	6759	89	84%
Total Balance (A)-(B) per month	-	1335	18	16%
Total loss of productivity (C_1) per month	205	205	3	3%
Due to collection of drinking water (*n*=623, 27%)	760	-		-
Total Balance (A) - (B) - (C_1) per month	-	1130	15	14%

In summary, the weighted average of loss of working days in a week by 27% of the slum households or population, that was due to fetching drinking water from different sources of drinking water was about 0.54 days per week. This signifies that the households or population in the slum areas missed about 2.16 (rounded off to 2) days in a month in order to fetch drinking water.

When considering the analysis of the average monthly income of the slum households which is about Rs. 8,094 (US $107) and taking into account the average number of working days for the working employees in the slum areas is 23, it can be stated that the average daily income of the household is about Rs. 351.91 (US $5). Therefore, employees missed work for an average of 2 days in a month may due to the collection of water, they will be making a loss of Rs. 760.13 (US $ 10) per month which affected 27% of the slum population.

4.4.2. Missing on working schedules due to ill-health

A significant number of slum households miss work and fall ill, due to the poor quality of the drinking water from the various sources in the selected slum areas in the Hyderabad city region. Various diseases were present in different sources of drinking water depending on the season. In order to comprehend the patterns associated with missing work and thus loss of income due to ill-health which was caused because of poor quality drinking water, it is also important to measure influencing factors such as the perception of the households, the types of illness cause and their seasonal variations and the medical expenditures. The box 8 illustrates the types of illness caused due to unclean drinking water.

Box 8: Types of illness caused due to unclean drinking water

> The most prevailing illnesses caused due to the poor quality of the drinking water in the selected slum areas of Hyderabad city region are **Amoebiasis**, also known as amoebic dysentery and **Diarrhea**.

Amoebiasis.

Within the last 12 months, 11% of the total slum households or population which was spread across the different slum areas in the Hyderabad city region suffered from Amoebiasis. They suffered between 1-2 times a year and each time they were ill for 3 to 4 days. In summary, this 11% of the slum population were ill for 5.25 (rounded off to 5) days per year due to suffering from this disease.

Diarrhoea.

Within the last 12 months, 19% of the total slum households or population which was spread across the different slum areas in the Hyderabad city region that suffered from diarrhoea. They suffered between 1-2 times a year and each time they were ill for 3 to 4 days. In summary, this 19% of the slum population were ill for 3.32 (rounded off to 3) days per year due to suffering from this disease.

Seasonal variations.

227 out of 2,281, 10% of the total slum households, claimed that they were ill and caught diseases from the drinking water from a variety of sources during the summer, during the months of March, April, May and June. 422 out of 2,281, 19% of the total slum households, claimed that they were ill and caught diseases from the drinking water from a variety of sources during the Monsoon seasons, during the months of July, August, September and October. 49 out of 2,281, 2% of the total slum households, claimed that they were ill and caught diseases from the drinking water from a variety of sources during winter season, during the months of November, December, January and February. Further details were provided in Annex 4E.

Missing on working schedules due to illness caused by unclean drinking water

136 out of 2281, 6% of the total slum households claimed that they missed going to work for at least 1 day every time they were ill due to consumption of unclean drinking water. 365 out of 2281, 16% of total slum households claimed that they missed attending their work for at least 2 days every time they were ill due to consumption of unclean drinking water. 23 out of 2281, 1% of slum households were not able to attend their regular work for 3 days every time they were ill due to consumption of collected water from different sources of drinking water. This is resulting in loss of income. The following table 30 provides the summary of household level loss of income per month per household in the slum areas of Hyderabad city region.

Table 30: Loss of productivity due to unclean drinking water consumption per month per household

Category	Income Loss	Amount (in INR)	Amount (in US$)	% of (A)
Total Income (A) per month	-	8094	107	-
Total Expenditure (B) per month	-	6759	89	84%

Category	Income Loss	Amount (in INR)	Amount (in US$)	% of (A)
Balance (A)-(B) per month	-	1335	18	16%
Total loss of productivity (C_1) per month	205	205	3	3%
Balance (A)-(B)-(C_1) per month	-	1130	15	13.96%
Total loss of productivity (C_2) per month	8.28	8	0.11	0.1%
Due to illness caused due to unclean drinking water (*n*=524, 23%)	36	-	-	-
Total Balance (A) - (B) - (C_1) - (C_2) per month	-	1122	15	13.86%

In summary, the weighted average of loss of working days of the 23% slum households or population due to illness or diseases was about 0.41 days, each time someone fell ill or was infected. The frequency that the slum households or population in the slum areas of the Hyderabad city region were infected with Amoebiasis happened about 1.5 times per year. Similarly, the frequency that the slum households or population in the slum areas of the Hyderabad city region were infected with diarrhoea was about 1.5 times a year.

Thus, the frequency of illness or diseases caused due to unsafe drinking water among the slum households was about three (3) times a year. Thus, the households or population in the slum areas missed about 1.23 days of work per year due to illness caused due to consumption of unsafe drinking water. The lack of work for the 1.23 days in a year implies an approximate loss of Rs. 432.85 (6 US$) per year, or Rs. 36.07 (0.48 US$) per month, 0.01% of the monthly or annual household income, of the 23% of the slum households or population that were affected by the consumption of unsafe quality of the drinking water which was collected from various sources of drinking water.

Medical expenses incurred due to illness caused.

Due to consumption of poor quality of drinking water, the households in the slum areas were spending on medical exigencies. The most common expenditure items in this category include doctor consultations fee and purchase of the medicines. The box 9 illustrates the household level medical expenses per month incurred due to unclean drinking water.

Box 9: Household level medical expenses per month due to unclean drinking water

Doctor consultations fee.

191 out of 2,281, 8% of the households pay Rs. 100 (US$ 1.32) every time they visit the doctor.
278 out of 2,281, 12% of the households pay Rs. 150 (US$1.99) every time they visit the doctor.
63 out of 2,281 3% of the households pay Rs. 200 (US$2.36) every time they visit the doctor.

Medicinal or Pharmaceutical expenses.

119 out of 2281, 5% of the households pay between Rs. 100-200 on medical bills every time they fall ill. 300 out of 2281, 13% of the households pay between Rs. 201-300 on medical bills every time they fall ill. 111 out of 2281, 5% of the households pay between Rs. 301-500 on medical bills every time they fall ill.

The following table 31 provides the summary of household level expenditure per month per household towards medical expenses due to the consumption of unsafe drinking water in the slum areas of the Hyderabad city region.

Table 31: Medical expenditures per household per month due to consumption of unsafe drinking water

Category	Income loss	Amount (in Rs.)	Amount (in US$)	% of (A)
Total Income (A) per month	-	8094	**107.18**	-
Total Expenditure (B) per month	-	6759	**89.50**	84%
Balance (A)-(B) per month	-	1335	**17.68**	16%
Loss of productivity (C_1) per month	-	205	**2.71**	3%
Balance (A)-(B)-(C_1) per month	-	1130	**14.96**	13.96%
Loss of productivity (C_2) per month	-	8	**0.11**	0.1%
Total Balance (A)-(B)-(C_1)-(C_2) per month	-	1122	**14.86**	13.86%
Total Expenditure (D_1) per month	5.29	5	**0.07**	0.07%
Doctor consultations fee (*n*=532, 23%)	8	-	-	-
Medicinal charges (*n=532,* 23%)	15	-	-	-
Total Balance (A)-(B)-(C_1)-(C_2)-(D_1) per month	-	1117	**14.79**	13.80%

The household level analysis of the average household expenditures, in Rupees, for a doctor consultation fee in the slum areas in the Hyderabad city region showed that the weighted average of the expenditure of 23% households or population in the slum areas of city is about Rs. 32 (US$ 0.42) per household per doctor visit, which works out to be about Rs. 92 (US$1.22) per household per year. Thus, the average monthly expenditure was about Rs. 7.67 (US$ 0.10) per household per month towards doctor consultations.

The household level analysis of average household expenditures in Rupees towards medicinal charges in the slum areas in the Hyderabad city region revealed that the weighted average of the expenditure for 23% households or population in the slum areas of the city is about Rs. 60.11 (US$ 0.80) per household per frequency of illness or disease caused, which is about Rs. 180.35 (US$ 2.38) per household per year. Thus, the average monthly expenditure is about Rs. 15.03 (US$ 0.20) per household per month towards medicinal expenses.

4.4.3. Expenditure for additional drinking water infrastructure facilities and services

Despite that fact that drinking water had been treated in the past as a free good in the slum areas of Hyderabad city region, a significant share of the household income was actually used towards water infrastructure facilities and services. With the exception of the freshwater taps within the individual houses and their facilities and services that were paid for by the slum dweller and were not considered as free.

The infrastructure facilities and services expenditure incurred using public taps, water tankers, bore wells, tube wells, hand pumps and bottled water can be counted as additional expenses that were incurred by the slum residents to meet their drinking water consumption needs.

The expenditure for the infrastructure facilities and services for the slum households or population included:

- Initial investments for installing different sources of drinking water
- Monthly expenses in terms of rentals, user charges, user fees, etc. for different sources of drinking water
- Annual miscellaneous expenses for operational and maintenance charges for different sources of drinking water.

The following section identifies the monetary burdens for the slum households or population in the Hyderabad city region for different sources of drinking water. Despite of inadequate quantity and unsafe quality of drinking water from the different sources (refer section 4.1.1), the slum households or population were obligated to pay these additional expenses. The box 10 illustrates the expenses towards drinking water facilities and services.

Box 10: Expenses towards drinking water facilities and services.

Individual tap connections

Initial investments.

The initial investments were toward installing individual tap connections in the house premises. 1175 out of 1,448, 81% of the household's initial investment was Rs. 1 (US$ 0.01). 139 out of 1,448, 10% of the household's initial investment was between Rs. 100-500 (US$1.32-6.62). 113 out of 1,448, 8% of the household's initial investment was between Rs. 3,000-4,000 (US$ 39.72-52.97).

Monthly charges.

The monthly charges were towards user charges/ fee for using the government drinking water services. 433 out of 1,448, 30% of the households spent monthly between Rs. 101-300 (US$ 3.34-3.97) as user charges or fees, for fetching drinking water for their individual tap connection(s) in their home. 701 out of 1,448, 48% of the households spent monthly between Rs. 301-500 (US$ 3.99-6.62) as user charges or fees, for fetching drinking water for their individual tap connection(s) in their home. 238 out of 1,448, 16% of the households spent monthly between Rs. 501-1,000 (US$ 6.63-13.24) as user charges or fees, for fetching drinking water for their individual tap connection(s) in their home. 9 out of 1,448 1% of the households spent monthly between Rs. 1,001-1,500 (US$ 13.25-19.86) as user charges or fees, for fetching drinking water for their individual tap connection(s) in their home.

Miscellaneous charges.

The annual charges were towards maintenance charges and repair works. 78 out of 1,448, 5% households had annual expenditures between Rs. 301-500 (US$ 3.99-6.62) and 456 out of 1,448, 31% households annually spent between Rs. 501-1000 (US$ 6.63-13.24), for fetching drinking water and maintaining individual tap connection(s) in good conditions in their home.

Public tap connections

Initial investments.

There is no expenditure under this category.

Monthly charges.

The monthly charges were towards payment to government officials for allowing to fetch drinking water from public tap connections. This, however, was not a common type of charges for all slum households. 29 out of 710, 4% of the households spent monthly between Rs. 101-300 (US$ 3.34-3.97), for fetching drinking water from public tap connections. 157 out of 710, 22% of the households spent monthly between Rs. 301-500 (US$ 3.99-6.62), for fetching drinking water from public tap connections. 6 out of 710, 1% of the households spent monthly between Rs. 501-1000 (US$ 6.63-13.24), for fetching drinking water from public tap connections.

Miscellaneous charges.

The annual charges were towards maintenance charges and repair works. This, however, was not a common type of charges for all slum households. 22 out of 710, 3% of the households annually spent between Rs.301-500 (US$ 3.99-6.62), for fetching drinking water from public tap connections. 5 out of 710, 1% of the households annually spent between Rs. 501-1000, (US$ 6.63-13.24) for obtaining water from public tap connections.

Borewells or Handpumps

Initial investments.

The initial investments were towards purchase and install of borewells or handpumps within the premises of house. 281 out of 622, 45% of the households made an initial investment in order to set up bore wells, tube wells or hand pumps between Rs. 100,001-150,000 (US$ 1324.16-1986.22).

Monthly charges.

There is no expenditure under this category because the slum resident shall own the installed infrastructure with initial investments and henceforth no monthly rentals or user fees.

Miscellaneous charges.

The annual charges were towards maintenance charges and repair works. 281 out of 622, 45% of the households had annual expenditures towards operational and maintenance of the bore wells or hand pumps at household level between Rs. 5,001-10,000 (US$ 66.22-132.41)

Water tankers

Initial investments.

There is no expenditure under this category.

Monthly charges.

The monthly charges were towards payment to government officials or private agencies for allowing to fetch drinking water from water tankers. 630 out of 877, 72% of the households spent monthly between Rs. 101-300 (US$ 3.34-3.97), in order to obtain water from water tankers. 59 out of 877, 7% of the households spent monthly between Rs. 301-500 (US$ 3.99-6.62), in order to obtain water from water tankers. 4 out of 877, 1% of the households spent monthly between Rs. 501-1000 (US$ 6.63-13.24), in order to obtain water from water tankers.

Miscellaneous charges.

435 out of 710, 50% of the households annually spend between Rs. 501-1000 (US$ 6.63-13.24), in order to obtain water from water tankers.

Bottled water

Initial investments.

There is no expenditure under this category.

Monthly charges.

The monthly charges were towards payment to private agencies to purchase packaged drinking water. About 32 out of 120, 26% of the households spent monthly between Rs. 501-1,000 (US$ 6.63-13.24), and 71 out of 120, 59% of the households spent monthly between Rs. 1001-1500 (US$ 13.25-19.86), to obtain water from water bottles.

Miscellaneous charges.

103 out of 120, 86% of the households annually spend Rs. 501 to 1000 (US$ 6.63-13.24), to obtain water from water bottles.

The following table 32 provides the summary of household expenditures per month per household regarding various sources of drinking water facilities and services in the slum areas of Hyderabad city region. The overall household expenditures on drinking water from different sources of drinking water is about 7.8% of the overall household income levels.

Table 32: Household expenses on various sources of drinking water per month

Category	Initial	Monthly Charges	Misc.	Amount (in INR)	Amount (in US$)	% of (A)
Total Income (A) per month	-	-	-	8094	107.18	-
Total Expenditure (B) per month	-	-	-	6759	89.50	84%
Balance (A)-(B) per month	-	-	-	1335	17.68	16%
Total loss of productivity (C_1) per month	-	-	-	205	2.71	3%
Balance (A)-(B)-(C_1) per month	-	-	-	1130	14.96	13.96 %
Total loss of productivity (C_2) per month	-	-	-	8	0.11	0.1%
Balance (A)-(B)-(C_1)-(C_2) per month	-	-	-	1122	14.86	13.86 %
Total Expenditure (D_1) per month	-	-	-	5	0.07	0.07%
Balance (A)-(B)-(C_1)-(C_2)-(D_1) per month	-	-	-	1117	14.79	13.80 %
Total Expenditure on drinking water (D_2) per month	130	398	104	632	8.37	7.8%
Individual tap connections (n= 1448, 63%)	5	398	21	424	5.61	-
Public tap connections (n= 710, 31%)	0	104	2	106	1.40	-
Borewells or Handpumps (n= 622, 27%)	469	0	281	750	9.93	-
Water tankers (n= 877, 38%)	0	180	31	211	2.79	-
Bottled or packaged water (n= 120, 5%)	0	933	54	987	13.07	-
Total Balance (A)-(B)-(C_1)-(C_2)-(D_1)- (D_2) per month	-	-	-	485	6.42	5.99%

Individual tap connections.

The weighted average of the initial investments in the slum areas of the city was about Rs. 310.81 (US$ 4.12) per household with individual tap connections. Considering the average life span of a municipal tap at the household level is 5 years (60 months), the monthly expenditure for the drinking water infrastructure facilities, for the individual municipal tap connections in the slum areas was about Rs. 5.18 (US$ 0.07) per household with individual tap connections per month. Further, the weighted average of household monthly expenditure levels towards drinking water from individual tap connections is about Rs.

397.48 (US$ 5.26) per household with individual tap connections. There were also miscellaneous expenses. The weighted average annual household level expenditures in the slum areas of the city was about 252.68 (US$ 3.35) per household with individual tap connections. This signifies that the average monthly household level expenditures (in Rs.) in the slum areas of the city was approximately Rs. 21.05 (US$ 0.28) per household with individual tap connections.

Public tap connections.

There were no initial investments. However, the average household monthly expenditure (in Rs.) for drinking water from public tap connections in the slum areas in Hyderabad city region had a weighted average of the monthly expenditures (in Rs.) in the slum areas of the city was about 103.64 (US$ 1.37) per household that had access to the public tap connections. In terms of miscellaneous expenses, the weighted average of the annual household level expenditures (in Rs.) in the slum areas of the city was about Rs. 19.52 (US$ 0.25) per household with access to public tap connections. This signifies that the average monthly household level expenditures (in Rs.) in the slum areas of the city was about Rs. 1.62 (US$ 0.02) per household with public tap connections.

Borewells or Handpumps.

The average household initial investments (in Rs.) towards bore wells or hand pumps amongst slum areas is about Rs. 56,250.23 (US$ 744.84) per household. Considering the average life span of a bore well or hand-pump at the household or community level is 10 years (120 months), the monthly expenditure (in Rs.) towards drinking water infrastructure facilities, i.e., bore well or hand-pump connections in the slum areas of the Hyderabad city region is about Rs. 468.75 (US$ 6.21) per household with bore well or hand-pump connections per month. There were no monthly expenses for this connection. However, there were miscellaneous expenses related to this. The weighted average of the annual household expenditures (in Rs.) is about Rs. 3375.23 (US$ 44.69) per household with access to bore wells or hand pumps as sources of drinking water. This signifies that the average monthly household level expenditures (in Rs.) in the slum areas of the city was about 281.27 (US$ 3.72) per household with access to bore wells or hand pumps.

Water tankers.

There were no initial investments. However, the average household monthly expenditure (in Rs.) levels towards drinking water from water tankers amongst slum areas is about Rs. 179.90 (US$ 2.38) per household with access to water tankers. There were miscellaneous expenses associated to this. The weighted average of the annual household level expenditures (in Rs.) in the slum areas of the city was about Rs. 375.25 (US$ 4.97) per household with access to water tankers. Thus, the average monthly household level of miscellaneous expenditures (in Rs.) in the slum areas of the city was about 31.27 (US$ 0.41) per household with access to water tankers.

Bottled water.

There were no initial investments. However, the households in the slum areas had varying household monthly expenditure levels towards purchasing drinking from different local markets. The average household monthly expenditure levels for purchasing drinking water amongst slum areas in Hyderabad city region is about 932.93 (US$ 12.35) per household with access to packaged or bottled drinking water. There were miscellaneous expenses related to this. The weighted average of the annual household level expenditures in the slum areas of the city was about Rs. 645.43 (US$ 8.55) per household who purchasing packaged drinking water to meet the needs. This signifies that the average monthly household level expenditures in the slum areas of the city was about 53.79 (US$ 0.71) per household with access to bottled drinking water.

4.4.4. Expenditure towards improving quality of drinking water

Due to the poor quality of drinking water that was available from different sources in the slum areas of Hyderabad city region, the slum population were forced to use various methods such as filters, boiling water using cooking gas and filtering water using water purifiers. These purification methods involved expenses and were recurring in nature.

The expenditure patterns under this category comprises of (a) initial investments for installing different preventive measures, (b) monthly expenses in terms of maintenance charges (c) annual miscellaneous expenses for maintenance charges. These expenses incurred by the slum residents could be referred to as preventive costs.

The following section identifies the monetary burdens for the slum households or population on different preventive measures to handle the poor quality of drinking water. The box 11 illustrates the expenditure incurred by the slum residents towards improving quality of drinking water.

a. ***Filters or clothes.*** 1451 out of 2281, 64% of the households claimed that they were using cloths or filters to purify the drinking water from the different sources of drinking water.

b. ***Cooking gas.*** 586 out of 2281, 26% of the households claimed that they were boiling the collected drinking water from different sources of drinking water using cooking gas before consumption.

c. ***Water purifiers***. 541 out of 2281, 24% of the households claimed that they were using water purifying machines to purify their drinking water from the different sources of drinking water before usage.

Box 11: Expenditure towards improving quality of drinking water

Filters/ Clothes

Initial investments.

187 out of 1451, 13% households claimed that they had made initial investments ranging between Rs. 50-100 (US$ 0.66-1.32) to buy the cloths and filters to be used to filter the different sources of drinking water.

Monthly charges.

There were no monthly charges incurred.

Miscellaneous charges.

There were no miscellaneous charges incurred.

Cooking gas

Initial investments.

There is no expenditure under this category.

Monthly charges.

78 out of 586, 13% of the households claimed that the monthly expenditure for boiling the collected and fetched drinking water from the different sources of drinking water using cooking gas before consumption ranged between Rs. 50-100 (US$ 0.66-1.32). 507 out of 586, 87% of the households claimed that the monthly expenditure for boiling the collected and fetched drinking water from the different sources of drinking water using cooking gas before consumption ranged between 100-150 (US$ 1.32-2.65).

Miscellaneous charges.

113 out of 586, 19% of the households claimed that the annual expenditure for maintaining the cooking gas equipment cost between Rs. 1-250 (US$ 0.01-3.31). 443 out of 586, 76% of the households claimed that the annual expenditure for maintaining the cooking gas equipment cost between Rs. 251-500 (US$ 3.32-6.62).

Water purifiers

Initial investments.

4 out of 541, 0.74% of the households claimed that their initial investments were between Rs. 1-5000 (US$ 1-66.21) to buy and install water purifiers to purify the drinking water. 395 out of 541,

73% of the households claimed that their initial investments were between Rs. 5,001-10,000 (US$ 66.21-132.31) to buy and install water purifiers to purify the drinking water. 142 out of 541, 26% of the households claimed that their initial investments were between Rs. 10,000-15,000 (US$ 132.31-198.62) to buy and install water purifiers to purify the drinking water.

Monthly charges.

There were no monthly charges incurred.

Miscellaneous charges.

395 out of 541, 73% of the households claimed that the annual expenditure for maintaining the usage of the water purifiers ranged between Rs. 1-2,500 (US$ 0.01-33.10). 142 out of 541, 26 of the households claimed that the annual expenditure for maintaining the usage of the water purifiers ranged between Rs. 2,501-5,000 (US$ 33.12-66.21).

The following table 33 provides a summary of household expenditures per month per household for preventive measures in order to avoid the consequences caused due to unsafe drinking water from different sources of drinking water in the slum areas of Hyderabad city region. The overall household expenditures on preventive measures was about 1% of the overall household income.

Table 33:Preventive measures to avoid the consequences caused due to unsafe drinking water

Category	Initial	Monthly Charges	Misc.	Amount (in Rs.)	Amount (in US$)	% of (A)
Total Income (A) per month	-	-	-	8094	107.18	-
Total Expenditure (B) per month	-	-	-	6759	89.50	84%
Balance (A)-(B) per month	-	-	-	1335	17.68	16%
Total Loss of productivity (C_1) per month	-	-	-	205	2.71	3%
Balance (A)-(B)-(C_1) per month	-	-	-	1130	14.96	13.96 %
Total loss of productivity (C_2) per month	-	-	-	8	0.11	0.1%
Balance (A)-(B)-(C_1)-(C_2) per month	-	-	-	1122	14.86	13.86 %
Total Expenditure (D_1) per month	-	-	-	5	0.07	0.07%
Balance (A)-(B)-(C_1)-(C_2)-(D_1) per month	-	-	-	1117	14.79	13.80 %
Total Expenditure on drinking water (D_2) per month	-	-	-	632	8.37	7.8%
Balance (A)-(B)-(C_1)-(C_2)-(D_1)-(D_2) per month	-	-	-	485	6.42	5.99%
Total Expenditure on preventive measures (E)/ mon.	37	31	0	68	0.90	1%

Category	Initial	Monthly Charges	Misc.	Amount (in Rs.)	Amount (in US$)	% of (A)
Filters/ Clothes (*n*= 1451, 64%)	3	0	0	3	0.04	-
Cooking gas (*n*= 586, 26%)	0	119	26	145	1.92	-
Water purifiers (*n*= 541, 24%)	146	0	32	178	2.36	-
Total Balance (A)-(B)-(C_1)-(C_2)-(D_1)-(D_2)-(E)/ month	-	-	-	**417**	5.52	4.99%

Filters and/or clothes.

There were no monthly miscellaneous expenses incurred by the slum residents. However, the average household initial investments of the filters or cloths cost about Rs. 9.75 (US$ 0.13). Considering the average life span of a filter or cloth that was used for filtration purposes as (3) three months, it can be stated that the monthly expenditure towards purification equipment such as filters or cloths was about 3.25 (US$ 0.04). per household those using filters or clothes per month for purifying the drinking water fetched from different sources of drinking water.

Cooking gas.

There were no initial costs. However, the average household expenditure for cooking gas that was used to purify the water was approximately Rs. 118.5 (US$ 1.57) per month per household. The weighted average of the annual expenditure for the maintenance of the apparatus to boil the water in order to purify the water was about Rs. 309.23 (US$ 4.09) per household. Thus, the average monthly household cost towards maintenance of the cooking gas equipment in the slum areas of the city was about Rs. 25.77 (US$ 0.34) per household.

Water purifiers.

There were no monthly costs. However, the average initial investments in buying a water purifier to purify the water collected from various sources of drinking water was about Rs. 8750.50 (US$ 115.87) per household. The average life span of a water purifier used for water filtration purposes was approximately 5 years (60 months). Thus, the monthly cost towards purification equipment such as water purifiers was about 145.84 (US$ 1.93) per household. The weighted average of the annual expenditure towards the maintenance of the water purifiers was about Rs. 1887.99 (US$ 25.00) per household. Thus, the average monthly household level expenditure for the maintenance of the water purifiers in the slum areas of the city was about 31.47 (US$ 0.42) per household.

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Chapter 5

Analysis of Decision making framework

Chapter 5 | Analysis of Decision making framework

This section of the research study primarily discusses the decision making processes to provide safe and adequate drinking water facilities and services to the slum population of the Hyderabad city region. It attempts to analyse the Hyderabad Metropolitan Water Supply and Sewerage Board (HMWSSB). The HMWSSB provide the drinking water facilities and services and influences the decisions that were taken by the stakeholders with respect to the drinking water in the province.

.Based on the literature study, and the theoretical framework, the key dimensions that are considered for the current research, and the analysis of independent variable, i.e., decision making process at Institutional level to comprise the influence of policies, and regulatory framework, Resource analysis and planning, and Stakeholder engagement, and enforcement in order to achieve the overarching objectives of the "systematic and integrated" decision making framework, i.e., effectiveness, efficiency, universal access, and transparency.

5.1. Rules of law

HMWSSB is the drinking water supply service provider to both the slum and non-slum areas in the Hyderabad city region. The rules and regulations for the service provider in providing drinking water facilities and services to the population of Hyderabad were enacted in the series of manuals comprising HMWSSB Act 1989, HMWSSB functional manual, HMWSSB Water Supply Rules and Regulations and the subsequent Government Orders that were released periodically. It can be noted that there have been no significant changes thereof in the HMWSSB Act, and is still acting as a guiding principle, and in providing structures to the functions and operations of the HMWSSB.

The HMWSSB Act (1989) typically governs the goals and functions of the organisation. According to HMWSSB Act (1989) and proceeding Government Orders, HMWSSB is the service provider that has been mandated to supply potable water. They were responsible for the drinking water supply systems, supply facilities and services in the Hyderabad Metropolitan area[82]. Their responsibilities include planning, designing, construction, maintenance, operation, and management, monitoring. The infrastructure facilities include water supply apparatus such as: Cisterns, Mains, Rising mains, Fountains, Pumps,

[82] At the time of establishment of the HMWSSB Act, the HMWSSB was mandated to providing safe and adequate potable water and maintain the water supply and sewerage systems in Hyderabad city. Over a period of time and the formation of the Greater Hyderabad Municipal Corporation and the Hyderabad Metropolitan Development Authority the boundaries of Hyderabad increased and the responsibilities of the HMWSSB increased in order to maintaining the water supplies and sewerage systems to the proliferating areas and population.

Pipes, Taps, Conduits. They were also responsible for the construction of Filtration plants, Reservoirs, Bridges, Buildings, Machinery, Conduits, Water pipelines, Water tanks, Wells, Bore wells, Work materials. They not only have the control over the above mentioned facilities but also the adjacent land of the facilities and other conveniences. The residents were responsible for purchase of their own water meters that were installed by the HMWSSB from the pipes at household level in order to calibrate the water consumption patterns and charge the consumers as per the defined tariff rates. Additional responsibilities of HMWSSB within the limits of the Hyderabad Metropolitan area include Sewerage, Sewage disposal and Sewage treatment works.

With these responsibilities pertaining to water supply facilities and services, the HMWSSB has framed a vision to cater for the needs of the population of the Hyderabad region in order to be able to supply safe drinking water and maintain the sanitation facilitates with the objectives of good health and disease-free services. In recent times, the vision transformed into a more ambitious statement:

> *To providing daily water supply and to ensure potable water to every household in the Hyderabad region by the year 2040.*

In order to meet this vision statement, the HMWSSB (2018) is aimed to manage the water resources that were available in order to cater for the needs and requirements of its population, adhere to achieve the WHO standards, serve the population effectively, become a people friendly organisation, strive to satisfy their consumers, involve the stakeholders, and be involved with sustainable development. Though it is ambitious to have such goals, it is predominately based on the National Water Policy and National Urban Policy initiated by Ministry of Water Resources and Ministry of Urban Development respectively at National level (HMWSSB, 2008; Nastar, 2014; MoUD, 2012; MoWR, 2012a).

The context and the content of the rule books, which were the basis for defining the vision statements and objectives for the service provides, were not clad tight, they are output driven and fail to clarify the statements. This in turn leads to the HMWSSB's own interpretation of the rules and regulations which in turn have significant impacts on all the approaches that were imposed to fulfil the rules and regulations. For example, the rule book or the vision and mission statements do not specifically include the parameters that define the quality or quantity of drinking water that should be provided, the satisfaction levels of the consumers were not taken into consideration and there is no defined terms of what the involvement of stakeholders should be.

The overall objectives of the HMWSSB were aligned to the overarching goals of the State Government that periodically change. But the main underlying objective always remains the same, that is to provide safe and adequate drinking water facilities and services to the residents of the Hyderabad city region.

5.1.1. Structure and Functions

The structure and functions of the HMWSSB pertaining to drinking water facilities and services were guided by the following manuals: HMWSSB Act 1989, HMWSSB Conduct of Business and Power Regulations 1990, Functional manual, HMWSSB Service Regulations and the HMWSSB Rules and Regulations.

The present day organisation structure and functions of the HMWSSB were under the policy directions of a Board who were a group of stakeholders. The board includes Chairperson, who is Honourable Chief Minister of the State, group of Ministers of the State who were publicly elected representatives, Secretaries to the State Government who were appointed by the concerned Ministers in consultations with Chief Minister of the State, other Dignitaries and Officials.

The day-to-day operations were supervised by the Managing Director (MD) who was appointed by the concerned Ministers in consultations with the Chief Minister of the State assisted by the Executive Director (ED), and the other Functional Directors for broad functional units such as Projects, Technical, Operations, Personnel and Administration, Revenue, and Finance.

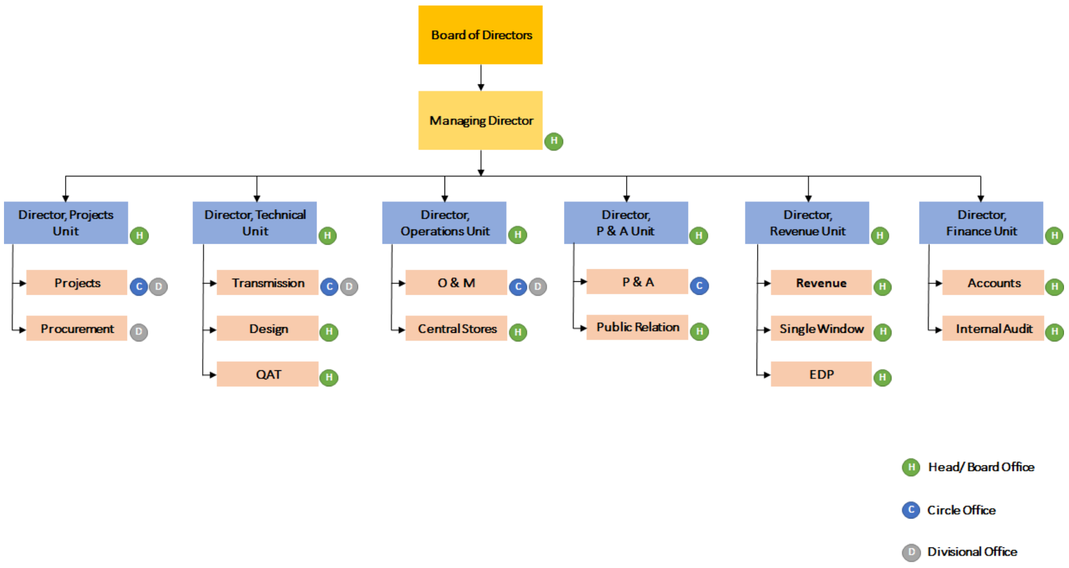

Figure 11: Organisational structure of HMWSSB

These Directors were employed by the HMWSSB and were appointed through recruitment processes as per the HMWSSB Service Regulations. The management team which were comprised of the Managing Director and Functional Directors were head of all the above-mentioned functional units and were positioned at the head of the board office which acts as a nodal office and the corresponding operational team were positioned in the Circle and Divisional offices[83] (Project offices) which were located in different parts of the Hyderabad city region. The diagram 10 illustrates the organisation structure of the HMWSSB and the functional units along with its office locations.

As illustrated in figure 11, the overall responsibilities of the HMWSSB, that aims to provide drinking water facilities and services to the Hyderabad city region were divided between following different functional units of the organisation:

a. ***Projects*** *– This unit plans and executes various construction works related to the water supply in the city, in the periphery and also near the water sources*
b. ***Transmission*** *- This unit takes care of drawing the raw water from the sources, purifying it and transmitting the treated water to the distribution lines*
c. ***Operations and Maintenance*** *(O&M) - This unit manages the huge distribution network, carries out the maintenance of the network, supplies the treated water to the households, carries out the maintenance and renovation of the city's water supply networks*
d. ***Quality Assurance and Testing*** *- This unit collects samples of water supplied through the distribution and transmission networks, tests those samples in the laboratories and assures that the water being supplied is safe and potable*
e. ***Quality Control and Vigilance*** *- This unit is responsible for the quality control of the various construction works that were carried out by the HMWSSB*
f. ***Central Stores*** *- This unit takes care of procurement and safe keeping of water supply related items and makes the appropriate supplies available for the various works being carried out by HMWSSB*
g. ***Personnel and Administration*** *- This unit takes care of the personnel from the HMWSSB*
h. ***Finance and Accounts*** *- This unit takes care of financial matters*
i. ***Revenue*** *- This unit takes care of citizen complaints and the handling and monitoring of the revenue collection*
j. ***Single Window Cell*** *- This unit judges whether to accept, scrutinises and processes the citizens' applications for new water supply connections*
k. ***EDP*** *- This unit takes care of all the information technology aspects of the HMWSSB and also maintains the Metro Customer Care Call Center*

[83] The Hyderabad city region has been divided into eighteen (18) administrative circles (boundaries) and each circle has a different number of divisions or areas. To make it administratively viable for operational and monitoring purposes, in each Circle the staff in the Circle offices report to the Head Office at City level and within each Circle there are staff in Divisional offices, which are the area levels, and they report to Circle offices.

5.1.2. Provision of drinking water facilities and services

The institutions that were accountable for customer service delivery were inextricably associated with the local environmental settings that influence their procedures and outcomes. In order to meet the objectives and fulfil the responsibilities of the HMWSSB, taking into account the local conditions, the institution works with multiple programs, schemes, projects and activities that have been organised through various funding sources for the population of the Hyderabad city region. The programmes typically:

- Involves the untreated or raw water sources from the rivers flowing nearby the city region
- Develops new transmission and distribution water supply facilities
- Upgrades the existing transmission and distribution water supply facilities
- Develops new end-user infrastructure water supply facilities
- Upgrades the existing end-user water supply facilities
- Develops new water quality control systems
- Upgrades the existing water quality control systems
- Restores or purifies the available freshwater lakes
- Improve the water supply operations and
- Improves the water supply maintenance
- Improves the customer relationship management through the introduction of Information and Communication Technology
- Conducts water saving and awareness campaigns

Since the inception of the HMWSSB to date, the HMWSSB strives to strike the balance between the limited supplies and the proliferating demands of the drinking water supply facilities and services in the Hyderabad city region (HMWSSB, 2018).

At household or community level, the provision of drinking water supply facilities and services is also directed by the rules and Government Orders of the HMWSSB which were defined in the Government Orders (Refer G.O. RT. No. 372 MAUD). These guidelines state that any infrastructure for the purpose of drinking water facilities that is developed for domestic purposes needs to firstly be based on a written application that has been received by the HMWSSB from the residents or communities of the Hyderabad city region.

The applications were then scrutinised by the concerned officers in the HWMSSB, per the defined guidelines that deal with providing water supply facilities to applicants for domestic consumption and usage. The factors that were looked at in order to determine whether an applicant has a right to the infrastructure include: purpose (such as domestic or non-domestic) for which the drinking water shall be used, size and length of the water supply facilities, area and height of the property, availability of drinking water facilities and services, income certificates of the households, certificate of ownership or rental agreements of the property, municipal tax receipts, and other support documents if any. The thresholds were defined for each of these factors that are specific to slum and non-slum households and communities, based on which the evaluation of the applications is carried out. Similarly, the water supply facilities for non-domestic purposes were also controlled by the HMWSSB as per the defined guidelines.

Upon the approvals and sanctions of the applications, the rates such as capital costs for installation of required infrastructure were determined for the applicants. The technical and financial feasibility analysis were conducted in providing the prescribed drinking water supply infrastructure such as pipes, water fittings, or other alternative facilities like public taps or water tankers, in case there is no feasibility of providing individual taps at household level and supply potable water through them accordingly by the authorized personnel of the HWMSSB only.

However, the rule books also state that the HMWSSB is not liable to any penalty or damages due to any reduced or no supply of drinking water services under any circumstances or unavoidable causes. All the infrastructure facilities pertaining to water supply provided by the HMWSSB were only made available at the ground level of the building or property premises. It is the responsibility of the HMWSSB to provide drinking water infrastructure facilities and services at no cost and charges for the public water that is supplied through public stand posts and other conveniences.

In the case of multi-storey buildings, it is the responsibility of the residents or owners of the building or property to organise water storage facilities such as underground tanks and then distribute the collected drinking water from the water supply infrastructure that is available at ground level to all of the apartments in the buildings using electrical pumps or other devices. It is unlawful to use any devices to draw water directly, or indirectly from the water supply mains, or service pipes of the service provider.

Nevertheless, considering the above-mentioned mammoth responsibilities and the activities taken up by the HMWSSB, it is vital to analyse how the decisions were taken in these complex settings. With regard to this, the following sections comprehend the decision making processes and procedures that have been defined and have been put into practice to provide safe and adequate drinking water facilities and services and the stakeholders who manage them.

5.1.3. Stakeholders involved in the decision making process

The stakeholders of the HMWSSB that were involved in the decision making process pertaining to drinking water facilities and services were guided, as has been already pointed out, by the following manuals: HMWSSB Act 1989, HMWSSB Conduct of Business and Power Regulations 1990 and other HMWSSB Rules and Regulations, etc.

According to the HMWSSB Act (1989), the decision making power rests with the group of stakeholders constituted and composed for HMWSSB who have the power to make the appropriate decisions in order to provide safe and adequate drinking water facilities and services to the inhabitants, include both slum and non-slum areas of the Hyderabad city region, which were subject to the provisions specified in the HMWSSB Act (1989).

This group of stakeholders were involved in the preparation and implementation of the decisions taken on policies, projects and any activities involving providing drinking water facilities and services[84]. The group of stakeholders, also known as Board of Directors, as per the HMWSSB Act (1989), include the ex-officio and officio personnel as shown in Table 34.

Table 34: Stakeholders involved in decision making process

Type	Stakeholders
Ex-Officio	a. Chief Minister of the State b. Minister for Municipal Administration c. Secretary to Government, Housing Municipal Administration & Urban Development Department d. Secretary to Government, Finance Department e. Secretary to Government, Irrigation Department f. Commissioner, Municipal Corporation of Hyderabad
Officio	a. Chairman, Andhra Pradesh State Pollution Control Board b. Director, Medical, Health, and Family Welfare Services c. Chief Engineer of the HMWSSB (to be appointed by the Government) d. Director, Finance and Accounts (to be appointed by the Government of the rank of Additional Accountant General drawn from either IA&AS, or any Financial Institution, or a Chartered Accountant with not less than twenty (20) years of experience in the field of Finance & Accounts) e. Nominated personnel for Director position from Mayor/ Chairpersons/ elected Members of GHMC and Municipalities falling within the area of the Board [85] f. Managing Director of the HMWSSB (IAS cadre nominated by the Government)

It can be noted that, any decisions at policy, or project level, in terms of providing safe and adequate drinking water facilities and services, those to be taken were discussed and finalised during the meetings[86] of the board, the group of stakeholders that were listed in Table 65, on a regular and need basis, with all the required detailed inputs from the Functional Directors and the Operational Staff of the HMWSSB. However, all the orders

[84] According to the Act 28 of 2007 w.e.f 10-02-2010 vide G.O. Ms. No. 60 MA & UD (W2) dt. 11-2-2010. Published in AP gaz. Pt. I, Ext. No. 103 dt. 25-2-2010

[85] The jurisdiction of the board expanded considerably with the establishment of the Greater Hyderabad Municipal Corporation and Hyderabad Metropolitan Development Authority, resulting in the formation of new divisions and circles and corresponding elected members

[86] The board shall hold ordinary meetings at such intervals as provided in the regulations and a meeting may be convened by the Managing Director at any other time for the transaction of urgent business.

and the decisions taken during the meetings of the Board shall be authorised by the Managing Director of the HMWSSB, or any Directors authorised by the Board on this behalf.

In addition to the above-mentioned internal stakeholders, the other set of stakeholder include external stakeholders such as educational institutions, private sector consultants, subject matter experts, public representatives, local associations, media, and residents/ customers. These external stakeholders were only involved in the matters of the government agency on a need to know basis. There were no rules and regulations in place to support the active participation of external stakeholders.

5.1.4. Decision making process in providing safe and adequate drinking water facilities and services

The scope for providing safe and adequate drinking water facilities and services to the residents in Hyderabad city region is expanding rapidly with new programmes, schemes, projects, etc. every year. Due to the persistent and proliferating disparities amongst the quality and quantity of drinking water in the Hyderabad city region that were covered by the various plans, programs, schemes, projects, activities and actions of the HMWSSB this study was motivated to analyse what decisions were taken to provide these infrastructure facilities and services.

This section analyses the decision making processes that were taken in order to develop programs, strategic plans and policies and it looks at what actions have been taken by the service provider to provide drinking water facilities and services to the slum areas in the Hyderabad city region. The diagram in Annex 8A describes the existing decision making processes in HMWSSB. It was constructed during the focus group discussions with the relevant stakeholders from the HMWSSB apprehending all the concerned stakeholders involved during the process, the inputs considered at different level to perform different activities, the activities performed by the stakeholders during the process, and the outputs and outcomes of all the activities.

This chapter provides a detailed step-by-step description of the decision making processes that were involved in providing drinking water facilities and services to the slum residents of Hyderabad city region. The sequential steps, as per the numbers given for the activities or tasks in the workflow diagram (refer Annex 8A), includes the stakeholders who were involved during the processes, the inputs that were considered each level in order to perform the different activities, a list of the activities performed by the stakeholders during the process and the outputs or outcomes of the activities.

1. Preparation of representations or proposals. The stakeholders (such as Central Government, State Government, Non-Government Organizations, Media, Welfare Associations, Community Level Associations, Local Representatives, etc.) receive the

concerns, requirements and requests pertaining to drinking water facilities and services from the slum residents. These concerns or requirements are either gathered during the field visits or from group discussions conducted by the stakeholders or by the slum residents visiting the stakeholders in person or contacting them through any ICT platforms such as phone, emails, SMS, etc. Depending on the severity of the concerns or the requirements, the stakeholders at their discretion, prepared proposals or representations stating the concerns and the requirements pertaining to the drinking water facilities and services. There was no official format in which these proposals or presentations were prepared for submission. The inputs for this activity include concerns, requests or a list of requirements from the slum residents, which were presented in the form of a proposal or presentation.

2. **Submit representations or proposals**. Post preparation of the representations or proposals based on the requirements or concerns of the slum residents, the same are submitted to the Head of the Department or Managing Director of HMWSSB for further perusal and necessary actions. However, it was observed that there is limited or no active role of these stakeholders' post submission of representations or proposals. The input was the submission of the proposal or presentations. The output was the receipt of proposal or presentations.

3. **Raise concerns about Operations and Maintenance (O&M) of drinking water facilities and services**. The slum residents or groups raise issues regarding the O&M of drinking water facilities and services such as: damaged pipes, quality issues and tail end issues. There were different channels through which the slum residents may raise the issues to the staff of HMWSSB. The slum residents can raise the concerns to the Customer Relationship Center of HMWSSB through mobile, SMS, or emails. The slum residents can also raise the concerns directly to the Managing Director or Head of the Department of HMWSSB through mobile, SMS, emails, or meeting in person. The inputs and outputs include concerns pertaining to operations and maintenance issues.

4. **Submit application for new household water supply connection**. The slum residents or groups may apply for water supply facilities at household or community level using an application form that is downloadable from the HMWSSB website or available at the single window services in the premises of HMWSSB offices. The application form along with the requisite support documents such as purpose for which the facilities will be used, area and height of the property for which the facilities will be required, Income certificates, affidavit for land area confirmation, registered sale deed, rental agreements, electricity bill, municipal tax receipts, etc. These support documents were collected to validate the applicant's financial status, the purpose for which the building structure is used and estimate the total number of residents in the building. Based on the rules laid out in HMWSSB rule books, the charges for the various facilities and

services vary based on the financial status of the applicant, building usage, etc. The inputs for this particular activity include the application request for water supply facilities, and the outputs include completed application forms.

5. **Check for completeness and authenticity of the applications received**. The officers in the Single Window Cell of the HMWSSB receive the application forms from the slum residents and scrutinise them as per the defined guidelines and government orders for further processing in order to provide the required drinking water facilities at subsidised rates. These officers check for the completeness and the authenticity of the application forms along with the support documents. As per the guidelines for the slum residents, the applications received were scrutinised based on the following parameters: (a) Water supply connection to be used for domestic purpose only, (b) Plot area should be less than 100 Sqm, (c) Height of the building should not be more than G+1 floor (6 m height), (d) No water facility already available in the premises of the residential building, (e) Income certificate issued by Revenue Department officers, and (f) Average annual income less than 2.0 lakhs (in INR). In case of any applications that do not meet the above-mentioned criteria, they were either rejected or returned to the applicants asking for additional information or clarifications. The applications meeting the above-mentioned criteria were shortlisted and an acknowledgement was given to the applicant and the applications were forwarded to the Managing Director or Head of the Department for further processing. The inputs include applications for water supply facilities and the outputs include shortlisted application forms.

6. **Receive concerns about O&M of drinking water facilities and services.** The staff of the EDP or MCC divisions of HMWSSB lodge the complaints received through the website, telephone, messages or emails pertaining to the operational and maintenance issues of drinking water quality and the physical infrastructure. The staff of the EDP or MCC divisions regularly generate Management Information System (MIS) reports and submit them to the Head of the Department or the Managing Director of the HMWSSB. These reports were also accessible to the Head of the Department and the Managing Director of the HMWSSB on the MIS dashboards at any given point of time. The inputs for this particular activity include concerns pertaining to operations and maintenance, and the outputs include MIS reports pertaining to the operations and maintenance issues.

7. **Assess the proposals or representations or applications**. The Head of the Department receives the following from different sources: (a) Proposals or representations for new or upgraded drinking water supply systems from concerned stakeholders (ref. activity #1), (b) Applications from a Single Window Cell of the HMWSSB for new or upgraded drinking water supply facilities at Household level (ref. activity #5), (c) MIS reports from the EDP and MCC divisions of HMWSSB and the concerns directly from slum residents

regarding O&M related issues (ref. activity #6). Based on the above received details pertaining to the requirements or issues of drinking water supply systems for the slum areas of Hyderabad city region, the Managing Director or Head of the Department of HMWSSB assesses the proposals, presentations, applications or concerns considering that they were: (a) In line with the HMWSSB rules of the laws, (b) In line with the HMWSSB policies and strategies, (c) In line with the city development plans and sectoral plans. Then the concerned staff of HMWSSB are instructed to look into the requests and decide what sort of action should be taken, taking the following points into consideration: (a) The size or scale, in terms of the monetary value, of the proposal, concern or application, (b) What sort of proposal, application or concerns. The inputs were from various stakeholders regarding the drinking water facilities and services that were required and their concerns; plans, policies and guidelines; city development plans, sectoral plans. The outputs include Instructions for the HMWSSB Staff.

8. Instructions to the concerned teams of HMWSSB. In cases of proposals, applications or concerns requiring planning and development of new or large-scale infrastructure facilities and services, or large-scale improvements to the existing drinking water infrastructure facilities and services, the Managing Director or Head of the Department of HMWSSB instructs the Director of Projects and Planning regarding further perusal and necessary actions. The inputs include scrutinising the size and type of the proposal, application or concern. The outputs include Instructions to the concerned staff of HMWSSB.

9. Instructions to the concerned teams of HMWSSB. In case of proposals, applications or concerns requiring operations and maintenance of existing drinking water facilities and services, the HMWSSB Managing Director or Head of the Department instructs the Director of Operations to look at the documents and decide on necessary actions. The inputs include identifying the size and type of the proposal, application or concern. The outputs include giving instructions given to the appropriate HMWSSB staff.

10. Instructions to the concerned teams of HMWSSB. When proposals, applications or concerns require any improvements or upgrades to the existing drinking water infrastructure facilities and services, the Managing Director or Head of the Department of HMWSSB instructs the Technical Director to look at the case and take the necessary actions. The inputs include identifying the size and type of proposal, application or concern. The outputs include instructions given to the appropriate HMWSSB staff.

11. Instructions to the concerned teams of HMWSSB. Upon the receipt of instructions from the HMWSSB Managing Director or Head of the Department, the HMWSSB Project Director verifies the instructions and then instructs the concerned officers at

circle level to validate the requests. The inputs for this activity were the instructions that were given by the HMWSSB Managing Director regarding the applications, proposals or concerns. The outputs include instructions to the concern Staff of HMWSSB.

12. **Instructions to the concerned teams of HMWSSB**. Upon the receipt of the instructions from the HMWSSB Managing Director or Head of the Department, the HMWSSB Operations and Technical Director verifies the instructions and then instructs the concerned circle or area level officers to validate the proposals. The inputs for this activity were the instructions from the HMWSSB Managing Director with what to do with the applications, proposals or concerns. The outputs include instructions to the concern Staff of HMWSSB.

13. **Field verifications to verify the concerns or requests raised**. Upon the receipt of instructions from the functional directors, the officers at circle level, in consultation with divisional or area level officers conduct a field level physical verification and inspection of the site and prepare a preliminary field verification report for each of the concerns raised, applications, proposals or presentations and submits the same preliminary verification report to the appropriate functional directors. The inputs for this particular activity include Instructions from the HMWSSB functional directors. The outputs include primary field verification reports.

14. **Drinking water quality testing and reporting**. The concerned stakeholders for this activity were the (Quality Assurance and Testing) QAT wing of the HMWSSB. In the case of any issues or concerns pertaining to the quality of drinking water, the team from the QAT wing of the HMWSSB conducts drinking water sample testing at the site or location, they then prepare and submit reports to the concerned circle or division or area level officers of the HMWSSB. The inputs for this particular activity include Instructions from the HMWSSB Functional Directors. The outputs include drinking water quality reports.

15. **Verify preliminary field inspection reports**. The concerned stakeholders for this activity were the Operations and Technical functional Directors. The primary field verification or inspection reports were thoroughly verified and discussed with the area level officers to confirm the validity of the concerns raised or the requirements pertaining to drinking water facilities and services. The inputs for this particular activity include primary field verification reports. The outputs include the validation of the primary field reports.

16. **Verification of the preliminary field inspection reports**. The concerned stakeholders for this activity were the project functional directors. The primary field verification or

inspection reports were verified and discussed with the concerned circle, divisional or area level officers to confirm the validity of the concerns raised or the requirements pertaining to drinking water facilities and services. The inputs for this particular activity include primary field verification reports. The outputs include validation of primary field reports.

17. **Instructions to the concerned teams of HMWSSB**. The concerned stakeholders for this activity include the Operations and Technical functional directors. In case of validations, the Operations and Technical Directors instruct the concerned staff at circle or area office to initiate further procedures in preparing technical and financial feasibility reports. The inputs for this activity include validation of the primary field verification reports. The outputs include instructions to the concerned HMWSSB staff.

18. **Instructions to the concerned teams of HMWSSB**. The concerned stakeholder for this activity were the Projects functional Directors. In case of validations, the projects directors instruct the concerned staff at circle or area office to initiate further procedures in order to prepare the technical and financial feasibility reports. The inputs for this activity include valid primary field verification reports. The outputs include instructions to the concerned staff of HMWSSB.

19. **Concludes the false concerns or requirements with no action**. The concerned stakeholders for this activity were the HMWSSB managing director or the head of the department in consultations with the HMWSSB functional directors. If it is concluded that there were false concerns or requirements then the managing director, in consultation with the HMWSSB functional directors, concludes the case and decides that no further actions were needed to be taken. The inputs for this particular activity include non-validation of primary field reports and the outputs include instructions for no further actions.

20. **Prepare technical and financial feasibility reports**. The stakeholders for this activity include the HMWSSB projects, operations or technical officers at circle or area level. The officers from the circle or area level in consultation with the divisional or area level staff, prepare the detailed technical and financial feasibility reports as per the HMWSSB guidelines to address the concerns or requirements raised pertaining to drinking water supply systems. These details and the technical and financial feasibility reports consider the following inputs: (a) Staff capabilities in order to plan, design and implement the plan. In case required staff were not available, the detailed technical and financial reports were prepared in consultation with a third party vendor. Tenders are called for selecting contractor or third party vendor for implementing the works, (b) Resource analysis to understand the natural resources availability and other man-made infrastructure facilities, man-power, etc., (c) Technical assessment to

understand the existing physical characteristics of the locality, existing quality and quantity aspects, Services need assessment, gap identifications, recommendations, implementation plans, engineering drawings, etc., (d) Financial analysis include potential funding options, revenue generation, risk analysis, internal financial analysis, etc. (e) Alterative Technology and Implementation options. The inputs for this particular activity include instructions from the HMWSSB Functional Directors, inputs on staff capabilities, resource analysis, technical assessments, financial analysis, technology and implementation options. The outputs include draft technical and financial reports.

21. **Inputs on Technology options**. The staff from the Internal research and development wing of the HMWSSB research the emerging and feasible solutions in water sector and provide inputs on potential technology options that may be considered to be included in the technical reports and implementation of the plan. These technology options rely on - resources data management, type of materials, recharge or restore and reuse or recycle options, sustainable and cost-effective sources of water, affordable and safe drinking water options, monitoring systems for quality and quantity, treatment technologies, local knowledge, etc. The inputs to perform this activity include making a draft technical report. The outputs include technology options.

22. **Inputs on implementation options**. The concerned stakeholders were HMWSSB Internal Implementation teams. The internal implementation teams of HWMSSB typically include all the functional directors and the operational staff. The staff from these different teams review and provide input on the various implementation options that may be considered for inclusion in the technical reports. These implementation options typically include - financing modes and sources, contracting and operational arrangement options and are based on previously implemented projects of similar nature. The inputs to perform this activity include Draft Technical Reports and the outputs include Implementation options.

23. **Submit technical and feasibility reports**. The stakeholders for this activity include HMWSSB operations, technical or projects functional directors and the HMWSSB managing director or head of the department. The functional directors review the technical and financial feasibility reports, then they discuss and finalise with via consultations with the concerned operational staff. The finalised technical and financial feasibility reports were submitted to HMWSSB managing director or head of the department, for further action. The inputs to perform this activity included draft technical and financial feasibility reports. The outputs include technical and financial feasibility reports.

24. **Verification and discussion of feasibility reports**. T The key stakeholder for this activity is HMWSSB managing director or head of the department and functional director. The managing director or head of the department reviews the technical and financial feasibility reports and discusses and finalises in consultations with the concerned functional directors and operational staff. The inputs and outputs for this activity include technical and financial feasibility reports.

25. **No further action on unfeasible proposals**. The stakeholders for this activity include HMWSSB managing director or head of the department and functional directors. In case of projects or proposals or plans technically and financially not feasible, the Managing Director shall conclude the case with no further action in consultations with the Functional Directors, HMWSSB. The inputs include Technical and financial feasibility reports and the outputs include instructions for no further actions.

26. **Prioritise the proposals for further actions**. The stakeholder for this activity is HMWSSB managing director or head of the department. In the case that the projects, proposals or plans were technically and financially feasible and the value of the projects, plans and schemes fall within the approval thresholds of US$ 1.5 million, the managing director prioritises the projects, plans and schemes based on the intensity of the concerns raised, external influences and the availability of the funds. The inputs for this particular activity include technical and financial feasibility reports. The outputs include the approval and prioritisation of projects, schemes and plans.

27. **Discussions with the Board of Directors and/or State Assembly**. The stakeholder for this activity were the assembly, board of directors and managing director or head of the Department, HMWSSB. If the projects, proposals or plans were technically and financially feasible and the value of the projects, plans or schemes does not fall within the approved threshold of US$ 1.5 million, the Assembly, Board of Directors and the Managing Director need to look at the technical and financial reports and prioritise the proposals or projects based on the intensity of the concerns raised, external influences and the amount of funds that were available. The inputs to perform this activity include technical and financial feasibility reports. The outputs include approval or non-approval of projects, schemes or plans.

28. **Prioritise the proposals for further actions.** When the proposal is approved by the assembly and board of directors, the board of directors then further prioritises the projects, plans or schemes based on the intensity of the concerns that have been raised and external influences. The inputs for this particular activity include technical and financial feasibility reports. The outputs include prioritisation of projects, schemes and plans.

29. **Procurement and project implementation procedures**. Upon approval and prioritization of projects, schemes, and plans, the Managing Director or Head of the Department instructs the concerned Functional Directors and Operational staff to initiate the tendering and implementation procedures. The inputs for this particular activity include approval and prioritisation of projects, schemes, and plans and the outputs include Instructions to the concerned staff.

30. **Publishing the project details**. After the approval and prioritisation of the projects, schemes and plans, the managing director or head of the department instructs the concerned staff to announce the upcoming, on-going and completed list of projects, schemes and plans. The inputs for this particular activity include the approval and prioritisation of projects, schemes, and plans. The outputs include instructions to the concerned staff.

The following section provides the analysis of the detailed decision making procedures in providing drinking water facilities and services to the slum residents in the slum areas of the Hyderabad city region. The objectives of the Water Board to provide drinking water services were also steered by City Development Plans which were prepared by the Greater Hyderabad Municipal Corporation (GHMC, 2006). The City Development Plan clearly defines the quality and quantity of drinking water facilities and services that should be provided to the city region population in terms of facilities and services gaps, and it also includes future requirements. This Plan also defines the potential strategies to meet the existing gaps and growing needs.

The potential strategies defined in the City Development Plan were further enhanced and developed in a Sectoral Development Plan. These Sectoral Plans are typically formulated by the responsible Departments. In the case of the Hyderabad city region, the sectoral development plans for drinking water facilities and services were prepared by the HMWSSB.

Articles have been written about many instances where fewer plans were developed by different parastatal agencies in Hyderabad than were actually planned (GIZ, 2013; The Hindu, 2015). It was also argued that the GHMC and HMDA, who were in charge of the preparation of city development plans, have only played a small role in preparing the sectoral development plans and the procedures for the HMWSSB, this made the water sector services in Hyderabad a techno-bureaucratic activity (Sahu, 2012). This has caused incongruity amid the city development plan and the sectoral development plans for the Hyderabad city region and it has hindered a coordinated approach for all the development activities in the City.

The overall supervision of the developmental activities or projects taken up by the Water Board in the entire Hyderabad Metropolitan Region and coordination of activities among the different local bodies, during the project implementation phases, is taken care of by the Hyderabad Metropolitan Development Authority (HMDA) (Nastar, 2014; GHMC, 2006; HMDA, 2010). The GHMC and HMDA were responsible for acquiring the required consensus from the concerned Urban Local Bodies (ULBs) for the HWMSSB to initiate any development activities in the respective jurisdictions' of ULBs.

HMWSSB is one of the youngest institutions, it was formed due to Act 15 of 1989, with administrative and financial independence from the Municipal administrative department[87] and the State government[88] (HMWSSB, 2008). However, due to the composition of the Water Board, it was compromised regarding administrative independence in decision making powers. The State government retained the ownership of board's assets and the powers to formulate policies and strategies was vested to the managerial committee, which acted as a central administrative body consisting of bureaucrats[89].

Due to the challenges that were faced by the Water Board90 by the public representatives during the discussions and board's functioning, the notion of public representation and participation in the decision making processes was excluded from Act 15 of 1989 (Sahu, 2012). There was also no direct involvement of the general or the slum population in any of the decision making processes.

The non-participation of the public in the decision making processes led to a lack of accountability and transparency in providing adequate drinking water facilities and services to the city's population by the HMWSSB, which means that the notion of good governance for the HMWSSB was put at risk (DIFD, 1998). However, several studies have indicated that the e-governance initiatives of the HMWSSB like the Metro Customer Care, Single Window Cell, Citizen Charter Center and Lok Adalat[91] were the only direct means for the general public to communicate with the Water Board with respect to the processing of new applications, user fee payments, complaint registration and the settlement of any issues or concerns, which pertain to providing drinking water facilities and handling operational and

[87] Before HMWSSB, the Water Works Department was responsible of supplying drinking water which was headed by Municipal Administrative department

[88] State government financially supported Water Works Department

[89] Chief Minister of the State, Ministers, Secretaries to Government (MAUD, Finance, Irrigation), Commissioner (GMCH), Chairman (Pollution Control Board), Director (Health), Chief Engineer, Accountant General, IAS (Indian Administrative Service) officer appointed by Chief Minister and other specialist officers

[90] Formed in 1982 under Andhra Pradesh Act No. 6 of 1982 to ensure autonomy in planning effectively; this is headed by the administrator/ engineer/ technical person and representatives from the community

[91] It is an alternative dispute redressal mechanism, a public platform or forum where disputes/ issues are settled or compromised amicably out of the courts

maintenance issues, but not in providing safe quality and adequate quantity of drinking water services (Caseley, 2006; McKenzie and Ray, 2009).

These e-governance initiatives had a constructive impact in delivering services to only a certain portion of the population in the Hyderabad city region, namely the affluent population as they had internet via telephones and computers to communicate with these bodies (Caseley, 2006; Robinson, 2007; Davis et al., 2008). The slum population who had limited access to computers and internet facilities, were thus disadvantaged (Sahu, 2012).

The public and the resident welfare associations in the slum areas generally discussed the matters pertaining to the provision of drinking water services and improvements to the existing services at the individual community level with the Municipal Corporators[92] [93] then the proposals[94] were prepared and submitted by the Corporators to the HMWSSB and/or the State Government.

The official rulebooks of the HMWSSB or any other parastatal agency guidelines do not specifically explain the procedures of communication with respect to drinking water in the slum communities. Though there was no distribution of duties dictated by official rulebooks of HMWSSB or any other parastatal agency per say, in this regard, it rather takes the form of informal arrangements in submitting representations or proposals to the Water Board (Sahu, 2012).

The effectiveness of the presentations or the proposals submitted differs from one Corporator to another and from one slum area or community to another. These sorts of arrangements were largely dependent on the Corporators' personal relationships, party affiliations, tensions and attentions surrounding the issue of water and the expectations of the population in the Hyderabad city region.

On the other hand, there were Non-Government Organisations (NGOs), Civil Society Organisations (CSOs) and Voluntary Organisations (VOs) involved in the decision making processes. It was observed that these actors play the role of frontrunners in transition areas to confront the policymakers asking for the creation of rights to basic needs and they were able to influence policies through petitions, public hearings, campaigns, press meetings, critical debates, resistances, disobedience movements and political conflicts (Frantzeskaki et al., 2012; Rotmans and Loorbach, 2009).

Indirectly, these organisations put pressure on the HMWSSB as well as on the government to provide better services. There were no adequate procedures and mandates in the HMWSSB to involve these stakeholders in the decision making processes. The consequences of the stakeholder's actions force the HMWSSB to initiate the required

[92] A Corporator is an elected member of a municipal corporation

[93] Elected members in charge of the development of their electoral constituencies

[94] General representation (in the form of a request letter) stating the challenges and requirements

actions; but as these actions were due to pressure, they were often started but not carried through to completion. They often take a standstill position during the implementation phase, unless there were interminable follow-ups by the external stakeholders with the concerned stakeholders in the HMWSSB to keep-up the pressure.

Despite the clear mandates, the Water Board enjoys neither administrative powers nor budgetary autonomy. Given the Water Board's lack of authority in the decision making processes, it also affects the financial status (Sahu, 2012). The notion behind the introduction of water tariffs was to make the public aware of the economic value of water, the water in Hyderabad was treated as a social good, which restricted the revenues to the Water Board and did not provide enough financial resources to be able to build adequate infrastructure.

Any proposals by the water board for the revisions of the water tariffs were strongly opposed by the political actors. Considering the vested interests of these political actors, they also propose to treat water as a "common good" and they want to provide it for no charge. Considering these factors, it is not surprising that the Water Board's service levels have been declining over the past several years, especially in the slum areas of the metropolitan region. The HMWSSB, whose primary and major income is through user charges and partly through grants-in-aid, is not financially self-sustainable, and is limited to what improvements in the services they were able to give to the poor (HMWSSB, 2008).

Historically, more than 60% of water is for domestic purposes and about 40% of the water is used for commercial and industrial purposes. However, the revenues generated from domestic consumption were only 30% of the Water Board's revenue (HMWSSB, 2011). The cross-subsidy pricing for water services combined with lack of adequate investment funds created tremendous pressures on the HMWSSB.

There were also physical losses of water due to the inadequate infrastructure, administrative losses due to illegal ciphering off of water and defaulters of user charges in slum areas. This has resulted in a substantial increase in the levels of non-revenue for the water that is used (Robbins, 2003; GHMC, 2006; Swyngedouw, 2006; McKenzie and Ray, 2009).

Due to the political influences, any preventive measures against these activities were hindered (Sahu, 2012). The objectives of the Water Board to provide equal, fair and efficient services due to this has been jeopardised. The service delivery assessment was carried out by indicators such as non-revenue water and bill collection efficiency ratio (DFID, 1998).

As the current bulk sources of water were drying up and it is not possible to meet the daily water requirements of the city residents, the HMWSSB decided to develop new water projects that fetch water resources from two rivers, namely Krishna and Godavari which were approximately 110 Km and 200 Km away from the city (HMWSSB, 2018). This shall not only increase the transmission losses but also production cost per unit, resulting in financial burdens on residents of the city (especially on slum population) in the form of user charges and eventually on HMWSSB in the form of non-revenue water (administrative losses).

In addition to the existing administrative setup of HMWSSB and role of informal actors, the operational and maintenance staff of the water board who were geographically spread across the metropolitan region were responsible for the meter readings, billing distribution, identifying illegal connections and carrying out feasibility studies in order to improve the water services in Hyderabad region (HMWSSB, 2008). These feasibility studies play a significant role in the decision making processes and procure funding assistance from the state, central or international agencies (Sahu, 2012; HMWSSB, 2008).

HMWSSB in coordination with professional companies[95] prepare these reports pertaining to the water sector services which predominantly covers the technical and financial aspects. The preparation of project reports was primarily based on the standardised reference template from the Ministry of Urban Development (MoUD) Department at National level on preparation of Detailed Project Reports (DPRs) for any infrastructure development and improvements activities (MoUD, year unknown).

The reports need to include the following details: (a) sector background, context and project rationale, (b) project definition, concept and scope, (c) project costing, (d) project institution framework, (e) project financial structuring, (f) project phasing, (g) project O&M framework and planning, (h) project financial viability or sustainability, (i) project benefits assessments, (j) engineering drawings, (k) specifications. However, the source for the projects identification can be a combination of (i) development or action plans, (ii) priorities of locally elected representatives or political leaders, (iii) demands from the interested groups or beneficiaries, (iv) dialogues between various agencies (MoUD, year unknown; Sahu, 2012).

Despite having urban planning instruments steering ambitious plans and policy initiatives[96] (and vice-versa) to improve the municipal water sector services in the city and living conditions of the slum settlements, the lack of institutional strengths with respect to administration and finance, lack of comprehensive and structured procedures, lack of inter-departmental coordination, lack of participation of the slum population in the decision making processes and estimations of their requirements of the slum population and what they will accept combined with treating water as a "social good" in the decision

[95] Generally appointed through a tendering process

[96] National level – National Water and Urban Policy; State level - Andhra Pradesh Urban Services for the Poor Programme (APUSP); Jawaharlal Nehru Urban Renewal Mission (JnNURM); Slum Free City Programme; Rajiv Awas Yojana (RAY); Institutional reforms

making processes has led to the disturbing conditions of current drinking water facilities and services amongst the slum areas in Hyderabad city region (Sharma, 2011; Nastar, 2014; Das, 2015).

The following table 35 explains the association between the indicators and sub-indicators that were discussed in the theoretical framework (refer section 2.4). It shows the systematic and integrated decision making processes that were used in order to provide safe and adequate drinking water facilities and services for the slum areas and to what extent the existing decision making processes of the HMWSSB complies with the assessment criteria.

The results presented in this Table 35 were based on the focus group discussions held at HMWSSB to understand the decision making procedures. This was so that it was possible to examine the factors that were considered during the decision making processes, in comparison with the theoretical framework pertaining to the systematic and integrated decision making processes in providing drinking water facilities and services to the slum areas.

Table 35: Indicators and sub-indicators in the existing decision making procedures

Indicators	Sub-Indicators	#	Existing Decision making process
Socio-Health	*Socio-economic conditions*	S1	Y
	Health conditions	S2	N
	Slum residents' involvement	S3	P
Institutional	*Policies, regulatory frameworks and procedures*	I1	Y
	Internal and External Stakeholders' involvement	I2	P
	Capacities and Enforcements	I3	P
Technical	*Resource analysis and planning*	T1	Y
	Requirements analysis and planning	T2	P
	Engineering and Innovation	T3	Y
Economic	*Damage costs for Slum residents*	E1	N
	Preventive costs for Slum residents	E2	N
	Willingness to Accept and Pay	E3	N

Legend: Y (Compliant), P (Partially compliant), N (Non-compliant)

Priority analysis was an additional factor that influenced the existing decision making processes at HMWSSB in providing the drinking water facilities and services to the slum areas. The following table 36 illustrates the additional sub-indicator which has not been included as part of the current research's theoretical framework.

Table 36: Additional indicators and sub-indicators which has not been included as part of current research's theoretical framework

Indicators	Sub-Indicators	#	Existing Decision making process
Others	Priority analysis	O1	P

Legend: Y (Compliant), P (Partially compliant), N (Non-compliant)

In summary, the decision making procedure in providing drinking water facilities and services to the population of Hyderabad city population, particularly slum population typically include consideration of: (a) socio-economic aspects, (b) participation of slum residents, (c) policies, regulatory frameworks and procedures, (d) participation of internal and external stakeholders, (e) capacities and enforcements, (g) resource analysis and planning, (h) engineering and innovation, (i) prioritization, etc. These parameters that are considered during the decision making processes at HMWSSB are typically classified into the following major categories:

a. **External Stakeholders' engagement.** The existing decision making process may involve all or few of the relevant external stakeholders such as Slum residents, Central or State Government agencies, Non-Government Organisations, Media, Community level associations or Welfare associations, Local representatives, etc. The concerns and requirements pertaining to drinking water facilities and services were passed on to the internal stakeholders of the HMWSSB, the service provider of drinking water facilities and services, by these external stakeholders.

b. **Internal Stakeholders' engagement.** The existing decision making processes involves all of the management and functional Directors of the HMWSSB, who provide drinking water facilities and services to slum and non-slum areas in the Hyderabad city region. All of the relevant internal stakeholders use a consultative approach during the decision making processes. The scarcity of resources and external influences such as political pressure plays a significant role during the decision making processes when trying to prioritise the provisions of drinking water facilities and services for a specific set of slum areas or members of the population.

c. **Vision, Policies, and Strategies.** The existing decision making processes take into consideration: The National and State level policies pertaining to the provision of a standard quality and quantity of drinking water, National and regulatory frameworks, State level and Institutional level policies, including Standard operating procedures, City development plans, and various Sectoral development plans. The concerned managerial stakeholders of the HMWSSB need to take into account the required policies and regulatory frameworks during the decision making process and provided the required inputs to the operational staff of the HMWSSB.

d. Resource Analysis and Planning. The existing decision making process needs to take into account: analysis of existing natural resources, existing man-made infrastructure facilities such as city and slum level drinking water supply infrastructure, service quality and service quantity needs assessment considering the existing situation in comparison with standards, socio-economic conditions, technical and financial feasibility assessments of the potential recommendations to meet the service needs, sustainable technology options, and implementation options. The internal stakeholders in consultation with the external experts, for example third party vendors or consultants, prepares these assessment reports. However, the assessments do not take into account inputs from the lessons learnt from the monitoring and evaluation reports of previously implemented projects, programs and schemes.

5.2. Stakeholders' Analysis of Decision making process at Institutional level

At the city level, the existing decision making processes appeared promising and considered a significant share of the sub-indicators, as 4 out of 12 were compliant and 4 out of 12 were partially compliant which was defined by the theoretical framework, thus it is possible to conclude that the existing decision making processes were systematic and integrated in their approach.

But there were disparities in the existing quality and quality of drinking water facilities and services in the slum areas. In addition to the indicators and sub-indicators, which were used for assessing the existing decision making processes, the prioritisation of the projects, plans and programs were influenced by the resource scarcity and external political influences during the processes to provide drinking water facilities and services.

This triggered the research analysis to further understand and present in-depth decision making process indicators and sub-indicators were considered in order to understand to what extent and under what circumstances the additional factors influenced the decision making processes. Therefore, in addition to analysing the overall decision making processes that were followed by the HMWSSB in providing drinking water facilities and services, the focus group discussions were also steered to understand the factors determining the decisions taken by the HMWSSB in providing facilities and services to the selected slum areas.

The following sections illustrates a detailed qualitative analysis of indicators and sub-indicators and that were taken into consideration for the selected slum areas that were used during the stakeholder interviews and focus group discussions which were conducted at the institutional level to understand the decision making procedures at each of the selected slum areas in the current research study.

Socio-economic conditions (S1).

There was an analysis of the socio-economic conditions in all 34 of the 34 selected slum areas. 100% of the total slum areas in the Hyderabad city region were analysed and any decisions regarding the drinking water facilities and services included a socio-economic analysis. The table 37 illustrates the distribution of slum areas with respect to compliance levels of socio-economic analysis in decision making procedures.

Table 37: Consider socio-economic analysis in decision making processes

% Complied	Slum Area number
100%	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 27, 28, 29, 30, 31, 32, 33, 34

The information on socio-economic conditions were collected using multiple sources which included: (a) existing census data at city level collected once in 10 years, (b) socio-economic surveys conducted at city level on periodic basis, (c) household interviews or surveys conducted at slum areas level under any particular project and programme or on need basis during the decision making process, etc. These results were compliant when considering the amount of socio-economic analysis in all 34 selected slum areas during the decision making process to provide drinking water to the slum areas in the Hyderabad city region.

Health conditions (S2).

There was no analysis of the health conditions of the population in all 34 out of 34 selected slum areas. 100% of the total slum areas in the Hyderabad city region were analysed and no decisions regarding the drinking water facilities and services included the health conditions of the population. The table 38 illustrates the distribution of slum areas with respect to compliance levels of health conditions in decision making procedures.

Table 38: Consider health condition analysis in decision making processes

% Complied	Slum Area number
0%	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 27, 28, 29, 30, 31, 32, 33, 34

This information can be accumulated through household interviews, interviews or surveys with doctors in the area, surveys or focus group discussions on a need to know basis to understand the prevailing water-borne diseases. However, in all of the selected slum areas, these details were not collected and analysed during the decision making procedures. This shows that there was a level of non-compliance in considering the analysis of the health conditions of the slum citizens in all of these 34 selected slum areas during the decision making process.

Slum residents' involvement (S3).

The slum residents' concerns and the requirements were taken into consideration and thus they were involved in the decision making processes in 22 out of 34 selected slum areas, which is about 65% of the total slum areas in the Hyderabad city region. 12 out of 34 selected slum areas, which is about 35% of the total slum areas in the Hyderabad city region were not involved in the decision making processes their concerns and the requirements were not taken into account. The concerns and requirements of the slum citizens were collected by various stakeholders such as the Central Government, State Government, Non-Government Organisations, Media, Welfare Associations, Community Level Associations and Local Representatives. These stakeholders collected the concerns and requirements from the slum residents through household interviews, surveys or focus group discussions on a need to know basis. Therefore, the involvement of the slum residents was treated as an indirect involvement which was also limited in sharing the concerns and requirements through the external stakeholders. The results regarding the involvement of the slum residents in the decision making processes from 22 of the selected slum areas were partially compliant and the remaining 12 selected slum areas were non-compliant. The table 39 illustrates the distribution of slum areas with respect to compliance levels of involvement of slum residents in decision making procedures.

Table 39: Consider Slum residents' involvement in decision making processes

% Complied	Slum Area number
50%	2, 3, 4, 5, 6, 7, 12, 13, 14, 16, 17, 18, 19, 20, 21, 23, 24, 27, 31, 34, 35, 36
0%	1, 8, 9, 10, 11, 15, 22, 28, 29, 30, 32, 33

Policies, regulatory frameworks and procedures (I1).

There was an analysis of the availability of documents such as policies, regulatory frameworks and procedures. In all of the 34 selected slum areas, 100% of the total slum areas in the Hyderabad city region, the documents such as policies, regulatory frameworks and procedures were used during the decision making procedures to provide drinking water facilities and services to the slum citizens. The table 40 illustrates the distribution of slum areas with respect to compliance levels of policies, regulatory frameworks and procedures in decision making procedures.

Table 40: Consider policies, regulatory frameworks and procedures in decision making processes

% Complied	Slum Area number
50%	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 27, 28, 29, 30, 31, 32, 33, 34

These documents also took into consideration of governments' agenda, city development plans, sectoral plans, laws, regulations, procedures, standards and benchmarks, vision and mission statements, National and State level policies, etc. These details were collected through the existing documentation that was available from the HWMSSB and stakeholder consultations. Even though the various documentation was available, the decisions taken to provide drinking water facilities and services to the slum citizens did not meet the standards, benchmarks, policies and vision statements in terms of quality and quantity of drinking water supplied. Therefore, the current level of the amount of consideration given to these policies, regulatory frameworks and procedures by the HMWSSB were treated as partially compliant for all the slum areas in the Hyderabad city region.

Internal and external stakeholders' involvement (I2).

There was an analysis of the involvement of internal and external stakeholders in the decision making processes, 22 out of 34 selected slum areas, 65% of the total slum areas in the Hyderabad city region, have a significant involvement with both internal and external stakeholders' during the decision making processes in order to provide drinking water facilities and services. These internal stakeholders were comprised of the management and operational staff of the HMWSSB who handle various internal procedures and the external stakeholders included the active participation of the Central and State government agencies, non-governmental agencies, local welfare associations, local representatives and the media during the decision making procedures at HMWSSB. Hence, these 22 selected slum areas fall under the category of compliance when considering inputs from both internal and external stakeholders during the decision making procedures to provide drinking water. However, about 12 out of 34 selected slum areas, 35% had a limited involvement of both the internal and external stakeholders during the decision making processes. Only the HMWSSB staff actively participated in the decision making processes and there was no or limited involvement of external stakeholders to provide drinking water facilities and services which resulted in a non-compliance with this category of analysis in these 12 selected slum areas. The table 41 illustrates the distribution of slum areas with respect to compliance levels of involvement of external stakeholders in decision making procedures.

Table 41: Consider involvement of external stakeholders' in decision making processes

% Complied	Slum Area number
100%	2, 3, 4, 5, 6, 7, 12, 13, 14, 16, 17, 18, 19, 20, 21, 23, 24, 27, 31, 34, 35, 36

% Complied	Slum Area number
50%	1, 8, 9, 10, 11, 15, 22, 28, 29, 30, 32, 33

Capacities and Enforcements (I3).

There was an analysis of the capacities and enforcements which were considered during the decision making procedures. In all of the 34 selected slum areas, 100% of the total slum areas in the Hyderabad city region, took into consideration the capacities and enforcements during the decision making procedures to provide drinking water facilities and services to the slum citizens. The table 42 illustrates the distribution of slum areas with respect to compliance levels of capacities and enforcements in decision making procedures.

Table 42: Consider capacities and enforcements in decision making processes

% Complied	Slum Area number
50%	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 27, 28, 29, 30, 31, 32, 33, 34

The aspects that were considered during the decision making processes included: Analysis of the Institutional capacities in terms of staff skills and experience to formulate plans and designs, Implementing and monitoring of the projects, programs, schemes, etc., Analysis of enforcement mechanisms to collect the inputs on implementation options relating to drinking water facilities and services programs or projects. These details during the decision making procedures were collected through stakeholder consultations and existing secondary materials which were available at the HMWSS. The existing procedures did not take into account the analysis from the monitoring and evaluation options which was based on the lessons learnt from the previously implemented projects, programs or schemes in order to successfully implement projects and programs. Hence, the current level of consideration given to capacities and enforcements analysis were treated as partial in nature for all of the slum areas in the Hyderabad city region.

Resource analysis and planning (T1).

In all of the 34 selected slum areas, 100% of the total slum areas in the Hyderabad city region, the resource analysis and planning of resources were completely taken into account when making any decisions in order to provide the required drinking water facilities and services. The table 43 illustrates the distribution of slum areas with respect to compliance levels of resource analysis and planning in decision making procedures.

Table 43: Consider Resource analysis and planning in decision making processes

% Complied	Slum Area number
100%	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 27, 28, 29, 30, 31, 32, 33, 34

The information on resource analysis and planning typically included both at city and slum area level the analysis and planning of natural resources, man-made resources, financial resources, man-power resources, construction material, etc. The information for the analysis and planning were usually collected through existing secondary material at the HMWSSB and reconnaissance surveys at the city and slum area levels on a need to know basis during the decision making process. This results in compliance when considering resource analysis and planning for all 34 selected slum areas to provide drinking water facilities and services to the slum areas in the Hyderabad city region.

Requirements analysis and planning (T2).

14 out of 34 selected slum areas, 41% of the total slum areas in the Hyderabad city region, for which the analysis and planning of requirements for slum areas were collected during the decision making procedures in order to provide drinking water facilities and services. The inputs for the exercise on drinking water related requirements analysis and planning were collected from the slum residents through household interviews or surveys and focus group discussions at the slum area level on a need to know basis. The other source of inputs was received from external stakeholders such as government agencies, non-government agencies, local welfare associations, local representatives, and the media. These 14 selected slum areas fall under the category of compliance when considering the requirements analysis and planning during the decision making procedures to provide drinking water facilities and services.

In 20 out of 34 selected slum areas, 59% of the total slum areas analysis and planning of requirements related to drinking water facilities and services during the decision making procedures at HMWSSB was either not taken into consideration or taken into consideration in a limited way. The inputs were received from an external stakeholders' and the information that was considered was limited during any decision making processes by the internal stakeholders of the HMWSSB. This resulted in non-compliance when these aspects were taken into consideration for the 20 selected slum areas of Hyderabad city region. The table 44 illustrates the distribution of slum areas with respect to compliance levels of requirement analysis and planning in decision making procedures.

Table 44: Consider Requirement analysis and planning in decision making processes

% Complied	Slum Area number
100%	2, 3, 4, 5, 6, 11, 16, 19, 20, 23, 24, 31, 35, 36
50%	1, 7, 8, 9, 10, 12, 13, 14, 15, 17, 18, 21, 22, 27, 28, 29, 30, 32, 33, 34

Engineering and Innovation (T3).

There was an analysis of the engineering and innovation requirements for slum areas which were considered during the decision making procedures in all of the 34 selected slum areas, 100% of the slum areas in the Hyderabad city region, the analysis of engineering and innovation was completely considered while taking any decisions to provide drinking water facilities and services. The analysis of engineering aspects such as a detailed technical feasibility, engineering drawings and cost estimates were developed by the staff of HMWSSB in consultations with third party subject matter experts and consultants available in the market. The table 45 illustrates the distribution of slum areas with respect to compliance levels of engineering and innovation analysis in decision making procedures

Table 45: Consider Engineering and innovation analysis in decision making processes

% Complied	Slum Area number
100%	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 27, 28, 29, 30, 31, 32, 33, 34

The analysis and reporting of the engineering aspects were typically collected through field studies at the slum areas level and via secondary material from the HMWSSB and other related departments in the Hyderabad city region and the State. When the staff of the HMWSSB evaluate engineering aspects they also evaluate the available and feasible innovative technologies and options for drinking water infrastructure, resources and usage of information technology to improve the sustainability of the services that will be provided at the slum area level. The analysis of these aspects was typically collected through desk research of the best available practices and the inputs received through field studies at the slum area level. This shows that HMWSSB was compliant when considering the engineering and innovation aspects in all of the 34 selected slum areas during the decision making procedures to provide drinking water facilities and services to the slum areas in the Hyderabad city region.

Damage and Preventive costs for slum residents (E1, E2).

All 34 out of 34 selected slum areas, 100% of the total slum areas in the Hyderabad city region, did not make an analysis of the damage and the prevention costs incurred due to unsafe and insufficient drinking water when making during the decision processes at HWMSSB to provide drinking water facilities and services to slum citizens. If there were cases of damage costs, the particulars can usually be collected through household interviews or surveys and focus group discussions to understand the expenditure towards the loss of productivity and medical expenses that were incurred due to ill-health caused because of the existing drinking water facilities and services. Prevention cost information is able to be collected through household interviews or surveys and focus group discussions in order to understand how much money is given out towards purifying mechanisms and different sources of drinking water. This shows a level of non-compliance in considering the analysis of damage and prevention costs of the slum citizens in all of these 34 selected slum areas during the decision making procedures. The table 46 illustrates the distribution of slum areas with respect to compliance levels of damage and preventive cost analysis in decision making procedures.

Table 46: Consider damage and preventive cost analysis in decision making processes

% Complied	Slum Area number
0%	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 27, 28, 29, 30, 31, 32, 33, 34

Willingness to Accept and Pay (E3).

In all of the 34 selected slum areas, 100% of the total slum areas in the Hyderabad city region there was no analysis of the willingness and ability to pay for different interventions to improve the drinking water facilities and services in the decision making process at the HMWSSB to provide drinking water facilities and services to slum citizens. This information is able to be accumulated through household interviews or surveys and focus group discussions to understand the level of acceptance of the slum citizens to various plans and proposals which were developed by the HMWSSB in providing drinking water facilities and services and the willingness and ability to pay for better drinking water facilities and services. This shows a level of non-compliance in considering the analysis of willingness and ability to pay for better drinking water facilities and services by the slum citizens in all of the 34 selected slum areas during the decision making procedures The table 47 illustrates the distribution of slum areas with respect to compliance levels of willingness to pay or accept in decision making procedures.

Table 47: Consider willingness to pay or accept analysis in decision making processes

% Complied	Slum Area number
0%	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 27, 28, 29, 30, 31, 32, 33, 34

Prioritisation (O1).

About 17 out of 34 selected slum areas, 50% of the total slum areas in the Hyderabad city region for which the scare resources are prioritised to provide drinking water facilities and services basing on external influences. These external influences typically include the pressure from government agencies, non-government agencies, local associations and representatives, media, etc. during the decision making procedures to provide facilities and services to these 17 slum areas. Hence, these 17 slum areas fall under the category of compliance with prioritization of slum areas during the decision making procedures to provide facilities and services. However, for the remaining 17 selected slum areas, 50% of the total slum areas, there is no prioritisation given in providing drinking water facilities and services due to lack of any external influences during the decision making procedures at HMWSSB. The table 48 illustrates the distribution of slum areas with respect to compliance levels of prioritisation in decision making procedures.

Table 48: Consider prioritisation in decision making processes

% Complied	Slum Area number
100%	3, 4, 5, 6, 11, 13, 14, 16, 17, 18, 19, 20, 21, 24, 27, 35, 36
0%	1, 2, 7, 8, 9, 10, 12, 15, 22, 23, 28, 29, 30, 31, 32, 33, 34

Corresponding Analysis.

This section discusses the indicators and sub-indicators of the existing decision making processes of the HMWSSB by analysing the patterns across the slum areas and level of compliance of each indicator and sub-indicators. In order to perform this exercise, table 49 was developed by mapping the Indicators and sub-indicators that were discussed in the theoretical framework for a systematic and integrated decision making process to provide safe and adequate drinking water facilities and services, and to the extent of consideration of these indicators and sub-indicators in the existing decision making process of HMWSSB across all of the selected slum areas complying to the assessment criteria.

This analysis also included an additional factor prioritisation as part of assessment criteria across all the slum areas, which was to a degree included in the existing decision making processes at HMWSSB, but it was not initially part of this research's theoretical framework.

Table 49: Corresponding analysis

Indicators		Social			Institutional			Technical			Economic			-
Sub Indicators		S1	S2	S3	I1	I2	I3	T1	T2	T3	E1	E2	E3	O1
Slum areas	#	-												
C 1-S A	1	Y	N	N	P	P	P	Y	P	Y	N	N	N	N
C 1-S B	2	Y	N	P	P	Y	P	Y	Y	Y	N	N	N	N
C 2-S A	3	Y	N	P	P	Y	P	Y	Y	Y	N	N	N	Y
C 2-S B	4	Y	N	P	P	Y	P	Y	Y	Y	N	N	N	Y
C 3-S A	5	Y	N	P	P	Y	P	Y	Y	Y	N	N	N	Y
C 3-S B	6	Y	N	P	P	Y	P	Y	Y	Y	N	N	N	Y
C 4-S A	7	Y	N	P	P	Y	P	Y	P	Y	N	N	N	N
C 4-S B	8	Y	N	N	P	P	P	Y	P	Y	N	N	N	N
C 5-S A	9	Y	N	N	P	P	P	Y	P	Y	N	N	N	N
C 5-S B	10	Y	N	N	P	P	P	Y	P	Y	N	N	N	N
C 6-S A	11	Y	N	N	P	P	P	Y	Y	Y	N	N	N	Y
C 6-S B	12	Y	N	P	P	Y	P	Y	P	Y	N	N	N	N
C 7-S A	13	Y	N	P	P	Y	P	Y	P	Y	N	N	N	Y
C 7-S B	14	Y	N	P	P	Y	P	Y	P	Y	N	N	N	Y
C 8-S A	15	Y	N	N	P	P	P	Y	P	Y	N	N	N	N

Indicators		Social			Institutional			Technical			Economic			-
Sub Indicators		S1	S2	S3	I1	I2	I3	T1	T2	T3	E1	E2	E3	O1
Slum areas	#	-												
C 8-S B	16	Y	N	P	P	Y	P	Y	Y	Y	N	N	N	Y
C 9-S A	17	Y	N	P	P	Y	P	Y	P	Y	N	N	N	Y
C 9-S B	18	Y	N	P	P	Y	P	Y	P	Y	N	N	N	Y
C 10-S A	19	Y	N	P	P	Y	P	Y	Y	Y	N	N	N	Y
C 10-S B	20	Y	N	P	P	Y	P	Y	Y	Y	N	N	N	Y
C 11-S A	21	Y	N	P	P	Y	P	Y	P	Y	N	N	N	Y
C 11-S B	22	Y	N	N	P	P	P	Y	P	Y	N	N	N	N
C 12-S A	23	Y	N	P	P	Y	P	Y	Y	Y	N	N	N	N
C 12-S B	24	Y	N	P	P	Y	P	Y	Y	Y	N	N	N	Y
C 14-S A	27	Y	N	P	P	Y	P	Y	P	Y	N	N	N	Y
C 14-S B	28	Y	N	N	P	P	P	Y	P	Y	N	N	N	N
C 15-S A	29	Y	N	N	P	P	P	Y	P	Y	N	N	N	N
C 15-S B	30	Y	N	N	P	P	P	Y	P	Y	N	N	N	N
C 16-S A	31	Y	N	P	P	Y	P	Y	Y	Y	N	N	N	N
C 16-S B	32	Y	N	N	P	P	P	Y	P	Y	N	N	N	N
C 17-S A	33	Y	N	N	P	P	P	Y	P	Y	N	N	N	N
C 17-S B	34	Y	N	P	P	Y	P	Y	P	Y	N	N	N	N
C 18-S A	35	Y	N	P	P	Y	P	Y	Y	Y	N	N	N	Y
C 18-S B	36	Y	N	P	P	Y	P	Y	Y	Y	N	N	N	Y

Legend: Y (Compliant), P (Partially compliant), N (Non-compliant)

There were selected slum areas for which few indicators and sub-indicators were taken into consideration and other indicators and sub-indicators that were not taken into consideration during the decision making processes. There were only a few indicators and sub-indicators that were taken into consideration across all of the selected slum areas and a few indicators and sub-indicators that were not taken into consideration across all the slum areas during the decision making processes to provide drinking water facilities and services. In summary, taking into consideration the theoretical and observed points from Table 49, the following corresponding analysis patterns have been recognised and were discussed further in this chapter.

Consideration of indicators and sub-indicators across all the slum areas.

The analysis of socio-economic conditions (S1) was considered across all of the slum areas during the decision making processes in providing drinking water facilities and services to the slum areas in the Hyderabad city region. In addition, during the decision making processes, the HMWSSB also analysed and planned for the resources (T1) in order to provide drinking water facilities to the all the slum areas. During the same phase, the HMWSSB also prepared the reports regarding the engineering and innovation (T3) aspects. Across all of the slum areas a positive corresponding pattern was observed between taking into consideration the socio-economic conditions, resource analysis and planning and engineering and innovations. The slum areas where the socio-economic analysis was carried out, also carried out the resource analysis and planning and the analysis of engineering and innovations aspects and they were included in the decision making processes, and vice-versa.

Partial consideration of indicators and sub-indicators across all the slum areas.

The analysis of policies, regulatory frameworks and procedures (I1) was only partially considered across all of the slum areas during the decision making processes in providing drinking water facilities and services to the slum areas in the Hyderabad city region. The analysis of capacities and enforcements (I3) was also partially considered for all the slum areas in order to provide drinking water facilities and services during the decision making processes. In all of the slum areas there were positive corresponding patterns between the partial considerations of policies, regulatory frameworks and procedures and the analysis of capacities and enforcements. The slum areas where the policies, regulatory frameworks and procedures were partially considered, the analysis of capacities and enforcements were also partially considered in the decision making processes, and vice-versa.

Non-consideration of indicators and sub-indicators across all the slum areas.

The analysis of health conditions (S2) of the slum residents during the decision making process was not considered in order to provide drinking water facilities. The analysis pertaining to damage costs (E1) and the preventive costs (E2) incurred by the slum residents was also completely neglected during the decision making processes. The analysis pertaining to willingness and ability to pay and accept various potential improvements pertaining to the drinking water facilities and services was not carried out and thus neglected during the decision making processes. In all of the slum areas there was a positive corresponding pattern between the non-consideration of damage costs, preventive costs, willingness and ability to pay and accept various potential improvements. In the slum areas where there was no analysis of health conditions, the analysis of damage and preventive costs and willingness and ability to pay and accept various potential improvements were also not considered in the decision making processes, and vice-versa.

Variations in consideration levels of indicators and sub-indicators across all the slum areas.

The analysis of inputs from stakeholders (S3, I2) were not similar across all of the slum areas. In the slum areas where both internal and external stakeholders were involved and taken into consideration during the decision making processes (I2), it was found that there was also a positive corresponding pattern with the inputs of the slum residents' that were also taken into consideration (S3). A similar pattern of variations was also observed with the analysis and planning of drinking water facilities and service requirements (T2) for the slum residents across the slum areas. The analysis of requirements analysis and planning was not similar across all the slum areas. In the slum areas where they considered the inputs of all of the stakeholders (S3, I2), there was a positive corresponding pattern in terms of requirement analysis and planning and vice versa. The other important sub-indicator, priority analysis (O1), which was discovered to be important during the stakeholders' interviews and focus group discussions at HMWSSB, also had variations in whether they were taken into consideration which were similar to the above-mentioned sub-indicators and they were not the same across all of the slum areas. In the slum areas in which there was involvement of all of the stakeholders (S3, i2) during the decision making processes, there was also a corresponding positive relationship in terms of considering to prioritise the slum areas in order to provide drinking water facilities and services and vice versa.

In summary, the qualitative analysis of decision making processes in providing drinking water facilities and services to the slum areas in Hyderabad city region data was collected through focus group discussions and stakeholders' interviews by the HMWSSB (Hyderabad). It showed that only partial consideration was given to the socio-health aspects and institutional aspects in the process of providing drinking water facilities and services were taken into consideration. The analysis of technical aspects in the decision making processes by the HMWSSB were significantly taken into consideration. The socio-health aspects, institutional aspects and technical aspects were mutually connected to each other. If the institutional aspects were greatly taken into consideration, then the socio-health aspects were also greatly taken into consideration as well as the technical aspects during the decision making processes. If the institutional aspects were not taken into consideration, then the socio-health and technical aspects were not taken into consideration during the decision making processes. However, the existing decision making processes did not consider the economic aspects that were needed to provide safe and adequate drinking water facilities and services to the slum areas in the Hyderabad city region. In addition to the analysis of the above-mentioned aspects, prioritisation or priority analysis was carried out by the HMWSSB to provide drinking water facilities and services to the slum areas.

5.3. Slum household's perception of Decision making process

To further reinforce the stakeholders' analysis of the factors considered during the decision making procedures at institutional level, household level interviews were conducted to carry out perception analysis of the selected slum areas. The following section provides an analysis of the slum households perception of the decision making processes taking into consideration the indicators and sub-indicators that were used during the decision making procedures by the HMWSSB for each of the selected slum areas in the current research study.

Socio-economic conditions (S1).

157 out of 2,281, 7% of the households strongly agreed that the decisions made by the HMWSSB consider the socio-economic analysis to provide drinking water facilities and services. 580 out of 2,281, 23% of slum households agreed that the decisions made by the HMWSSB consider the socio-economic analysis to provide drinking water facilities and services. 200 out of 2,281, 10% of the slum households moderately agreed/ did not agree that the decisions made by the HMWSSB consider the socio-economic analysis to provide drinking water facilities and services. 243 out of 2,281, 11% of the slum households did not agree that the decisions made by the HMWSSB consider the socio-economic analysis to provide drinking water facilities and services. 1089 out of 2,281, 48% of households strongly did not agree that the decisions made by the HMWSSB consider the socio-economic analysis to provide drinking water facilities and services. The table 50 below translated the household perception analysis into the analysis of consideration levels at slum area level.

Table 50: Compliance levels of socio-economic conditions in decision making process

Level	Slum Area number
Compliance	5, 24, 7, 12, 21, 33, 4, 6, 17, 20, 25, 34
Partial compliance	23, 29, 2
Non-compliance	1, 32, 3, 8, 9, 10, 11, 13, 19, 22, 27, 28, 30, 31, 14, 15, 16, 18, 26
None	-

12 out of 34, 35% of the total slum areas in the Hyderabad city region completely considered that the socio-economic analysis was considered during the decision making procedures. 3 out of 34, 9% of the total slum areas in the Hyderabad city region partially considered that the socio-economic analysis was considered during the decision making procedures. 19 out of 34, 56% of the total slum areas in the Hyderabad city region did not consider the of socio-economic analysis was considered during the decision making processes.

Health conditions (S2).

4 out of 2,281, less than 1% of the slum households agreed that the decisions made by the HMWSSB considered the analysis of the health conditions in order to provide drinking water facilities and services. 68 out of 2,281, 3% of slum households did not agree that the decisions made by the HMWSSB considered the analysis of the health conditions in order to provide drinking water facilities and services. 2197 out of 2,281, 96% of the slum households strongly did not agree that the decisions made by the HMWSSB considered the analysis of the health conditions in order to provide drinking water facilities and services. The table 51 below translated the household perception analysis into the analysis of consideration levels at slum area levels.

Table 51: Compliance levels of health conditions in decision making process

Level	Slum Area number
Compliance	-
Partial compliance	-
Non-compliance	2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 18, 19, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 33, 34, 31, 16, 1, 17, 20, 32
None	-

34 out of 34 selected slum areas, 100% of the total slum areas in the Hyderabad city region did not consider that the health analysis was considered regarding the drinking water facilities and services during the decision making processes.

Slum residents' involvement (S3).

481 out of 2,281, 21% of the slum households strongly agreed that the decisions made by the HMWSSB included citizen participation in providing safe and adequate drinking water facilities and service to the slum areas in the Hyderabad city region. 552 out of 2,281, 24% of the slum households agreed that the decisions made by the HMWSSB included citizen participation in providing safe and adequate drinking water facilities and service to the slum areas in the Hyderabad city region. 231 out of 2,281, 10% of the slum households moderately agreed/ not agreed that the decisions made by the HMWSSB included citizen participation in providing safe and adequate drinking water facilities and service to the slum areas in the Hyderabad city region. 260 out of 2,281, 11% of the slum households did not agree that the decisions made by the HMWSSB included citizen participation in providing safe and adequate drinking water facilities and service to the slum areas in the Hyderabad city region. 722 out of 2,281, 32% of the slum households strongly did not agree that the decisions made by the HMWSSB included citizen participation in providing safe and adequate drinking water facilities and service to the slum areas in the Hyderabad city region. The table 52 below translated the household perception analysis into slum area level analysis.

Table 52: Compliance levels of slum residents' involvement in decision making process

Level	Slum Area number
Compliance	2, 5, 4, 7, 21, 24, 29, 16, 17, 32, 12, 13, 14, 18, 19, 23, 25, 34, 20, 3
Partial compliance	6, 33
Non-compliance	11, 1, 31, 8, 9, 10, 15, 22, 26, 27, 28, 30
None	-

20 out of 34, 59% of the selected slum areas in the Hyderabad city region felt that the slum residents' opinions were completely taken into consideration during the decision making procedures of the HMWSSB. 2 out of 34, 2% of the selected slum areas in the Hyderabad city region felt that the slum residents' opinions were partially considered during the

decision making procedures of the HMWSSB. 12 out of 34, 35% of the selected slum areas in the Hyderabad city region felt that the slum residents' opinions were not considered during the decision making procedures of the HMWSSB.

Policies, regulatory frameworks, and procedures (I1).

3 out of 2,281, less than 1% of the households strongly agreed that the decisions made by the HMWSSB are in line with the policies, regulatory frameworks and procedures to provide drinking water facilities and services. 49 out of 2,281 households, 2% of households agreed that the decisions made by the HMWSSB were in line with the policies, regulatory frameworks and procedures to provide drinking water facilities and services. 309 out of 2,281, 14% of the slum households moderately agreed/ not agreed that the decisions made by the HMWSSB were in line with the policies, regulatory frameworks and procedures to provide drinking water facilities and services. 790 out of 2,281, 35% of the slum households claimed that they did not agree that the decisions made by the HMWSSB were in line with the policies, regulatory frameworks and procedures to provide drinking water facilities and services. 1,097 out of 2,281, 48% of the slum households strongly did not agree that the decisions made by the HMWSSB were in line with the policies, regulatory frameworks and procedures to provide drinking water facilities and services. The table 53 below translated the household perception analysis into slum area level analysis.

Table 53: Compliance levels of policies, regulatory frameworks and procedures in decision making process

Level	Slum Area number
Compliance	2
Partial compliance	1, 6, 14, 15, 17, 18, 20, 32
Non-compliance	16, 26, 4, 5, 7, 8, 9, 10, 12, 13, 19, 21, 22, 23, 24, 25, 27, 28, 30, 33, 34, 11, 29, 3, 31
None	-

1 out of 34, 3% of the total slum areas in the Hyderabad city region agreed that the decisions made by the HMWSSB, during the decision making procedures were in line with the policies, regulatory frameworks and procedures to provide drinking water facilities and services. 8 out of 34, 24% of the total slum areas in the Hyderabad city region partially agreed that the decisions made by the HMWSSB, during the decision making procedures were in line with the policies, regulatory frameworks and procedures to provide drinking water facilities and services. 25 out of 34, 74% of the total slum areas in the Hyderabad city region did not agree that the decisions made by the HMWSSB, during the decision making procedures were in line with the policies, regulatory frameworks and procedures to provide drinking water facilities and services.

Internal and external stakeholders' involvement (I2).

481 out of 2,281, 21% of slum households strongly agreed that the decisions made by the HMWSSB included the participation of both internal and external stakeholders from the HWMSSB in order to provide the required drinking water facilities and services. 552 out of 2,281, 24% of the slum households agreed that the decisions made by the HMWSSB included the participation of both internal and external stakeholders from the HWMSSB in order to provide the required drinking water facilities and services. 231 out of 2,281, 10% of slum households moderately agreed/ not agreed that the decisions made by the HMWSSB included the participation of both internal and external stakeholders from the HWMSSB in order to provide the required drinking water facilities and services. 260 out of 2,281, 11% of slum households claim that they did not agree that the decisions made by the HMWSSB included the participation of both internal and external stakeholders from the HWMSSB in order to provide the required drinking water facilities and services. 722 out of 2,281, 32% of the slum households in the city region strongly did not agree that the decisions made by the HMWSSB included the participation of both internal and external stakeholders from the HWMSSB in order to provide the required drinking water facilities and services. The table 54 below translated the household perception analysis into slum area level analysis.

Table 54: Compliance levels of internal and external stakeholders' involvement in decision making process

Level	Slum Area number
Compliance	2, 5, 4, 7, 21, 24, 29, 16, 17, 32, 12, 13, 14, 18, 19, 23, 25, 34, 20, 3
Partial compliance	6, 33
Non-compliance	11, 1, 31, 8, 9, 10, 15, 22, 26, 27, 28, 30
None	-

20 out of 34, 59% of the total slum areas in the Hyderabad city region completely agreed that the HMWSSB included the participation of both internal and external stakeholders in the decision making processes in order to provide the required drinking water facilities and services. 2 out of 34, 2% of the total slum areas in the Hyderabad city region partially agreed that the HMWSSB included the participation of both internal and external stakeholders in the decision making processes in order to provide the required drinking water facilities and services. 12 out of 34, 35% of the total slum areas in the Hyderabad city region did not agree that the HMWSSB included the participation of both internal and external stakeholders in the decision making processes in order to provide the required drinking water facilities and services.

Capacities and Enforcements (I3).

3 out 2,281, less than 1% of the slum households strongly agreed that the decisions made by the HMWSSB considered the analysis of capacities and enforcements to provide safe and adequate drinking water facilities and services to the slum areas in the Hyderabad city region. 4 out of 2,281 households, less than 1% of the slum households agreed that the decisions made by the HMWSSB considered the analysis of capacities and enforcements to provide safe and adequate drinking water facilities and services to the slum areas in the Hyderabad city region. 2 out of 2,281 households, less than 1% of the slum households moderately agreed/ did not agree that the decisions made by the HMWSSB considered the analysis of capacities and enforcements to provide safe and adequate drinking water facilities and services to the slum areas in the Hyderabad city region. 294 out of 2,281, 13% of the households did not agree that the decisions made by the HMWSSB considered the analysis of capacities and enforcements to provide safe and adequate drinking water facilities and services to the slum areas in the Hyderabad city region. 1966 out of 2,281, 86% of the households strongly did not agree that the decisions made by the HMWSSB considered the analysis of capacities and enforcements to provide safe and adequate drinking water facilities and services to the slum areas in the Hyderabad city region. The table 55 below translated the household perception analysis into slum area level analysis.

Table 55: Compliance levels of capacities and enforcement in decision making process

Level	Slum Area number
Compliance	-
Partial compliance	-
Non-compliance	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34
None	-

34 out of 34, 100% of the total slum areas in the Hyderabad city region did not agree that in the decisions making processes the HMWSSB considered the analysis of capacities and enforcements to provide safe and adequate drinking water facilities and services to the slum areas in the Hyderabad city region

Resource analysis and planning (T1).

144 out of 2,281, 6% of the slum households strongly agreed that the decisions made by the HMWSSB took into consideration resource analysis and planning in providing drinking water facilities and services. 1952 out of 2,281, 86% of the slum households agreed that the decisions made by the HMWSSB took into consideration resource analysis and planning in providing drinking water facilities and services. 62 out of 2,281, 3% of the slum households moderately agreed/ did not agree that the decisions made by the HMWSSB took into consideration resource analysis and planning in providing drinking water facilities

and services. 110 out of 2,281, 5% of the slum households did not agree that the decisions made by the HMWSSB took into consideration resource analysis and planning in providing drinking water facilities and services. The table 56 below translated the household perception analysis into slum area level analysis.

Table 56: Compliance levels of resource analysis and planning in decision making process

Level	Slum Area number
Compliance	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34
Partial compliance	-
Non-compliance	-
None	-

34 out of 34, 100% of the total slum areas in the Hyderabad city region agreed that the HMWSSB took into consideration the analysis and planning of resources for drinking water facilities and services during the decision making processes.

Requirements analysis and planning (T2).

157 out of 2,281, 7% of the slum households strongly agreed that the decisions made by the HMWSSB took into consideration the analysis and planning of service requirements in order to provide drinking water facilities and services. 580 out of 2,281, 23% of the slum households agreed that the decisions made by the HMWSSB took into consideration the analysis and planning of service requirements in order to provide drinking water facilities and services. 200 out of 2,281, 10% of the slum households were moderately agreed/ did not agree that the decisions made by the HMWSSB took into consideration the analysis and planning of service requirements in order to provide drinking water facilities and services. 243 out of 2,281, 11% of the slum households did not agree that the decisions made by the HMWSSB took into consideration the analysis and planning of service requirements in order to provide drinking water facilities and services.1,089 out of 2,281, 48% of the slum households strongly did not agree that the decisions made by the HMWSSB took into consideration the analysis and planning of service requirements in order to provide drinking water facilities and services. The table 57 below translated the household perception analysis into slum area level analysis.

Table 57: Compliance levels of requirements analysis and planning in decision making process

Level	Slum Area number
Compliance	5, 24, 7, 12, 21, 33, 4, 6, 17, 20, 25, 34
Partial compliance	23, 29, 2
Non-compliance	1, 32, 3, 8, 9, 10, 11, 13, 19, 22, 27, 28, 30, 31, 14, 15, 16, 18, 26
None	-

12 out of 34, 35% of the total slum areas in the Hyderabad city region completely agreed that the HMWSSB took into consideration the analysis and planning of service requirements during the decision making processes. 3 out of 34, 9% of the total slum areas in the Hyderabad city region partially agreed that the HMWSSB took into consideration the analysis and planning of service requirements during the decision making processes. 19 out of 34, 56% of the total slum areas in the Hyderabad city region did not agree that the HMWSSB took into consideration the analysis and planning of service requirements during the decision making processes.

Engineering and Innovation (T3).

144 out of 2,281, 6% of the slum households in the Hyderabad city region strongly agreed that the decisions made by the HMWSSB to provide drinking water facilities and services included the aspects of engineering and innovation. 1,952 out 2,281, 86% of the slum households agreed that the decisions made by the HMWSSB to provide drinking water facilities and services included the aspects of engineering and innovation. 62 out of 2,281, 3% of the slum households moderately agreed/ did not agree that the decisions made by the HMWSSB to provide drinking water facilities and services included the aspects of engineering and innovation.110 out of 2,281, 5% of the slum households did not agree that the decisions made by the HMWSSB to provide drinking water facilities and services included the aspects of engineering and innovation. The table 58 below translated the household perception analysis into slum area level analysis.

Table 58: Compliance levels of engineering and innovation in decision making process

Level	Slum Area number
Compliance	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34
Partial compliance	-
Non-compliance	-
None	-

34 out of 34, 100% of the total slum areas completely agreed that the HMWSSB took into consideration aspects of engineering and innovation during the decision making procedures.

Damage and preventive costs for slum residents (E1, E2).

4 out of 2,281, less than 1% of the slum households agreed that the decisions made by the HMWSSB to provide drinking water facilities and services included the analysis of damage and preventive costs. 68 out of 2,281, 3% of the slum households did not agree that the decisions made by the HMWSSB to provide drinking water facilities and services included the analysis of damage and preventive costs.2197 out of 2,281, 96% of the slum households strongly did not agree that the decisions made by the HMWSSB to provide

drinking water facilities and services included the analysis of damage and preventive costs. The table 59 below translated the household perception analysis into slum area level analysis.

Table 59: Compliance levels of damage and preventive cost analysis in decision making process

Level	Slum Area number
Compliance	-
Partial compliance	-
Non-compliance	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34
None	-

34 out of 34, 100% of the total slum areas in the Hyderabad city region completely did not agree that damage and preventive costs of the slum citizens were taken into consideration during the decision making procedures of the HMWSSB in order to provide drinking water facilities and services.

Willingness to Accept and Pay (E3).

4 out of 2281, less than 1% of the slum households agreed that the decisions made by the HMWSSB included the analysis of the willingness to accept and pay for drinking water facilities and services. 6 out of 2281, less than 1% of the slum households did not agree that that the decisions made by the HMWSSB included the analysis of willingness to accept and pay for drinking water facilities and services. 2197 out of 2281, 96% of the slum households strongly did not agree that the decisions made by the HMWSSB included the analysis of willingness to accept and pay for drinking water facilities and services. The table 60 below translated the household perception analysis into slum area level analysis.

Table 60: Compliance levels of willingness to accept and pay in decision making process

Level	Slum Area number
Compliance	-
Partial compliance	-
Non-compliance	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34
None	-

34 out of 34, 100% of the total slum areas in the Hyderabad city region completely did not agree that the analysis of slum resident's willingness to accept and pay for drinking water facilities and services was taken into consideration during the decision making procedures of the HWMSSB. The box 12 illustrates the requirements of slum households with respect to drinking water facilities and services.

Box 12: What the slum households perceive that they require

During the household level interviews and focus group discussions, it was identified that the slum residents had specific ideas regarding what was important and not important in terms of the quality and quantity of drinking water facilities and services. The different requirements are listed below.

a. **Improving Individual taps facilities** – 844 out of 2,281, 37% of the slum population thought that it was not very important to improve the facilities and services of the water taps in the houses. 1255 out of 2,281, 55% of the slum population thought that it was extremely important to improve the facilities and services of the water taps in the houses. 182 out of 2,281, 8% of the slum population thought that it was semi important to improve the facilities and services of the water taps in the houses.

b. **Improving Public taps facilities.** 388 out of 2,281, 17% of slum population did not think that it was important to improve the facilities and services of the public taps. 890 out of 2,281, 39% of slum population thought that it was semi-important to improve the facilities and services of the public taps. 844 out to 2,281, 37% of slum population thought that it was extremely important to improve the facilities and services of the public water taps.

c. **Improve drinking water quality from Individual and Public facilities.** 1460 out of 2,281, 64% of the slum population thought that it was very important to improve the drinking water quality. 433 out of 2,281, 19% of the slum population thought that it was fairly important to improve the drinking water quality. 319 out of 2,281, 14% of the slum population thought that it was not important to improve the drinking water quality.

d. **Improve number of hours of drinking water supply from Individual and Public facilities.** 1026 out of 2,281, 45% of the slum population wanted to increase in number of hours of drinking water supplied per day. 570 out of 2,281, 25% of the slum population were neutral regarding increasing the number of hours of drinking water supplied per day. 411 out of 2,281, 18% of the slum population did not think that it was important to increase the number of hours of drinking water supply per day.

e. **Fixed timings of water supply and availability.** 1,255 out of 2,281, 55% of the slum population really wanted that the fixed timings of the availability of the water supply would improve. 456 out of 2,281, i.e., 20% of slum population were neutral regarding improvements of the fixed timings of the availability of the water supply. 502 out of 2,281, i.e., 22% of slum population thought that it was not important to improve the fixed timings of the availability of the water supply.

f. **24X7 water supply.** 547 out of 2,281, 24% of slum population wanted a 24X7 water supply. 935 out of 2,281, 41% of the slum population had a neutral standpoint on 24x7 water supply. 776 out of 2,281, 34% of the slum population did not want a 24X7 water supply.

g. **Decreasing water tariffs.** 684 out of 2,281, 30% of slum population were in favour of decreasing the water tariffs. 661 out of 2,281, 29% of slum population were not in favour of decreasing the water tariffs. 935 out of 2,281, 41% of slum population were neutral regarding decreasing the water tariffs.

h. **Increasing water tariffs**. 1232 out of 2,281, 54% of slum population were willing to pay additional water tariffs for improved water facilities and services. 935 out of 2,281, 41% of slum population were neutral about wanting the water tariffs to increase in price. 137 out of 2,281, 6% of slum population did not want the water tariffs to increase in price.

i. **Privatize water services** – 182 out of 2,281, 8% of slum population were completely in support of the privatisation of drinking water facilities and services. 616 out of 2,281, 27% of slum population were partially in support of the privatisation of drinking water facilities and services. 547 out of 2,281, 24% of slum population supported the idea of privatising the drinking water facilities and services.

During the household level interviews and focused group discussions, it was also identified that the slum residents are willing to pay additional amounts for improved drinking water facilities and services.

a. **Individual taps.** 228 out of 2,281, 10% of the slum residents were willing to pay between Rs. 51-100 extra for improved individual tap facilities and services. 1072 out of 2,281, 47% of the slum residents were willing to pay between Rs. 31-50 extra for improved individual tap facilities and services. 684 out of 2,281, 30% of the slum population were willing to additionally pay between Rs. 20-30 extra for improved individual tap facilities and services.

b. **Public taps.** There were no tariffs collected for public taps facilities and services. 319 out of 2,281, 14% of the slum residents were willing to pay between Rs. 20-30 INR for improved public tap water facilities and services.91 out of 2,281, 4% of the slum population were willing to pay between Rs. 31-50 INR for improved public tap water facilities and services.

c. **Borewells and Handpumps.** There were no charges paid to the government agencies for facilities and services related to water from bore wells and hand pumps.

d. **Water tankers.** There were no tariffs collected for drinking water supplied through water tankers.502 out of 2,281, 22% of the slum residents were willing to pay between Rs. 20-30 INR for improved facilities and services. 1118 out of 2,281, 49% of the slum residents were willing to pay between Rs. 31-50 INR for improved facilities and services.

Prioritization (O1).

244 out of 2281, 11% of slum households strongly agreed that the decisions made by the HMWSSB prioritise slum areas in providing drinking water facilities and services. 497 out of 2281, 22% of slum households agreed that the decisions made by the HMWSSB prioritise slum areas in providing drinking water facilities and services. 71 out of 2281 households, 3% of slum households moderately agreed/ did not agree that the decisions made by the HMWSSB prioritise slum areas in providing drinking water facilities and services. 253 out of 2281 households, 11% of slum households did not agree that the decisions made by the HMWSSB prioritise slum areas in providing drinking water facilities and services. 1202 out of 2281, 53% households strongly did not agree that the decisions made by the HMWSSB prioritise slum areas in providing drinking water facilities and services. The table 61 below translated the household perception analysis into slum area level analysis.

Table 61: Compliance levels of priority analysis in decision making process

Level	Slum Area number
Compliance	5, 19, 24, 33, 7, 12, 21, 4, 14, 25, 34
Partial compliance	29, 2, 20
Non-compliance	3, 8, 9, 10, 11, 13, 22, 23, 27, 28, 30, 16, 17, 31, 6, 15, 18, 26, 1
None	-

11 out 34, 32% of the total slum areas agreed that during the decisions processes carried out by the HMWSSB that they prioritised the slum areas regarding providing drinking water facilities and services. 2 out of 34, 9% of the total slum areas in the Hyderabad city region partially agreed that during the decisions processes carried out by the HMWSSB that they prioritised the slum areas regarding providing drinking water facilities and services. 20 out of 34, 59% of the total slum areas in the Hyderabad city region did not agree that during the decisions processes carried out by the HMWSSB that they prioritised the slum areas regarding providing drinking water facilities and services.

Corresponding analysis.

This section discusses the indicators and sub-indicators that were included in the existing decision making processes of the HMWSSB. It analysed the patterns throughout the slum areas and the levels of compliance of each indicator and sub-indicators. In order to perform this exercise Table 88 was developed, by mapping the indicators and sub-indicators that were discussed in the theoretical framework in order to show the systematic and integrated decision making processes that were used to provide safe and adequate drinking water facilities and services and also show the extent of the amount of consideration given to the indicators and sub-indicators of the existing decision making processes of the HMWSSB throughout all of the selected slum areas and whether they complied with the assessment criteria.

This analysis also included the additional factor prioritisation as part of the assessment criteria throughout all of the slum areas, which were part of the existing decision making processes at the HMWSSB but were not part of the current research’s theoretical framework.

Table 62: Corresponding analysis

Indicators		Social			Institutional			Technical			Economic			-
Sub Indicators		S1	S2	S3	I1	I2	I3	T1	T2	T3	E1	E2	E3	O1
Slum areas	#	-												-
C 1-S A	1	N	N	N	P	P	N	Y	N	Y	N	N	N	N
C 1-S B	2	P	N	Y	Y	Y	N	Y	P	Y	N	N	N	P
C 2-S A	3	N	N	Y	N	Y	N	Y	N	Y	N	N	N	N
C 2-S B	4	Y	N	Y	N	Y	N	Y	Y	Y	N	N	N	Y
C 3-S A	5	Y	N	Y	N	Y	N	Y	Y	Y	N	N	N	Y
C 3-S B	6	Y	N	Y	P	P	N	Y	Y	Y	N	N	N	N
C 4-S A	7	Y	N	Y	N	Y	N	Y	Y	Y	N	N	N	Y
C 4-S B	8	N	N	N	N	P	N	Y	N	Y	N	N	N	N
C 5-S A	9	N	N	N	N	P	N	Y	N	Y	N	N	N	N
C 5-S B	10	N	N	N	N	P	N	Y	N	Y	N	N	N	N
C 6-S A	11	N	N	N	N	P	N	Y	N	Y	N	N	N	N
C 6-S B	12	Y	N	Y	N	Y	N	Y	Y	Y	N	N	N	Y
C 7-S A	13	N	N	Y	N	Y	N	Y	N	Y	N	N	N	N
C 7-S B	14	N	N	Y	P	Y	N	Y	N	Y	N	N	N	Y
C 8-S A	15	N	N	N	P	P	N	Y	N	Y	N	N	N	N
C 8-S B	16	N	N	Y	N	Y	N	Y	N	Y	N	N	N	N
C 9-S A	17	Y	N	Y	P	Y	N	Y	Y	Y	N	N	N	N
C 9-S B	18	N	N	Y	P	Y	N	Y	N	Y	N	N	N	N
C 10-S A	19	N	N	Y	N	Y	N	Y	N	Y	N	N	N	Y
C 10-S B	20	Y	N	Y	P	Y	N	Y	Y	Y	N	N	N	P
C 11-S A	21	Y	N	Y	N	Y	N	Y	Y	Y	N	N	N	Y
C 11-S B	22	N	N	N	N	P	N	Y	N	Y	N	N	N	N
C 12-S A	23	P	N	Y	N	Y	N	Y	P	Y	N	N	N	N
C 12-S B	24	Y	N	Y	N	Y	N	Y	Y	Y	N	N	N	Y
C 14-S A	27	Y	N	Y	N	Y	N	Y	Y	Y	N	N	N	Y
C 14-S B	28	N	N	N	N	P	N	Y	N	Y	N	N	N	N
C 15-S A	29	N	N	N	N	P	N	Y	N	Y	N	N	N	N
C 15-S B	30	N	N	N	N	P	N	Y	N	Y	N	N	N	N
C 16-S A	31	P	N	Y	N	Y	N	Y	P	Y	N	N	N	P
C 16-S B	32	N	N	N	N	P	N	Y	N	Y	N	N	N	N
C 17-S A	33	N	N	N	N	P	N	Y	N	Y	N	N	N	N
C 17-S B	34	N	N	Y	P	Y	N	Y	N	Y	N	N	N	N
C 18-S A	35	Y	N	Y	N	P	N	Y	Y	Y	N	N	N	Y
C 18-S B	36	Y	N	Y	N	Y	N	Y	Y	Y	N	N	N	Y

Legend: Y (Compliant), P (Partially compliant), N (Non-compliant)

There were few slum areas for which certain indicators and sub-indicators were considered and other indicators and sub-indicators were not considered during the decision making procedures. Similarly, some indicators and sub-indicators were considered throughout all of the slum areas and other indicators and sub-indicators were not considered throughout all the slum areas during the decision making processes to provide drinking water facilities and services. In summary, considering the theoretical and observed points from Table 62, the following corresponding analysis patterns were recognised and discussed.

Consideration of indicators and sub-indicators across all the slum areas.

The analysis of resource analysis and planning (T1) was considered throughout all of the slum areas during the decision making process in providing drinking water facilities and services to the slum areas in the Hyderabad city region. During the same phase of decision making processes, the HMWSSB also prepared detailed reports pertaining to engineering and innovation (T3) aspects. Throughout all of the slum areas there were positive corresponding patterns between the considerations for resource analysis, planning, engineering and innovations.

Non-consideration of indicators and sub-indicators across all the slum areas.

The analysis of the health conditions (S2) of the slum residents during the decision making processes in order to provide drinking water facilities were not considered. The analysis pertaining to damage costs (E1) and preventive costs (E2) incurred by the slum residents were also completely neglected during the decision making processes at HMWSSB. The analysis pertaining to the willingness to pay and accept various potential improvements pertaining to drinking water facilities and services were not carried out by the HMWSSB during the decision making processes.

The analysis of policies, regulatory frameworks and procedures (I1) were also not considered throughout the slum areas during the decision making processes in providing drinking water facilities and services to the slum areas in the Hyderabad city region. The analysis of capacities and enforcements (i3) were not considered for all of the slum areas to provide drinking water facilities and services during the decision making processes.

Throughout all of the slum areas there were positive corresponding patterns between the non-considerations of policies, regulatory frameworks and procedures, the analysis of capacities and enforcements, damage costs, preventive costs, willingness to pay and accept and health conditions.

Variations in consideration levels of indicators and sub-indicators across all the slum areas.

The analysis of inputs from stakeholders (S3, i2) were not similar throughout all the slum areas. In the slum areas where the inputs from both the internal and external stakeholders’ that were involved were considered (i2), there was also a positive corresponding pattern that related to the inputs from slum residents' involvement (S3), during the decision making processes at HMWSSB in order to provide drinking water facilities and services to the slum areas in the Hyderabad city region.

A similar pattern of variations was also observed regarding the analysis and planning of drinking water facilities and service requirements (T2) and the socio-economic conditions (S1) of the slum residents throughout the slum areas. The requirement analysis, planning and socio-economic conditions were not similar throughout all of the slum areas. There were positive corresponding patterns between socio-economic conditions and requirement analysis and planning.

The slum areas where requirement analysis and planning were carried out during the decision making processes, an analysis of socio-economic conditions were also collected. In the slum areas that thought that there were inputs from all of the stakeholders (S3, I2), there were also positive corresponding patterns in terms of socio-economic conditions and requirement analysis and planning. In the slum areas where there were considered to be significant inputs from all of the stakeholders, the HMWSSB also conducted the analysis of socio-economic conditions and requirements.

An important sub-indicator; priority analysis (O1), was discovered during the stakeholders' interviews and focus group discussions at HMWSSB. Priority analysis was similar to the above-mentioned sub-indicators which were not the same throughout all of the slum areas, different priorities were considered more or less important depending on the slum area. The slum areas for which the slum dwellers thought that the stakeholders were involved (S3, I2) during the decision making processes to provide drinking water facilities and services, there was also a corresponding positive relationship in terms of considering the prioritisation of slum areas in providing drinking water facilities and services and vice versa.

In summary, the households' perception analysis of decision making processes in providing drinking water facilities and services to the slum areas in Hyderabad city region, was collected through focus group discussions and interviews. It showed that there was limited consideration taken for the socio-health aspects and institutional aspects in the decision making processes by the HMWSSB to provide drinking water facilities and services.

The technical aspects in the decision making processes at HMWSSB were significantly considered during the decision making processes. The level of consideration that was taken regarding the socio-health aspects, institutional aspects and technical aspects were mutually associated with each other. For example, the more the institutional aspects were taken into consideration, the more the socio-health aspects and the technical aspects were taken into consideration during the decision making processes.

However, the existing decision making processes did not consider that the slum dwellers would be willing to pay more for safe and adequate drinking water facilities and services to the slum areas in the Hyderabad city region. In addition to the analysis of the above-mentioned aspects, priority analysis was carried out at HMWSSB to provide drinking water facilities and services to the slum areas.

5.4. Comparative analysis

The section of the study has been developed by mapping the indicators and sub-indicators discussed in the theoretical framework for a systematic and integrated decision making process to provide safe and adequate drinking water facilities and services and to what extent indicators and sub-indicators of the existing decision making process of HMWSSB across all the selected slum areas complies with the assessment criteria identified through stakeholders' analysis and household perceptions' analysis. The following table 63 illustrates the comparative analysis between these two sets of results.

The analysis of the stakeholders' interviews at institutional level and the perception analysis of slum area households revealed trifling unalike corresponding patterns on the aspects pertaining to sub-indicators and indicators which were considered during the decision making process in order to provide drinking water facilities and services to the slum areas. From the table above relating to identification of the extent (level of compliance) to which the parameters (sub-indicators) were considered in the decision making processes in providing drinking water facilities and services to the slum areas in the Hyderabad city region, there were limitations in terms of considering health conditions (S2), policies, damage costs (E1), Preventive costs (E2) and Willingness to accept and pay (E3). The decision making processes considered the inputs from resource analysis and planning (T1) and engineering and innovation aspects (T3) in order to provide drinking water facilities and services. The stakeholders' analysis and the perception analysis showed similar results for these aspects of consideration during the decision making procedures.

There were significant differences among the selected slum areas in terms of considering the inputs from the regulatory frameworks and procedures (i1), capacities and enforcements (i3), involvement of stakeholders (S3, I2), socio-economic conditions (S1), requirements analysis and planning (T2) and prioritisation (O1). There were certain selected slum areas in which these aspects were considered and certain selected slum areas in which these aspects were not considered during the decision making processes.

Table 63: Results comparison between perception analysis (A) and stakeholders' analysis (B)

Indicators		Social						Institutional						Technical						Economic						-	
Sub Indicators		S1		S2		S3		I1		I2		I3		T1		T2		T3		E1		E2		E3		O1	
Analysis source		A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Slum areas	#																										
Circle 1 _ Slum A	1	N	Y	N	N	N	N	P	P	P	P	N	P	Y	Y	N	P	Y	Y	N	N	N	N	N	N	N	N
Circle 1 _ Slum B	2	P	Y	N	N	Y	P	Y	P	Y	Y	N	P	Y	Y	P	Y	Y	Y	N	N	N	N	N	N	P	N
Circle 2 _ Slum A	3	N	Y	N	N	Y	P	N	P	Y	Y	N	P	Y	Y	N	Y	Y	Y	N	N	N	N	N	N	N	Y
Circle 2 _ Slum B	4	Y	Y	N	N	Y	P	N	P	Y	Y	N	P	Y	Y	Y	Y	Y	Y	N	N	N	N	N	N	Y	Y
Circle 3 _ Slum A	5	Y	Y	N	N	Y	P	N	P	Y	Y	N	P	Y	Y	Y	Y	Y	Y	N	N	N	N	N	N	Y	Y
Circle 3 _ Slum B	6	Y	Y	N	N	Y	P	P	P	P	Y	N	P	Y	Y	Y	Y	Y	Y	N	N	N	N	N	N	N	Y
Circle 4 _ Slum A	7	Y	Y	N	N	Y	P	N	P	Y	Y	N	P	Y	Y	Y	P	Y	Y	N	N	N	N	N	N	Y	N
Circle 4 _ Slum B	8	N	Y	N	N	N	N	N	P	P	P	N	P	Y	Y	N	P	Y	Y	N	N	N	N	N	N	N	N
Circle 5 _ Slum A	9	N	Y	N	N	N	N	N	P	P	P	N	P	Y	Y	N	P	Y	Y	N	N	N	N	N	N	N	N
Circle 5 _ Slum B	10	N	Y	N	N	N	N	N	P	P	P	N	P	Y	Y	N	P	Y	Y	N	N	N	N	N	N	N	N
Circle 6 _ Slum A	11	N	Y	N	N	N	N	N	P	P	P	N	P	Y	Y	N	Y	Y	Y	N	N	N	N	N	N	N	Y
Circle 6 _ Slum B	12	Y	Y	N	N	Y	P	N	P	Y	Y	N	P	Y	Y	Y	P	Y	Y	N	N	N	N	N	N	Y	N
Circle 7 _ Slum A	13	N	Y	N	N	Y	P	N	P	Y	Y	N	P	Y	Y	N	P	Y	Y	N	N	N	N	N	N	N	Y
Circle 7 _ Slum B	14	N	Y	N	N	Y	P	P	P	Y	Y	N	P	Y	Y	N	P	Y	Y	N	N	N	N	N	N	Y	Y
Circle 8 _ Slum A	15	N	Y	N	N	N	N	P	P	P	P	N	P	Y	Y	N	P	Y	Y	N	N	N	N	N	N	N	N
Circle 8 _ Slum B	16	N	Y	N	N	Y	P	N	P	Y	Y	N	P	Y	Y	N	Y	Y	Y	N	N	N	N	N	N	N	Y
Circle 9 _ Slum A	17	Y	Y	N	N	Y	P	P	P	Y	Y	N	P	Y	Y	Y	P	Y	Y	N	N	N	N	N	N	N	Y
Circle 9 _ Slum B	18	N	Y	N	N	Y	P	P	P	Y	Y	N	P	Y	Y	N	P	Y	Y	N	N	N	N	N	N	N	Y
Circle 10 _ Slum A	19	N	Y	N	N	Y	P	N	P	Y	Y	N	P	Y	Y	N	Y	Y	Y	N	N	N	N	N	N	Y	Y
Circle 10 _ Slum B	20	Y	Y	N	N	Y	P	P	P	Y	Y	N	P	Y	Y	Y	Y	Y	Y	N	N	N	N	N	N	P	Y
Circle 11 _ Slum A	21	Y	Y	N	N	Y	P	N	P	Y	Y	N	P	Y	Y	Y	P	Y	Y	N	N	N	N	N	N	Y	Y
Circle 11 _ Slum B	22	N	Y	N	N	N	N	N	P	P	P	N	P	Y	Y	N	P	Y	Y	N	N	N	N	N	N	N	N
Circle 12 _ Slum A	23	P	Y	N	N	Y	P	N	P	Y	Y	N	P	Y	Y	P	Y	Y	Y	N	N	N	N	N	N	N	N
Circle 12 _ Slum B	24	Y	Y	N	N	Y	P	N	P	Y	Y	N	P	Y	Y	Y	Y	Y	Y	N	N	N	N	N	N	Y	Y
Circle 14 _ Slum A	27	Y	Y	N	N	Y	P	N	P	Y	Y	N	P	Y	Y	Y	P	Y	Y	N	N	N	N	N	N	Y	Y
Circle 14 _ Slum B	28	N	Y	N	N	N	N	N	P	P	P	N	P	Y	Y	N	P	Y	Y	N	N	N	N	N	N	N	N
Circle 15 _ Slum A	29	N	Y	N	N	N	N	N	P	P	P	N	P	Y	Y	N	P	Y	Y	N	N	N	N	N	N	N	N
Circle 15 _ Slum B	30	N	Y	N	N	N	N	N	P	P	P	N	P	Y	Y	N	P	Y	Y	N	N	N	N	N	N	N	N

Indicators		Social						Institutional						Technical						Economic						-	
Sub Indicators		S1		S2		S3		I1		I2		I3		T1		T2		T3		E1		E2		E3		O1	
Circle 16 _ Slum A	31	P	Y	N	N	Y	P	N	P	Y	Y	N	P	Y	Y	P	Y	Y	Y	N	N	N	N	N	N	P	N
Circle 16 _ Slum B	32	N	Y	N	N	N	N	N	P	P	P	N	P	Y	Y	N	P	Y	Y	N	N	N	N	N	N	N	N
Circle 17 _ Slum A	33	N	Y	N	N	N	N	N	P	P	P	N	P	Y	Y	N	P	Y	Y	N	N	N	N	N	N	N	N
Circle 17 _ Slum B	34	N	Y	N	N	Y	P	P	P	Y	Y	N	P	Y	Y	N	P	Y	Y	N	N	N	N	N	N	N	N
Circle 18 _ Slum A	35	Y	Y	N	N	Y	P	N	P	P	Y	N	P	Y	Y	Y	Y	Y	Y	N	N	N	N	N	N	Y	Y
Circle 18 _ Slum B	36	Y	Y	N	N	Y	P	N	P	Y	Y	N	P	Y	Y	Y	Y	Y	Y	N	N	N	N	N	N	Y	Y

Legend: A: Slum residents’ perception analysis; B: Institutional level stakeholders’ analysis; Y: Compliant; P: Partial compliant; N: Not compliant; S1: Socio-economic conditions; S2: Health conditions; S3: Slum residents’ involvement; I1: Policies, regulatory frameworks, and procedures; I2: Internal and external stakeholders’ involvement; I3: Capacities and enforcements; T1: Resource analysis and planning; T2: Requirements analysis and planning; T3: Engineering and Innovation; E1: Damage costs; E2: Preventive costs; E3: Willingness/ ability to accept/ pay.

There were variations in how much something was considered during the decision making processes of the mentioned aspects, these variations were observed in both the stakeholders' analysis and the perception analysis. A close comparison of the analysis of independent variable revealed from these two sources of information had the following variations and similarities which have been detailed in the table 64 below.

Table 64: Comparison of the analysis of Independent variables

Indicators and Sub-Indicators	Stakeholders' interviews at institutional level (A)	Perception analysis of households at slum area level (B)	Variations between (A) and (B)
Socio-economic conditions (S1)	Analysis of socio-economic conditions were considered for all of slum areas	Analysis of socio-economic conditions were not considered in a few slum areas	The level of compliance varied between the various slum areas
Health conditions (S2)	Analysis of health conditions were not considered for all of the slum areas	Analysis of Health conditions were not considered for all of the slum areas	None
Slum residents' involvement (S3)	Analysis of inputs considered from the involvement of slum residents were not the same across all of the slum areas	Analysis of inputs considered from the involvement of slum residents were not same across all of the slum areas	The level of compliance varied between the slum areas
Policies, regulatory frameworks and procedures (i1)	Analysis of inputs considered from the policies, regulatory frameworks and procedures were the same across all of the slum areas	Analysis of inputs from the policies, regulatory frameworks and procedures were not considered for the slum areas	The level of compliance varied between the slum areas
Involvement of internal and external stakeholders' (i2)	Analysis of inputs considered from the involvement of internal and external stakeholders were not the same across all the slum areas	Analysis of inputs considered from the involvement of internal and external stakeholders were not the same across all the slum areas	The level of compliance varied between the slum areas
Capacities and enforcements (i3)	Analysis of inputs from capacities and enforcements were partially considered for all the slum area	Analysis of inputs from capacities and enforcements were not considered for all the slum areas	The level of compliance varied between the slum areas
Resource analysis and planning (T1)	Analysis of inputs considered from resource analysis and planning were the same for all of the slum areas	Analysis of inputs considered from resource analysis and planning were the same for all of the slum areas	None
Requirements analysis and planning (T2)	Analysis of inputs considered from requirements analysis and planning were not same across all the slum areas	Analysis of inputs considered from requirements analysis and planning were not same across all the slum areas	The level of compliance varied between the slum areas
Engineering and innovation (T3)	Analysis of inputs considered from engineering and	Analysis of inputs considered from engineering and	None

Indicators and Sub-Indicators	Stakeholders’ interviews at institutional level (A)	Perception analysis of households at slum area level (B)	Variations between (A) and (B)
	Innovation were the same for all of the slum areas	Innovation were the same for all of the slum areas	
Damage Costs (E1)	Analysis of damage costs were not considered for all of the slum areas	Analysis of damage costs were not considered for all of the slum areas	None
Preventive Costs (E2)	Analysis of preventive costs were not considered for all of the slum areas	Analysis of preventive costs were not considered for all of the slum areas	None
Willingness to Accept or Pay (E3)	Analysis of willingness to accept / pay were not considered for all of the slum areas	Analysis of willingness to accept / pay were not considered for all of the slum areas	None
Prioritisation (O1)	Analysis of priority considered was not the same for all of the slum areas	Analysis of priority considered was not the same for all of the slum areas	The level of compliance varied between the slum areas

Considering that there were certain variations in the findings between the stakeholders’ analysis and perception analysis regarding the factors that were considered during the decision making procedures, it was necessary to combine these results to arrive at a congruence. In order to conglomerate the results from these two information sources, both of the tables (refer table no. 49, 62) were grouped as per the overlapping scales which have been defined in table 65 below.

Table 65: Combinations of compliance levels

Stakeholders / Perception analysis compliance levels	Stakeholders / Perception analysis compliance levels	Combined compliance levels
Compliance (Y)	Compliance (Y)	Compliance (Y)
Compliance (Y)	Partial Compliance (P)	Partial Compliance (P)
Compliance (Y)	Non-Compliance (N)	Partial Compliance (P)
Partial Compliance (P)	Compliance (Y)	Partial Compliance (P)
Partial Compliance (P)	Partial Compliance (P)	Partial Compliance (P)
Partial Compliance (P)	Non-Compliance (N)	Partial Compliance (P)
Non-Compliance (N)	Compliance (Y)	Partial Compliance (P)
Non-Compliance (N)	Partial Compliance (P)	Partial Compliance (P)
Non-Compliance (N)	Non-Compliance (N)	Non-Compliance (N)

The level of compliance from the stakeholders’ analysis was combined with the level of compliance from the perception analysis for the corresponding indicators and sub-indicators in the selected slum areas to arrive at consolidated results on factors that were considered during the decision making processes. Based on this exercise, Table 66 in chapter 6 was generated which provides the consolidated results on the levels of compliance of the definite sub-indicators during the decision making processes of

HMWSSB for analysing the patterns across the slum areas and the level of compliance of each indicator and sub-indicator.

Chapter 6

Relationship between Independent and Dependent variables

Chapter 6 | Relationship between Independent and Dependent variables

This section of the study shows the relationship between the indicators and sub-indicators which were discussed in the theoretical framework for quality and quantity of drinking water and to what extent there is a relationship between the existing decision making process of HMWSSB and the quality and quantity of drinking water across the slum areas of the Hyderabad city region. The table 66 below illustrates the relationship between the independent and dependent variables.

Table 66: Relationship between the Independent and Dependent variables

Variables		Independent													Dependent	
Indicators		Social			Institutional			Technical			Economic			-	Quantity	Quality
Sub Indicators		S1	S2	S3	I1	I2	I3	T1	T2	T3	E1	E2	E3	O1	-	-
Slum areas	#	-												-	-	-
C1_SA	1	P	N	P	P	P	P	Y	P	Y	N	N	N	N	N	N
C1_SB	2	P	N	Y	P	Y	P	Y	P	Y	N	N	N	P	N	N
C2_SA	3	P	N	Y	P	Y	P	Y	P	Y	N	N	N	P	Y	Y
C2_SB	4	Y	N	Y	P	Y	P	Y	Y	Y	N	N	N	Y	Y	Y
C3_SA	5	Y	N	Y	P	Y	P	Y	Y	Y	N	N	N	Y	Y	Y
C3_SB	6	Y	N	Y	P	P	P	Y	Y	Y	N	N	N	P	Y	Y
C4_SA	7	Y	N	Y	P	Y	P	Y	Y	Y	N	N	N	P	Y	Y
C4_SB	8	P	N	P	P	P	P	Y	P	Y	N	N	N	N	Y	N
C5_SA	9	P	N	P	P	P	P	Y	P	Y	N	N	N	N	N	N
C5_SB	10	P	N	P	P	P	P	Y	P	Y	N	N	N	N	N	N
C6_SA	11	P	N	P	P	P	P	Y	P	Y	N	N	N	P	N	N
C6_SB	12	Y	N	Y	P	Y	P	Y	Y	Y	N	N	N	P	Y	Y
C7_SA	13	P	N	Y	P	Y	P	Y	P	Y	N	N	N	P	Y	N
C7_SB	14	P	N	Y	P	Y	P	Y	P	Y	N	N	N	Y	Y	Y
C8_SA	15	P	N	P	P	P	P	Y	P	Y	N	N	N	P	N	N
C8_SB	16	P	N	Y	P	Y	P	Y	P	Y	N	N	N	P	Y	N
C9_SA	17	Y	N	Y	P	Y	P	Y	Y	Y	N	N	N	P	Y	N
C9_SB	18	P	N	Y	P	Y	P	Y	P	Y	N	N	N	P	Y	N
C10_SA	19	P	N	Y	P	Y	P	Y	P	Y	N	N	N	P	Y	Y
C10_SB	20	Y	N	Y	P	Y	P	Y	Y	Y	N	N	N	P	Y	N
C11_SA	21	Y	N	Y	P	Y	P	Y	Y	Y	N	N	N	P	Y	N
C11_SB	22	P	N	P	P	P	P	Y	P	Y	N	N	N	N	Y	N
C12_SA	23	P	N	Y	P	Y	P	Y	P	Y	N	N	N	N	N	N
C12_SB	24	Y	N	Y	P	Y	P	Y	Y	Y	N	N	N	Y	Y	Y
C14_SA	27	Y	N	Y	P	Y	P	Y	Y	Y	N	N	N	Y	Y	Y
C14_SB	28	P	N	P	P	P	P	Y	P	Y	N	N	N	N	N	N
C15_SA	29	P	N	P	P	P	P	Y	P	Y	N	N	N	N	N	N
C15_SB	30	P	N	P	P	P	P	Y	P	Y	N	N	N	N	N	N

Variables		Independent													Dependent	
Indicators		Social			Institutional			Technical			Economic			-	Quantity	Quality
Sub Indicators		S1	S2	S3	I1	I2	I3	T1	T2	T3	E1	E2	E3	O1	-	-
C 16 _ S A	31	P	N	Y	P	Y	P	Y	P	Y	N	N	N	P	N	N
C 16 _ S B	32	P	N	P	P	P	P	Y	P	Y	N	N	N	N	N	N
C 17 _ S A	33	P	N	P	P	P	P	Y	P	Y	N	N	N	N	N	N
C 17 _ S B	34	P	N	Y	P	Y	P	Y	P	Y	N	N	N	N	N	Y
C 18 _ S A	35	Y	N	Y	P	P	P	Y	Y	Y	N	N	N	Y	Y	Y
C 18 _ S B	36	Y	N	Y	P	Y	P	Y	Y	Y	N	N	N	Y	Y	Y

Legend: Y (Compliant), P (Partially compliant), N (Non-compliant)

Variations among slum areas in quality and quantity of drinking water.

The focus group discussions and the stakeholders’ interviews at the institutional level (HMWSSB) and perception analysis of households in the slum areas of Hyderabad city region disclosed a close connection between the **availability of adequate quality and quantity of drinking water and the level of stakeholders’ involvement** during the decision making processes of the HMWSSB.

Referring to the Table 66, it can vividly be perceived that the selected slum areas in the Hyderabad city region for which there was a relatively adequate quality and quantity of drinking water, had a corresponding positive relationship with the participation of the stakeholders’, which included slum residents, external stakeholders and internal stakeholders, in the decision making processes and vice versa.

In the slum areas where there was a significant level of participation by the stakeholders’, there was a relatively adequate quality and quantity of drinking water in those slum areas and vice versa. In the perception analysis of the slum residents from the selected slum areas pertaining to the quality and quantity of drinking water, it can be stated that more than 50% of the slum areas had access to a relatively good quality and quantity of drinking water for which there was a significant involvement of stakeholders during the decision making process.

Anecdotal evidence collected during the household interviews in the slum areas in the Hyderabad city region testified that the role of stakeholders’ participation plays a significant part in the decision making processes by the HMWSSB and eventually in providing a good quality and quantity of drinking water facilities and services.

> One of the slum residents, during the household interviews said that “*We have to be vocal about the drinking water quality and quantity challenges we encounter on regular basis without which the HMWSSB will not take any actions. Our locality does not have any local groups and welfare associations which is*

> *making it difficult to voice our opinions to the HMWSSB. There are, however, some slum areas nearby, having strong community level associations. The members of these associations will maintain good relations and communications with the elected local representatives and even with HMWSSB to resolve challenges and meet the requirements of the slum residents pertaining to drinking water and other infrastructure facilities and services on need basis*" (Slum resident, Circle 5 _ Slum B, Hyderabad, 20-25 April 2017).

The analysis from the two sources, namely the perception analysis of slum residents and focused group discussions at HMWSSB, also disclosed that there was a close connection between the availability of relatively adequate **quality and quantity drinking water and the level of consideration given to the socio-economic conditions, and requirements analysis and planning** during the decision making processes of HMWSSB.

Referring to the table 66 in the previous section, it can be observed that the selected slum areas in the Hyderabad city region where there was a relatively adequate quality and quantity of drinking water, has a corresponding positive relation with the level of consideration given to the socio-economic conditions and requirements analysis and planning in the decision making process and vice versa.

The slum areas for which there is significant level of consideration given to the requirements analysis and socio-economic analysis, there is adequate (relative) quality and quantity of drinking water in the slum areas and vice versa. According to the perception analysis of the slum residents it can be observed that about 50% of the slum areas had access to a relatively good quality and quantity of drinking water facilities and services for which there were significant levels of consideration given to the analysis pertaining to socio-economic conditions and requirements analysis and planning during the decision making processes.

The anecdotes below strongly indicate that the level of consideration given to the socio-economic conditions and requirements analysis play a significant role in having an adequate quality and quantity of drinking water.

> One of the slum residents, during the focused group discussions claimed that "*Few months before initiating the upgrading of the drinking water supply systems in our locality, HMWSSB and other Government agencies captured our socio-economic conditions, issues and requirements pertaining to infrastructure facilities and services through household level interviews, focused group discussions with the slum residents, and community level association. This helped HWMSSB to appreciate our problems and requirements*" (Slum residents, Circle 3 _ Slum A, Hyderabad, 15-19 April 2017). One of the stakeholders at the HMWSSB reveals that "*it is always better to capture the challenges and*

> *requirements of the slum residents before planning or formulating for the projects and schemes, i.e. during or before the decision making process. And the only better way to capture them is through household interviews and focused group discussions at slum area level. This will not only help making communities happier, but also the projects and schemes successful"* (Director - Technical, HMWSSB, 07-09 June 2017).

Further, the focus group discussions and the stakeholders' interviews at institutional level (HMWSSB) and perception analysis of households in the slum areas of the Hyderabad city region disclosed a close relationship between the **availability of adequate quality and quantity of drinking water and the level of considerations of priority analysis** during the decision making processes of HMWSSB.

Referring to the table 66 in the previous section, it can be observed that the selected slum areas in the Hyderabad city region for which there is adequate quality and quantity of drinking water, they had a corresponding positive relationship with the level of consideration given to the priority analysis in the decision making processes and vice versa.

The slum areas for which there was a significant level of consideration given to the priority analysis, there was relatively adequate quality and quantity of drinking water in the slum areas and vice versa.

The anecdotes below indicate that the consideration given to the priority analysis play a significant role in having adequate quality and quantity of drinking water.

> During the stakeholder interviews conducted at HMWSSB to understand the decision making processes, one of the stakeholders of HMWSSB highlighted that *"HMWSSB has limited drinking water resources and financial resources to manage and cater the proliferating needs of population of Hyderabad. Considering this situation, and other external factors, we incline to provide better drinking water facilities and services to some localities than others"* (Director, Operations, HMWSSB, 07-09 June 2017).

Spatial disparities in the involvement of the stakeholders' (S3, I2) in the decision making process.

The focus group discussions and the stakeholders' interviews at Institutional level (HMWSSB) and perception analysis of households in the slum areas of Hyderabad city region showed a close connection between the slum residents' involvement and internal and external stakeholders' involvement during the decision making processes of HMWSSB in order to provide drinking water facilities and services to the slum areas in the Hyderabad city region.

At this juncture, it is essential to note that the involvement of external stakeholders' and the involvement of the slum residents were treated distinctly in the current theoretical framework to understand the profound relationship between these two parameters in the decision making processes.

Thus, there were three layers of stakeholder in the decision making process, i.e., slum residents, external stakeholders, and internal stakeholders. The ***first level***, the internal stakeholders include the managerial and functional staff at the Institutional (Service provider) level. The ***second level***, the external stakeholders include Central government or State government agencies, Non-governmental agencies, Local associations and Welfare associations, etc. but not the slum residents. The ***third level*** was comprised of the slum residents themselves.

The following anecdotes strongly qualify that there were only certain slum areas in the city region that had an active participation in the decision making procedures.

> During the stakeholder interviews conducted at HMWSSB to understand the decision making processes, one of the stakeholders of HMWSSB highlighted that "*Availability of Local associations or Welfare associations or Community level groups play a significant role in communicating the concerns and requirements of slum residents to internal staff of HWMSSB. The roles and responsibilities of internal staff of HMWSSB are fixed. There are quite a few number of slum areas in Hyderabad city region where there are no Local/ Welfare associations - this is limiting the role of slum residents in the decision making processes*" (Managing Director, HMWSSB, 02-03 June 2017).

Referring to the table 66 in the previous section (ref. table no), it can vividly be perceived that the selected slum areas in the Hyderabad city region for which there were significant levels of participation from both the internal and external stakeholders (I3), had a corresponding positive relationship with the participation of slum residents (S3) in the decision making processes and vice versa.

It can also be observed that the slum areas for which there was no participation of slum residents (S3), there was only a limited or no participation of both internal and external stakeholders (I3) in the decision making processes and vice versa. Since, the roles and responsibilities of the internal stakeholders of the HMWSSB were defined and followed in all cases, the only differentiating factors determining the involvement of the slum residents were the external stakeholders, especially the local or welfare associations.

This signifies that, since there was no direct involvement of slum residents in the decision making processes at HMWSSB, the presence and participation of external stakeholders, especially the local or welfare associations or community level groups made a difference and played a significant role in the decision making processes. These local associations or welfare associations acted as the linchpin between the service providers and the slum residents in order to explain the challenges and the requirements pertaining to the drinking water facilities and services of the slum residents to the internal stakeholders of the service providers.

> One of the slum residents, during the household interviews said that "*We only communicate our concerns and requirements pertaining to quality and quantity aspects of drinking water facilities and services to our Local association's members only*" (Slum resident, Circle 6_Slum B, Hyderabad, 06-15 May 2017).

Prejudice in analyzing socio-economic conditions (S1) and service requirements and planning (T2) of the slum residents in the decision making process.

The households' perception analysis from the slum areas of the Hyderabad city region and the focus group discussions at Institutional level (HMWSSB) revealed varied results among the slum areas in relation to analysing the socio-economic conditions and service requirements of the slum residents during the decision making processes of HMWSSB in order to provide drinking water facilities and services to the slum areas in the Hyderabad city region.

Based on the focus group discussions at institutional level, it was revealed that the existing decision making processes collects the socio-economic conditions and the service needs from multiple sources such as comprehensive city development plans, census data and through household interviews. In the case of information that was analysed through household interviews, the socio-economic aspects and the service requirements were collected simultaneously.

Depending on the need and case basis, the inputs from different sources were considered for analysis during the decision making processes. However, it was important to note that capturing the updated socio-economic conditions and the service requirements through household interviews was critical rather than analysing obsolete information from secondary sources during the decision making stages in order to provide the required drinking water services to the slum areas. This was also mentioned in the anecdotal evidence.

> During the household interviews, one of the slum residents stated that "*Drinking water facilities and services' concerns and requirements are not captured through any household interviews/ surveys or focused group discussions in our locality. But there are certain slum areas for which the details are captured by HMWSSB officials*" (Slum resident, Circle 4_Slum B, Hyderabad, 16-26 May 2017).

Referring to the table 66 in the previous section, it can be stated that there were certain slum areas for which there was a significantly low level of consideration given to socio-economic conditions' analysis (S1) and for certain slum areas the socio-economic analysis was taken into consideration during the decision making processes.

Similarly, there were certain slum areas for which there was a significant low level of consideration given to the requirements for analysis and planning (T1) and in certain slum areas analysis and planning requirements were taken into consideration during the decision making processes.

A closer look at the patterns of level of compliance between the consideration given to the analysis of resource analysis and planning and socio-economic conditions revealed a corresponding positive relationship. The slum areas for which the requirements analysis and planning was carried out by the service provider (HMWSSB), consideration was given to the analysis of socio-economic conditions and vice versa.

Similarly, the slum areas for which the requirements analysis and planning was not carried out, there was limited analysis of socio-economic conditions and vice versa during the decision making processes. Further, it can also be observed from the table the positive corresponding patterns between involvement of stakeholders (S3, I2) and the consideration given to the analysis pertaining to socio-economic conditions and service requirements (S1, T2).

In the slum areas for which there was no consideration given to the analysis of socio-economic conditions and service requirements during the decision making processes, there was a limited presence and participation of stakeholders (S3, I2) and vice versa.

The anecdotes below also mention that the analysis of socio-economic conditions and service requirements were carried out at the same time and the presence and participation of stakeholders, especially the local or welfare associations or groups influenced the level of compliance for consideration given to the analysis pertaining to socio-economic conditions and requirements analysis and planning during the decision making processes to provide drinking water facilities and services.

> During the stakeholder interviews at the HMWSSB, one of the stakeholder specified that "*Demographic details, income-expenditure patterns, requirements analysis and planning by capturing the actual service needs through household interviews and focused group discussions is conducted only for select slum areas in Hyderabad city region during the decision making processes. We get representation letters and follow-ups from local associations/ representatives for this. Alternatively, we analyze and project the required details from Comprehensive City Development Plans, and*

> *Comprehensive City level household surveys conducted once in 10-15 years. But it is always worthy to have updated details for reliable analysis*" (Director – Projects and Planning, HMWSSB, Hyderabad, 05-06 June 2017).

***Coherence in analyzing and planning resources (T1), engineering aspects and innovative technologies (T3) for the proposed solutions in the decision making process*.**

The focus group discussions and stakeholders' interviews at institutional level (HMWSSB) and the households' perception analysis from the slum areas of the Hyderabad city region reveals a positive connection between the resource analysis and planning and engineering and innovation during the decision making processes of HMWSSB to provide drinking water facilities and services to the slum areas in the Hyderabad city region.

It can be noted that the resource analysis and planning include analysing the availability of natural resources of drinking water, man-made infrastructure facilities and services pertaining to drinking water supply system, human resources to plan, develop, implement, and monitor the projects and schemes, financial resources analysis and planning, etc. In addition to this, the analysis of engineering and innovation aspects which include the analysis and planning for physical characteristics of the localities, and innovative technologies and options available that would suit the local conditions, etc.

> During the stakeholder interviews at the HMWSSB, the stakeholders specified that "*The technical and financial detailed feasibility reports are prepared capturing the analysis of existing resources, physical conditions of the localities. Accordingly, recommendations are proposed to meet the requirements and overcome the concerns. Detailed engineering drawings along with specifications are prepared. All possible innovative technology options are suggested in these technical feasibility reports*" (Director – Technical, Director – Finance, Director – Projects and Planning, HMWSSB, Hyderabad, 07-09 June 2017).

Referring to the table 66 in the previous section, it can vividly be perceived that the selected slum areas in the Hyderabad city region for which there were significant levels of resource analysis and planning (T1), they had a corresponding positive relationship with the level of consideration for analysis of engineering and innovative technologies (T3). It can be noted that for all of the selected slum areas both of these parameters were considered during the decision making processes. It can be noted that for all the selected slum areas both these parameters are considered during the decision making processes.

It can also be noted that as per the procedures defined in the rules of law for HMWSSB, it was mandatory to develop technical and financial feasibility reports that covered these aspects of analysis and planning in order to take the required decisions of providing drinking water facilities and services in the Hyderabad city region. Thus, despite any external and internal influences or constraints, the existing decision making processes at HMWSSB which provide drinking water facilities and services prepares technical and financial detailed project reports capture the analysis and planning of resources, engineering aspects, options for innovative technologies, etc.,

> During the stakeholder consultations, one of the stakeholders in HMWSSB said that "*Detailed technical and financial feasibility reports are prepared by HMWSSB in consultations with external experts for all the proposals during the decision making process*" (Director – Technical, Director – Projects and Planning, HMWSSB, Hyderabad, 05-15 July 2017).

Overlook of health conditions (S2) and economic aspects (E1, E2, E3) of the slum residents during the decision making processes.

The focus group discussions and stakeholders' interviews at Institutional level (HMWSSB) and the households' perception analysis from the slum areas of the Hyderabad city region revealed that there was no consideration given during the decision making processes to provide adequate and safe drinking water facilities and services to the slum areas to analysing: health conditions (S2), economic aspects such as damage costs (E1), preventive costs (E2), and willingness to pay and accept (E3).

These parameters were comprised of an analysis of health conditions in order to understand from the perspective of the slum households: What sorts of illness which were due to the existing drinking water supply, What were the frequencies of the illnesses which were due to the existing drinking water supply, Damage costs which included loss of productivity, Expenses towards sources of drinking water other than that supplied and charged by the Service provider (HMWSSB), Preventive costs, Medical expenses incurred due to ill health from drinking water quality, Expenses towards purification methods and equipment, Analyse the willingness to pay for better quality, quantity and regularity of the drinking water and whether they would accept various alternative projects and schemes of HMWSSB.

> During the stakeholder consultations, one of the stakeholders in HMWSSB said that "*We are not mandated to analyze the damage costs, preventive costs, and willingness to pay or accept. Drinking water facilities and services are however provided to the slum residents on a subsided rates, when compared to rest of the population in the Hyderabad city region*" (Executive Director, HMWSSB, Hyderabad, 12-15 June 2017).

Referring to the table 66 in the previous section, it can clearly be stated that there were slum areas for which the analysis of these aspects was considered. It can also be noted that as per the procedures defined in the rules of law for HMWSSB, it was not mandatory to develop reports covering analysis and planning of these aspects in order to take the required decisions of providing drinking water facilities and services in the Hyderabad city region. This signifies that despite of any external and internal influences and constraints, the existing decision making processes at HMWSSB in order to provide drinking water facilities and services do not analyse the health conditions and economic aspects.

> During the household interviews, one of the slum residents said that "*We are spending addition costs towards medical expenses, loss of productivity and purification methods, due to insufficient and unsafe drinking water supplied. Instead of these expenses, we are ready to pay more than the subsided charges that we are currently paying for inadequate and unsafe drinking water, if we can get adequate and safe drinking water facilities and services*" (Slum resident, Circle 4_Slum B, Hyderabad, 16-26 May 2017).

Limited attention to policies, regulatory frameworks, and procedures (I1), and analysis of capacities and enforcements (I3) during the decision making process.

The focused group discussions and the stakeholders' interviews at the Institutional level (HMWSSB) and the households' perception analysis from the slum areas of the Hyderabad city region revealed a mixed perceptions. The analysis of policies, regulatory frameworks and procedures include analyzing the vision statements, existing policies, programs, projects, standards, frameworks and procedures in providing adequate and safe drinking water facilities and services, etc. In addition, the analysis of capacities and enforcements include internal staff capacities to develop, implement and monitor projects, programs, schemes, etc., and analyzing the procurement methods, implementation options, monitoring and evaluation options, and impact analysis of previously implemented projects, programs, and schemes, etc.

> During the household interviews, one of the slum residents said that "*The decisions taken are not in line with their policies, frameworks, procedures, especially in terms of providing standard quality and quantity of drinking water. And the HMWSSB do not consider and learn from the lessons from previously implemented projects or schemes*" (Slum resident, Circle 16_Slum A, Hyderabad, 03-18 August 2017).

Referring to the table 66 in the previous section, it can be perceived that the selected slum areas in the Hyderabad city region have partial levels of compliance of consideration given to the polices, regulatory frameworks, and procedures, capacities analysis and enforcements. It can be noted that for all the selected slum areas, these parameters were not considered to the fullest possible extent during the decision making processes. However, it can also be noted that as per the procedures defined in the rules of law for

HMWSSB, it was mandatory to develop and implement projects, programs and schemes in line with policies, regulatory frameworks, procedures, capacities, and enforcements. This signifies that despite the stated rules, the existing decision making processes at HMWSSB in order to provide drinking water facilities and services do not completely comply with analyzing the policies, regulatory frameworks, procedures, capacities and enforcements.

> During the stakeholder interviews in HMWSSB, few of the stakeholders said that "*We are determined to achieve the vision and objectives of the HMWSSB in providing adequate and safe drinking water facilities to all the households of Hyderabad city region. Our decisions are in line with the policies, regulatory frameworks, and procedures and these undergo changes to keep up to the pace of changing societies and needs. We keep track of our staff's capabilities and capacities, and conduct training sessions on periodic basis*" (Managing Director, Executive Director, Director (Personnel & Administration), HMWSSB, Hyderabad, 11-12 June 2017).

Preferences (O1) to certain slum areas during the decision making processes.

The focus group discussions and the stakeholders' interviews at the institutional level (HMWSSB) and the perception analysis of households in the slum areas of the Hyderabad city region disclosed a close corresponding relationship between the priority analysis (O1) and the involvement of stakeholders (S3, I2) during the decision making processes in the HMWSSB in order to provide drinking water facilities and services to the selected slum areas in the Hyderabad city region. It was essential to note that the priority analysis was carried out by the management staff of the HMWSSB based on the estimated size of the project in terms of resource requirements and external influences. However, it can also be stated that this was not part of current rules and regulations.

> During the stakeholder interviews in HMWSSB, one of the stakeholders said that "*Hyderabad have limited resources of drinking water and the HMWSSB is financially weak; providing drinking water facilities and services to proliferating population is a challenge. Though we strive to provide drinking water facilities and services to all, certain slum areas are better paid off with services than others*" (Managing Director, Executive Director, Director (Personnel & Administration), HMWSSB, Hyderabad, 02-03 June 2017).

Referring to the table 66 in the previous section, it can be stated that there were certain slum areas for which there was a significantly low level of consideration given to the priority analysis (O1) and for certain slum areas there was no consideration given to the priority analysis during the decision making processes.

It can also be observed from the table that there was a positive corresponding pattern between the involvement of stakeholders (S3, I2) and the consideration that was given to the analysis pertaining to prioritisation (O1). The slum areas for which there was no consideration given to the priority analysis during the decision making processes, there was limited presence and participation of stakeholders (S3, I2) and vice versa. This signifies that priority analysis was carried out and the slum areas were identified for providing drinking water facilities and services where the presence and participation of stakeholders, especially the local or welfare associations or groups were highly active during the decision making processes to provide drinking water facilities and services.

> During the household level interviews, one of the slum residents said that "*Better drinking water facilities and services are provided to those areas with good relations between Local/ welfare associations and HMWSSB. Because we don't have good relations, though we have Local association, we do not have better services*" (Slum resident, Circle 17_Slum B, Hyderabad, 16-30 May 2017).

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Chapter 7

Conclusions and Reflections

Chapter 7 | Conclusions and Reflections

7.1. Epilogue

One might recall that I started this study with the details regarding the prevailing conditions of the drinking water facilities and services in the Hyderabad city region presented in the meeting that I attended and the follow-up meeting with my friend in an informal settlement with prevailing desperate conditions of drinking water. In retrospection of these details that were in the prologue as stated in Chapter 1 were the minutes of the meeting held in my neighbourhood that I attended on 15 January 2015 and notes of the subsequent conversations with my friend who resides in an urban poor community.

These informal conversations turned out to be, not just other meetings at the community level and not just other conversations with friends. During the community level meetings, I discovered that there were variations in the availability of the drinking water facilities and services in and around our neighbourhoods and the discussions with my friend revealed desperate conditions pertaining to drinking water facilities and services.

However, at that instance, it was unclear whether these conditions were pertinent across the Hyderabad city region and there was only minimal and dated literature which was available to arrive at any conclusions. Based on the current research study which initially focused on assessing these conditions, especially in urban poor communities of the Hyderabad city region, the empirical analysis has shown that the prevailing desperate conditions of drinking water in the selected neighbourhoods of the Hyderabad city region were significant.

Evidently, the analysis also displayed that there were variations in the provisions of drinking water facilities and services to the poor neighbourhoods in and around the Hyderabad city region. Due to these prevailing conditions, the apprehensions that were raised are in terms of how the decisions were taken in providing these services to the residents, particularly to the slum residents in the Hyderabad city region.

Thus, I performed a qualitative analysis in order to understand the factors that influenced the decision making processes of the HMWSSB. The decision making processes in order to provide facilities and services that was followed by the HMWSSB, typically followed a techno-bureaucratic approach, they considering only the technical or engineering aspects, the institutional aspects and they listened to various voices such as the political party that was in government at the time and influential citizens in the society.

The qualitative analysis also clearly showed that the socio-health conditions and the economic aspects were not taken into consideration during the decision making procedures at HMWSSB. As a consequence, there were urban poor communities with adequate drinking water facilities and service and others who were left abandoned and deprived of the basic services.

The initial community level meetings and the conversations with my friend, triggered my thought processes and became the foundation for the thought-provoking empirical research findings and formulation of a novel implementable systematic and integrated decision making framework which has been discussed in this study with the intention of providing safe and adequate drinking water facilities and services to the urban poor communities in an equitable and cost-efficient fashion.

The questions that that were initially raised have been, through this research, answered with clarity and have also paved a way for a potential solution that would help the urban poor have access to clean drinking water and services. The following section will retrospect those questions to state possible answers based on this research study.

7.2. Answering Research Questions

As stated at the beginning of this research, in order to address the problems and provide suitable solutions, it was vital to primarily understand the problems. Therefore, it became crucial to examine the prevailing conditions of drinking water facilities and services in the slum areas of the Hyderabad city region, where the water related challenges were rampant and in disparity and at the same time understand the decision making procedures that were followed by the drinking water service provider, the Hyderabad Metropolitan Water Supply and Sewerage Board, in providing a safe quality and adequate quantities of drinking water facilities and services.

On the basis of the relevant literature and the available theoretical concepts, the current research's conceptual model was constructed. Using independent variables, a systematic and integrated decision making framework was developed which comprised of social-health aspects (S), institutional aspects (I), technical aspects (T), and economic aspects (E) and dependent variables as quality (Q1) and quantity (Q2). They were all related to drinking water facilities and services in the study area which were part of the current research's conceptual model.

Nevertheless, recalling the primary objective, the overarching research question of this research study, which was to discover: "***What factors in systematic and integrated decision making framework influenced, positively (or negatively), to provide the safe quality and adequate quantity of drinking water for the urban poor population***", and build-up on the qualitative relationships between the above stated independent and dependent elements to confirm or modify the conceptual framework considering the fundamentals of a retroductive approach.

In order to address the primary research objective, the field level analysis was conducted at household level and institutional level based on a qualitative approach during the year 2016 to 2017 in the Hyderabad city region, India. The following techniques and criteria were used:

- The multi-stage sampling techniques comprised of spatial cluster sampling, simple random sampling and stratified random sampling were applied to the selected slum areas, slum dwellers in each slum area, workers at the institution and a collection of drinking water samples.
- Detailed selection criteria and spatial cluster sampling techniques were applied to identify the slum areas to be used which were located in the Hyderabad city region.
- Simple random sampling techniques were applied in order to select the subjects chosen to be interviewed to collect the perceptions of the slum population regarding the quality and quantity of the drinking water facilities and services and the decision making procedures which were followed by the service provider.
- A spatial cluster sampling technique and a stratified random sampling technique were applied to collect the drinking water samples from the different sources of drinking water in the slum areas.
- A stratified random sampling technique was applied to select the participants for interviewing and conducting focus group discussions to collect the decision making procedures followed at the service provider level.

Post-completion of the above-mentioned field level data collection and the data analysis methods that were executed in this research study, aided in providing the following sub-research questions and subsequently the main research question.

a. Sub-research question: *What was the existing quality and quantity of drinking water from the different sources*

In retrospection of the details specified in chapter 5 regarding the analysis of drinking water quality and quantity in this study, the qualitative analysis carried through this research study was broadly classified into two parts: (a) the slum households' perception and (b) the expert's judgement on quality and quantity of drinking water. The households' perceptions typically included the satisfaction levels of the slum residents in the sample case studies in the informal settlements of the Hyderabad city region which were collected through household level interviews and focus group discussions. The expert's judgement typically included the analysis of the drinking water quantities in the sample case studies (informal settlements) which was attained through household level interviews and focus group discussions. Further, analysis of the drinking water qualities in the sample case studies (informal settlements) was done by taking samples of the water and testing them in the laboratory.

Sources of drinking water.

Considering the perception analysis of the slum residents in the sample case studies (informal settlements) in the Hyderabad city region, there were three different sources of drinking water, namely (i) surface water supplied through household level individual taps by the service provider, (ii) surface water supplied through community level public taps by the service provider, (iii) ground water fetched through borewells, tubewells and handpumps either at household level or community level, and (iv) surface water supplied through water tankers by the service provider. However, perception analysis revealed that the slum residents had access to multiple sources of drinking water, and the majority had access to surface water infrastructure facilities and services such as individual tap connections, community level public taps and water tankers, followed by ground water sources such as bore wells, tube wells and hand pumps.

Households' perceptions of quality and quantity of drinking water.

The perception analysis was conducted with slum residents who lived in the selected informal settlements. It was about the quality and quantity of drinking water which was supplied through the following different sources: individual taps in the houses of the slum dweller, public taps, bore wells, tube wells, hand pumps and water tankers. There were certain number sample case studies (informal settlements) in despair and others in the content with the quality and quantity of drinking water facilities and services provided by the HMWSSB. The analysis of Table 93 above revealed that the slum areas that were satisfied with one source of drinking water, were also satisfied with another source of drinking water. Nevertheless, the overall perception analysis showed that there were variations within the sample case studies, informal settlements, in terms of access to or availability of safe quality and adequate quantity of drinking water from different sources of drinking water in the Hyderabad city region. The following table 67 illustrates the perceptions of slum residents in terms of their satisfaction levels regarding the quality and quantity of drinking water from different sources across the sample case studies (informal settlements) in the Hyderabad city region.

Table 67: Perceptions of satisfaction levels on quality and quantity of drinking water

Sources		Individual taps		Public taps		B.Well/ H.Pump		Water tankers		**Overall Score**	
Indicator		Qty.	Qly.	Qty.	Qly.	Qty.	Qly.	Qty.	Qly.	**Qty.**	**Qly.**
Slum areas	#										
Circle 1 _ Slum A	1	N/A	N/A	N	Y	N	P	N	Y	**N**	**N**
Circle 1 _ Slum B	2	N	P	N	N	N	Y	N	N	**N**	**N**
Circle 2 _ Slum A	3	Y	Y	Y	Y	N	P	Y	Y	**Y**	**Y**
Circle 2 _ Slum B	4	Y	Y	Y	Y	N	Y	Y	Y	**Y**	**Y**
Circle 3 _ Slum A	5	Y	Y	N/A	N/A	N	Y	Y	Y	**Y**	**Y**
Circle 3 _ Slum B	6	Y	Y	N/A	N/A	Y	Y	Y	Y	**Y**	**Y**

Sources		Individual taps		Public taps		B.Well/ H.Pump		Water tankers		**Overall Score**	
Indicator		Qty.	Qly.	Qty.	Qly.	Qty.	Qly.	Qty.	Qly.	**Qty.**	**Qly.**
Slum areas	#										
Circle 4 _ Slum A	7	Y	Y	Y	Y	P	N	Y	Y	**Y**	**Y**
Circle 4 _ Slum B	8	N	P	Y	N	P	Y	N	N	**N**	**N**
Circle 5 _ Slum A	9	N	P	N	N	N	N	N	N	**N**	**N**
Circle 5 _ Slum B	10	N	N	N	N	N	Y	N	Y	**N**	**P**
Circle 6 _ Slum A	11	N/A	N/A	N	N	N/A	N/A	N	N	**N**	**N**
Circle 6 _ Slum B	12	Y	Y	Y	Y	Y	N	Y	Y	**Y**	**Y**
Circle 7 _ Slum A	13	N	N	N	P	Y	Y	Y	Y	**Y**	**P**
Circle 7 _ Slum B	14	Y	Y	Y	Y	N	N	Y	Y	**Y**	**Y**
Circle 8 _ Slum A	15	N/A	N/A	N	N	N	N	N	N	**N**	**N**
Circle 8 _ Slum B	16	Y	Y	N	N	N	Y	Y	Y	**Y**	**Y**
Circle 9 _ Slum A	17	Y	Y	N	N	N	N	Y	P	**Y**	**P**
Circle 9 _ Slum B	18	P	Y	N	N	N	N	Y	P	**P**	**P**
Circle 10 _ Slum A	19	Y	Y	Y	Y	N	N	Y	N	**Y**	**Y**
Circle 10 _ Slum B	20	Y	P	N	N	N	N	Y	P	**Y**	**P**
Circle 11 _ Slum A	21	Y	Y	N	Y	N	N	Y	Y	**Y**	**Y**
Circle 11 _ Slum B	22	Y	N	N	N	N	N	N	N	**N**	**N**
Circle 12 _ Slum A	23	N	Y	N	Y	N	N	N	Y	**N**	**Y**
Circle 12 _ Slum B	24	Y	Y	Y	Y	Y	P	Y	Y	**Y**	**Y**
Circle 14 _ Slum A	27	Y	Y	Y	Y	Y	N	Y	Y	**Y**	**Y**
Circle 14 _ Slum B	28	P	P	N	N	N	Y	N	Y	**N**	**N**
Circle 15 _ Slum A	29	N	P	N	N	N	N	N	N	**N**	**N**
Circle 15 _ Slum B	30	N	Y	N/A	N/A	N	N	N	P	**N**	**P**
Circle 16 _ Slum A	31	N	N	N	N	N/A	N/A	N	N	**N**	**N**
Circle 16 _ Slum B	32	N	N	N/A	N/A	N/A	N/A	N	P	**N**	**N**
Circle 17 _ Slum A	33	N	P	N	N	N	P	N	N	**N**	**N**
Circle 17 _ Slum B	34	Y	Y	N/A	N/A	N	Y	Y	Y	**Y**	**Y**
Circle 18 _ Slum A	35	Y	Y	Y	Y	Y	Y	Y	Y	**Y**	**Y**
Circle 18 _ Slum B	36	Y	Y	Y	Y	Y	N	Y	Y	**Y**	**Y**

Legend: Y (Compliant), P (Partially compliant), N (Non-compliant), N/A – Not Applicable (not currently using as the source of drinking water)

Expert's judgement on drinking water quantity.

The above stated key findings from the perception analysis of variations in availability of drinking water quantities were further strengthened by the expert's judgement analysis which was carried out with the same sample case studies in the informal settlements in the Hyderabad city region for which the perception analysis was carried out. In order to arrive at the quantity of drinking water that was available from all of the sources of drinking water to the slum residents across the sample case studies (informal settlements), the details pertaining to (a) the average household size, (b) the average quantity of drinking water collected by the household from different sources and (c) the average number of days for which the collected water was stored by the households, were collected through household level interviews in the sample case studies (informal settlements) in the Hyderabad city region. The average quantity of drinking water in number of litres per day person was calculated for each of the sample case studies in the informal settlements and compared with the applicable standards of quantity of drinking water that was to be made available to each slum resident. According to the expert's judgement analysis the quantity of drinking water that was available to the slum households was far below the water quantity requirement standards. However, the analysis pertaining to quantities amongst the sample case studies (informal settlements) on relative terms showed that there were a certain number of sample case studies in the informal settlements for which the quantity of drinking water available was relatively reasonable compared to the other sample case studies from the informal settlements. The following table 68 is a comparative assessment of the existing quantities of drinking water compared with standards across all of the sample case studies in the informal settlements and in relative terms amongst the sample case studies in the informal settlements of the Hyderabad city region.

Table 68: Comparative assessment of existing quantities of drinking water with quantity standards

Parameters		Existing quantity (lpcd)	Required quantity standards (lpcd)	%	Compliance with standards (Y/N)	Relative (more than average) (Y/N)
Slum name	#					
Circle 1 _ Slum A	1	21.40	135	15.85%	N	N
Circle 1 _ Slum B	2	21.30	135	15.78%	N	N
Circle 2 _ Slum A	3	40.31	135	29.86%	N	Y
Circle 2 _ Slum B	4	43.37	135	32.12%	N	Y
Circle 3 _ Slum A	5	40.63	135	30.10%	N	Y
Circle 3 _ Slum B	6	42.42	135	31.43%	N	Y
Circle 4 _ Slum A	7	64.38	135	47.69%	N	Y
Circle 4 _ Slum B	8	27.61	135	20.45%	N	N
Circle 5 _ Slum A	9	18.38	135	13.61%	N	N
Circle 5 _ Slum B	10	21.17	135	15.68%	N	N
Circle 6 _ Slum A	11	17.84	135	13.22%	N	N
Circle 6 _ Slum B	12	49.73	135	36.84%	N	Y
Circle 7 _ Slum A	13	48.79	135	36.14%	N	Y
Circle 7 _ Slum B	14	51.31	135	38.01%	N	Y
Circle 8 _ Slum A	15	21.34	135	15.81%	N	N
Circle 8 _ Slum B	16	40.45	135	29.96%	N	Y
Circle 9 _ Slum A	17	40.83	135	30.25%	N	Y
Circle 9 _ Slum B	18	47.06	135	34.86%	N	Y
Circle 10 _ Slum A	19	55.28	135	40.95%	N	Y
Circle 10 _ Slum B	20	46.56	135	34.49%	N	Y
Circle 11 _ Slum A	21	43.14	135	31.95%	N	Y
Circle 11 _ Slum B	22	37.03	135	27.43%	N	Y
Circle 12 _ Slum A	23	26.49	135	19.62%	N	N
Circle 12 _ Slum B	24	54.28	135	40.20%	N	Y
Circle 14 _ Slum A	27	40.61	135	30.08%	N	Y

Parameters		Existing quantity (lpcd)	Required quantity standards (lpcd)	%	Compliance with standards (Y/N)	Relative (more than average) (Y/N)
Slum name	#					
Circle 14 _ Slum B	28	26.54	135	19.66%	N	N
Circle 15 _ Slum A	29	17.86	135	13.23%	N	N
Circle 15 _ Slum B	30	17.52	135	12.98%	N	N
Circle 16 _ Slum A	31	14.47	135	10.72%	N	N
Circle 16 _ Slum B	32	16.41	135	12.16%	N	N
Circle 17 _ Slum A	33	20.17	135	14.94%	N	N
Circle 17 _ Slum B	34	35.06	135	25.97%	N	Y
Circle 18 _ Slum A	35	56.93	135	42.17%	N	Y
Circle 18 _ Slum B	36	53.44	135	39.59%	N	Y
Average Values		**35.63**	**135**	**26.40%**	N	-

Legend: Y (Compliant), P (Partially compliant), N (Non-compliant)

Expert's judgement on drinking water quality.

The above stated key findings from the perception analysis of the variations in drinking water qualities were further strengthened by the expert's judgment analysis which was carried out using the same sample case studies in the informal settlements in the Hyderabad city region for which the perception analysis was carried out. However, in order to arrive at the analysis of overall quality of drinking water for all the sources of drinking water, the drinking water samples collected from different sources from the select sample case studies in the informal settlements underwent laboratory tests which included investigation of the presence of microbiological, chemical and physical parameters and compared with the applicable Indian standards of drinking water quality. The expert's judgment analysis found that the quality of drinking water amongst the sample case studies in the informal settlements and from the different sources of drinking water was not consistent. There were a certain number of sample case studies in the informal settlements for which the quality of drinking water that was available met the drinking water quality standards and there was also a certain number of sample case studies for which the quality of the drinking water did not meet the drinking water quality standards. The following table 69 shows the laboratory test results regarding the quality of drinking water from the different sources compared with the quality standards across all of the sample case studies in the informal settlements in the Hyderabad city region.

Table 69: Quality of drinking water compared with quality standards

Parameters		Microbiological			Chemical			Physical			Overall		
Sources		IT	BW	WT	IT	BW	WT	IT	BW	WT	IT	BW	WT
Slum Name	#												
Circle 1 _ Slum A	1	-	-	-	-	-	-	-	-	-	-	-	-
Circle 1 _ Slum B	2	N	Y	Y	Y	N	Y	Y	Y	Y	N	N	Y

Parameters		Microbiological			Chemical			Physical			Overall		
Sources		IT	BW	WT	IT	BW	WT	IT	BW	WT	IT	BW	WT
Slum Name	#												
Circle 2 _ Slum A	3	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	N	Y
Circle 2 _ Slum B	4	-	-	-	-	-	-	-	-	-	-	-	-
Circle 3 _ Slum A	5	Y	N	Y	Y	Y	Y	Y	N	Y	Y	N	Y
Circle 3 _ Slum B	6	-	-	-	-	-	-	-	-	-	-	-	-
Circle 4 _ Slum A	7	-	-	-	-	-	-	-	-	-	-	-	-
Circle 4 _ Slum B	8	N	N	Y	Y	N	Y	Y	Y	Y	N	N	Y
Circle 5 _ Slum A	9	-	-	-	-	-	-	-	-	-	-	-	-
Circle 5 _ Slum B	10	N	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y
Circle 6 _ Slum A	11	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Circle 6 _ Slum B	12	-	-	-	-	-	-	-	-	-	-	-	-
Circle 7 _ Slum A	13	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Circle 7 _ Slum B	14	-	-	-	-	-	-	-	-	-	-	-	-
Circle 8 _ Slum A	15	N	N	Y	Y	Y	Y	Y	Y	Y	N	N	Y
Circle 8 _ Slum B	16	-	-	-	-	-	-	-	-	-	-	-	-
Circle 9 _ Slum A	17	N	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y
Circle 9 _ Slum B	18	-	-	-	-	-	-	-	-	-	-	-	-
Circle 10 _ Slum A	19	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	N	Y
Circle 10 _ Slum B	20	-	-	-	-	-	-	-	-	-	-	-	-
Circle 11 _ Slum A	21	N	Y	Y	N	N	Y	Y	N	Y	N	N	Y
Circle 11 _ Slum B	22	-	-	-	-	-	-	-	-	-	-	-	-
Circle 12 _ Slum A	23	N	N	Y	Y	N	Y	Y	Y	Y	N	N	Y
Circle 12 _ Slum B	24	-	-	-	-	-	-	-	-	-	-	-	-
Circle 14 _ Slum A	27	-	-	-	-	-	-	-	-	-	-	-	-
Circle 14 _ Slum B	28	N	N	Y	Y	N	Y	Y	Y	Y	N	N	Y
Circle 15 _ Slum A	29	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Circle 15 _ Slum B	30	-	-	-	-	-	-	-	-	-	-	-	-
Circle 16 _ Slum A	31	-	-	-	-	-	-	-	-	-	-	-	-
Circle 16 _ Slum B	32	Y	N	N	Y	N	Y	Y	N	Y	Y	N	N
Circle 17 _ Slum A	33	N	N	Y	Y	N	N	N	Y	Y	Y	Y	Y
Circle 17 _ Slum B	34	-	-	-	-	-	-	-	-	-	-	-	-
Circle 18 _ Slum A	35	N	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y
Circle 18 _ Slum B	36	-	-	-	-	-	-	-	-	-	-	-	-

Legend: Y (Compliant), N (Non-compliant)

In summary, the overall perception analysis and expert's judgement analysis regarding the quality and quantity of drinking water facilities and services from the different sources of drinking water showed that there were variations amongst the sample case studies in the informal settlements in terms of the availability of safe quality and whether there were adequate quantities of drinking water in the Hyderabad city region. The overall quality and quantity of drinking water was compliant in some of the slum areas, partially compliant in other slum areas and non-compliant in other slum areas. Considering the varying results in the quality and quantity of drinking water amongst the informal settlements in the Hyderabad city region, the research study then further focused on trying to understand the decision making frameworks and procedures and the factors considered during the decision making process that were followed by the HMWSSB to provide drinking water facilities and services, especially to the slum residents within the Hyderabad city region. The Hyderabad Metropolitan Water Supply and Sewerage Board (HMWSSB) was the responsible body that has a mandate to provide safe quality and an adequate quantity of drinking water to all of its citizens and neighbourhoods in the Hyderabad city region.

b. Sub-research question: *What factors constitute the existing decision making processes to provide quality and quantity of drinking water*

In retrospect of the details specified in chapter 6 regarding the analysis of factors considered in the decision making procedures which were followed by the HMWSSB to provide safe and adequate drinking water facilities and services to the Hyderabad city region. In this study, the qualitative analysis that was carried out in this phase of the research study was twofold: (a) stakeholders' interviews and focus group discussions at HMWSSB regarding the decision making process, and (b) slum households' interviews and focus group discussions regarding their perceptions of factors which they thought the HMWSSB considered during the decision making process to provide drinking water facilities and services. The stakeholders' analysis compiled data about the overarching and sample case study (informal settlement) specific decision making workflow processes that were followed by the HWMSSB in deciding which slum area shall get what quality and quantity of drinking water. This was achieved through stakeholders' interviews and focus group discussions. The households' perceptions analysis was done using interviews and focus group discussions. They were asked their opinions regarding which factors they thought the HMWSSB considered during the decision making procedures.

Stakeholders' analysis of overarching decision making procedure.

The analysis of the stakeholders' interviews and focus group discussions held at the Hyderabad Metropolitan Water Supply and Sewerage Board (HMWSSB, which is responsible for providing drinking water facilities and services to the residents of Hyderabad city region) was to understand the overarching decision making procedures. The decision making procedures, regarding the drinking water facilities and services that are provided, were based on the following procedures: (a) Proposals received by the HMWSSB from various stakeholder, which included the government agencies, non-government agencies, public representatives, local associations or community organizations, public and the media, (b) A detailed pre-feasibility study, (c) Feasibility analysis, (d). detailed technical (engineering) and financial analysis for the proposed solution. However, the final decision regarding what sort of the quality and quantity of drinking water services was determined by detailed deliberations between the internal staff of the HMWSSB, political players and external influences. Based on this overall understanding of the decision making framework, an in-depth analysis was carried out in order to understand the factors that were considered during the decision making processes at the HMWSSB.

Stakeholders’ analysis of factors considered during decision making process.

In retrospect of the qualitative analysis of the stakeholders’ interviews and focus group discussions at the HMWSSB in order to understand the factors that were considered during the decision making procedures to provide drinking water facilities and services to the sample case studies in the informal settlements in the Hyderabad city region, in comparison with the S.I.T.E valuation framework (detailed in chapter 2), revealed that: partial consideration of social-health aspects (S) and institutional aspects (I), Significant level of consideration of analysis of technical aspects (T), and complete non-consideration of economic aspects (E). In addition, a priority analysis (O1) was carried out in order to prioritise or shortlist the neighbourhoods in order to provide drinking water facilities and services. Analysing the amount of consideration that was given to the factors in the decision making process in each sample case study, the qualitative analysis of stakeholder discussions signifies that there were variations amongst the sample case studies (informal settlements) in terms of considering the analysis of socio-health (S), Institutional (I), Technical (T) aspects and Prioritisation (O1). The analysis revealed a positive corresponding relationship between socio-health (S), institutional (I), technical (T) and priority analysis (O1). The higher the level of involvement of the institutional aspects (I), the higher the level of involvement of social-health aspects (S) and the higher the level of involvement of technical aspects (T) during the decision making procedures. The following table 70, which was compiled from information from the stakeholders’ interviews and focus group discussion analysis, shows the determining factors which were considered during the decision making procedures by the HMWSSB in order to provide drinking water facilities and services for the sample case studies in the informal settlements of the Hyderabad city region.

Table 70: Factors considered during decision making procedures at HMWSSB

Indicators		Social (S)			Institutional (I)			Technical (T)			Economic (E)			-
Sub Indicators		S1	S2	S3	I1	I2	I3	T1	T2	T3	E1	E2	E3	O1
Slum areas	#	-												-
Circle 1 _ Slum A	1	Y	N	N	P	P	P	Y	P	Y	N	N	N	N
Circle 1 _ Slum B	2	Y	N	P	P	Y	P	Y	Y	Y	N	N	N	N
Circle 2 _ Slum A	3	Y	N	P	P	Y	P	Y	Y	Y	N	N	N	Y
Circle 2 _ Slum B	4	Y	N	P	P	Y	P	Y	Y	Y	N	N	N	Y
Circle 3 _ Slum A	5	Y	N	P	P	Y	P	Y	Y	Y	N	N	N	Y
Circle 3 _ Slum B	6	Y	N	P	P	Y	P	Y	Y	Y	N	N	N	Y
Circle 4 _ Slum A	7	Y	N	P	P	Y	P	Y	P	Y	N	N	N	N
Circle 4 _ Slum B	8	Y	N	N	P	P	P	Y	P	Y	N	N	N	N
Circle 5 _ Slum A	9	Y	N	N	P	P	P	Y	P	Y	N	N	N	N
Circle 5 _ Slum B	10	Y	N	N	P	P	P	Y	P	Y	N	N	N	N

Indicators		Social (S)			Institutional (I)			Technical (T)			Economic (E)			-
Sub Indicators		S1	S2	S3	I1	I2	I3	T1	T2	T3	E1	E2	E3	O1
Circle 6 _ Slum A	11	Y	N	N	P	P	P	Y	Y	Y	N	N	N	Y
Circle 6 _ Slum B	12	Y	N	P	P	Y	P	Y	P	Y	N	N	N	N
Circle 7 _ Slum A	13	Y	N	P	P	Y	P	Y	P	Y	N	N	N	Y
Circle 7 _ Slum B	14	Y	N	P	P	Y	P	Y	P	Y	N	N	N	Y
Circle 8 _ Slum A	15	Y	N	N	P	P	P	Y	P	Y	N	N	N	N
Circle 8 _ Slum B	16	Y	N	P	P	Y	P	Y	Y	Y	N	N	N	Y
Circle 9 _ Slum A	17	Y	N	P	P	Y	P	Y	P	Y	N	N	N	Y
Circle 9 _ Slum B	18	Y	N	P	P	Y	P	Y	P	Y	N	N	N	Y
Circle 10 _ Slum A	19	Y	N	P	P	Y	P	Y	Y	Y	N	N	N	Y
Circle 10 _ Slum B	20	Y	N	P	P	Y	P	Y	Y	Y	N	N	N	Y
Circle 11 _ Slum A	21	Y	N	P	P	Y	P	Y	P	Y	N	N	N	Y
Circle 11 _ Slum B	22	Y	N	N	P	P	P	Y	P	Y	N	N	N	N
Circle 12 _ Slum A	23	Y	N	P	P	Y	P	Y	Y	Y	N	N	N	N
Circle 12 _ Slum B	24	Y	N	P	P	Y	P	Y	Y	Y	N	N	N	Y
Circle 14 _ Slum A	27	Y	N	P	P	Y	P	Y	P	Y	N	N	N	Y
Circle 14 _ Slum B	28	Y	N	N	P	P	P	Y	P	Y	N	N	N	N
Circle 15 _ Slum A	29	Y	N	N	P	P	P	Y	P	Y	N	N	N	N
Circle 15 _ Slum B	30	Y	N	N	P	P	P	Y	P	Y	N	N	N	N
Circle 16 _ Slum A	31	Y	N	P	P	Y	P	Y	Y	Y	N	N	N	N
Circle 16 _ Slum B	32	Y	N	N	P	P	P	Y	P	Y	N	N	N	N
Circle 17 _ Slum A	33	Y	N	N	P	P	P	Y	P	Y	N	N	N	N
Circle 17 _ Slum B	34	Y	N	P	P	Y	P	Y	P	Y	N	N	N	N
Circle 18 _ Slum A	35	Y	N	P	P	Y	P	Y	Y	Y	N	N	N	Y
Circle 18 _ Slum B	36	Y	N	P	P	Y	P	Y	Y	Y	N	N	N	Y

Legend: Y (Compliant), P (Partially compliant), N (Non-compliant)

The above stated key findings from the stakeholders' analysis regarding the variations when considering various factors during the decision making procedures in order to provide drinking water for the sample case studies in the informal settlements in the Hyderabad city region. These were further reinforced by the slum residents' perception analysis which was carried out in the same sample case studies in the informal settlements in the Hyderabad city region to understand the factors that were considered by the HMWSSB during the decision making procedures. The viewpoint of slum households revealed similar results that were given in the qualitative analysis of the stakeholders' interviews and focus group discussions at HMWSSB.

***Households' perceptions of factors considered during decision making procedure*.**

In retrospect of the perception analysis that was collected from the slum residents through household interviews and focus group discussions at the HMWSSB level to understand the factors that were considered during the decision making procedures to provide drinking water facilities and services to the sample case studies in the informal settlements in the

Hyderabad city region, in comparison with the S.I.T.E valuation framework which was detailed in chapter 2, reveals that during the decision making processes: there was limited consideration given to the Socio-health aspects (S), there was limited consideration given to the Institutional aspects (I), there was significant consideration given to the analysis of Technical aspects (T) and there was no consideration was given to the analysis of Economic aspects (E) in the decision making processes at HMWSSB. In addition to the analysis of the above-mentioned aspects, priority analysis (O1) is carried out at HMWSSB to provide drinking water facilities and services to the slum areas.

Analysing the factors that were considered in the decision making processes for each sample case study , the qualitative analysis of perceptions of slum residents showed that there were variations amongst the sample case studies (informal settlements) in terms of how the slum population thought the HMWSSB had taken into consideration the analysis of socio-health (S), institutional (I), technical (T) aspects and prioritisation (O1).

The analysis revealed a positive corresponding relationship between socio-health (S), institutional (I), technical (T) and prioritisation or priority analysis (O1). The higher the level of consideration that was given to the institutional aspects (I), the higher the level of consideration was given to the socio-health aspects (S) and eventually the higher the level of consideration was given to the technical aspects (T) during the decision making procedures.

In some of the sample case studies, in the informal settlements, there was consideration given to the socio-health (S) aspects, the slum residents (S3) were involved in discussing the socio-economic conditions (S1) such as the requirements and concerns pertaining to the drinking water facilities and services.

It was observed that the active involvement of slum residents was significantly dependent on politically driven local associations. The requirements or concerns from these local associations were also put forth through external pressures, such as political pressure and influenced the government agencies to prioritise (O1) providing the services and facilities.

The active involvement of the slum residents influenced how much consideration was given to the Technical (T) aspects of the proposal. Which was mainly the conversion of the collected requirements or concerns into a requirements analysis and planning (T2) and resource analysis and planning (T1). These requirements were further converted into feasibility reports and detailed project reports which also took into consideration the engineering and innovation (T3) aspects.

The requirements, resource analysis, planning and preparation of detailed project reports involved consideration that was given to the institutional (I) aspects which required expertise both from internal and external stakeholders (I2) such as departmental staff, professionals and subject matter experts.

The sample case studies in the informal settlements for which there was a limited involvement of the slum residents (S3) and external stakeholders (I2), the subsequent amount of consideration that was given to the socio-economic (S1), requirements analysis and planning (T2) and the internal and external stakeholders (I2) were observed to be limited.

The following table 71 illustrates the slum residents' perception analysis based on household interviews and focus group discussions in determining the factors that were considered during the decision making procedures at HMWSSB to provide drinking water facilities and services for the sample case studies in the informal settlements of the Hyderabad city region.

Table 71: Slum resident's perception analysis

Indicators		Social			Institutional			Technical			Economic			-
Sub Indicators		S1	S2	S3	I1	I2	I3	T1	T2	T3	E1	E2	E3	O1
Slum areas	#	-												-
Circle 1 _ Slum A	1	N	N	N	P	P	N	Y	N	Y	N	N	N	N
Circle 1 _ Slum B	2	P	N	Y	Y	Y	N	Y	P	Y	N	N	N	P
Circle 2 _ Slum A	3	N	N	Y	N	Y	N	Y	N	Y	N	N	N	N
Circle 2 _ Slum B	4	Y	N	Y	N	Y	N	Y	Y	Y	N	N	N	Y
Circle 3 _ Slum A	5	Y	N	Y	N	Y	N	Y	Y	Y	N	N	N	Y
Circle 3 _ Slum B	6	Y	N	Y	P	P	N	Y	Y	Y	N	N	N	N
Circle 4 _ Slum A	7	Y	N	Y	N	Y	N	Y	Y	Y	N	N	N	Y
Circle 4 _ Slum B	8	N	N	N	N	P	N	Y	N	Y	N	N	N	N
Circle 5 _ Slum A	9	N	N	N	N	P	N	Y	N	Y	N	N	N	N
Circle 5 _ Slum B	10	N	N	N	N	P	N	Y	N	Y	N	N	N	N
Circle 6 _ Slum A	11	N	N	N	N	P	N	Y	N	Y	N	N	N	N
Circle 6 _ Slum B	12	Y	N	Y	N	Y	N	Y	Y	Y	N	N	N	Y
Circle 7 _ Slum A	13	N	N	Y	N	Y	N	Y	N	Y	N	N	N	N
Circle 7 _ Slum B	14	N	N	Y	P	Y	N	Y	N	Y	N	N	N	Y
Circle 8 _ Slum A	15	N	N	N	P	P	N	Y	N	Y	N	N	N	N
Circle 8 _ Slum B	16	N	N	Y	N	Y	N	Y	N	Y	N	N	N	N
Circle 9 _ Slum A	17	Y	N	Y	P	Y	N	Y	Y	Y	N	N	N	N
Circle 9 _ Slum B	18	N	N	Y	P	Y	N	Y	N	Y	N	N	N	N
Circle 10 _ Slum A	19	N	N	Y	N	Y	N	Y	N	Y	N	N	N	Y
Circle 10 _ Slum B	20	Y	N	Y	P	Y	N	Y	Y	Y	N	N	N	P
Circle 11 _ Slum A	21	Y	N	Y	N	Y	N	Y	Y	Y	N	N	N	Y
Circle 11 _ Slum B	22	N	N	N	N	P	N	Y	N	Y	N	N	N	N
Circle 12 _ Slum A	23	P	N	Y	N	Y	N	Y	P	Y	N	N	N	N
Circle 12 _ Slum B	24	Y	N	Y	N	Y	N	Y	Y	Y	N	N	N	Y
Circle 14 _ Slum A	27	Y	N	Y	N	Y	N	Y	Y	Y	N	N	N	Y
Circle 14 _ Slum B	28	N	N	N	N	P	N	Y	N	Y	N	N	N	N
Circle 15 _ Slum A	29	N	N	N	N	P	N	Y	N	Y	N	N	N	N
Circle 15 _ Slum B	30	N	N	N	N	P	N	Y	N	Y	N	N	N	N
Circle 16 _ Slum A	31	P	N	Y	N	Y	N	Y	P	Y	N	N	N	P
Circle 16 _ Slum B	32	N	N	N	N	P	N	Y	N	Y	N	N	N	N

Indicators		Social			Institutional			Technical			Economic			-
Sub Indicators		S1	S2	S3	I1	I2	I3	T1	T2	T3	E1	E2	E3	O1
Circle 17 _ Slum A	33	N	N	N	N	P	N	Y	N	Y	N	N	N	N
Circle 17 _ Slum B	34	N	N	Y	P	Y	N	Y	N	Y	N	N	N	N
Circle 18 _ Slum A	35	Y	N	Y	N	P	N	Y	Y	Y	N	N	N	Y
Circle 18 _ Slum B	36	Y	N	Y	N	Y	N	Y	Y	Y	N	N	N	Y

Legend: Y (Compliant), P (Partially compliant), N (Non-compliant)

In summary, the overall slum residents' perception analysis and the stakeholders' analysis of the factors that were considered during the decision making processes by the HMWSSB in order to provide drinking water facilities and services showed that there were limitations in the amount of consideration that was given to the socio-health aspects and institutional aspects with variations amongst the sample case studies in the informal settlements. It can be concluded that there was significant consideration given to the analysis of the technical aspects. It can also be concluded that there was no consideration given to the analysis of the economic aspects throughout all of the sample case studies in the informal settlements during the decision making process in order to provide drinking water facilities and services, especially to the slum residents within the Hyderabad city region. Taking into consideration the above factors, the research study then focused on understanding the relationship between the quality and quantity of drinking water in the informal settlements and in what way did the factors influence the decision making procedures and what decision making processes were followed by the HMWSSB.

c. Sub-research question: *What was the relationship between the existing decision making process and the existing quality and quantity of drinking water*

In retrospect of the details specified in chapter 7 regarding the relationship analysis between quality and quantity of drinking water and the decision making processes that were involved to provide an adequate quantity and safe quality of drinking water facilities and services in this study revealed that there was a positive relationship between the existing decision making procedures and the existing quality and quantity of drinking water in the sample case studies in the informal settlements.

The relationship analysis was comprised of the corresponding pattern analysis between the overall findings from the analysis of drinking water quality and quantity and the analysis of the decision making framework. It was evident from the perception analysis and expert's judgement analysis that there were variations in the quality and quantity of drinking water between the sample case studies in the informal settlements in the Hyderabad city region.

The overall quality and quantity of drinking water was compliant in some of the slum areas, partially compliant in other slum areas and non-compliant in other slum areas. The quantity of drinking water in all of the slum areas did not meet the proposed standards. However, the quantity of drinking water supplied or made available to certain slum areas was relatively good, when compared to other slum areas.

Similarly, the stakeholders' analysis and the households' perception analysis of the factors that were considered during the decision making procedures also showed variations in considering factors during the decision making procedure amongst the sample case studies in the informal settlements in the Hyderabad city region. The factors considered during the decision making process to provide drinking water facilities and services was non-compliant for certain slum areas and partially compliant for certain slum areas. There were no slum areas for which all the factors (S, I, T, E) were considered during the decision making procedures to provides services and facilities.

Relationship between decision making procedures (factors considered) and drinking water (quality and quantity).

Analysis of the corresponding patterns between the independent (factors that were considered in decision making procedures) and dependent (such as drinking water quality and quantity aspects) variables, the sample case studies in the informal settlements for which the factors associated with socio-health (S), institutional (I), technical (T) and priority analysis (O) are considered during the decision making procedures at HMWSSB are having safe quality and adequate (in relative terms) of drinking water facilities and services.

This implies a positive corresponding relationship between socio-health (S), institutional (I), technical (T) and priority analysis (O) and quality and quantity of drinking water amongst the sample case studies in the informal settlements. Thus, the availability of drinking water facilities and services were influenced by decision making procedures which were compliant with socio-health (S), institutional (I), technical (T) and priority analysis (O). The sample case studies in the informal settlements for which the factors such as socio-economic (S1), slum residents' involvement (S3), internal and external stakeholders' involvement (i2), requirements analysis and planning (T2) and prioritisation (O1) were considered during the decision making procedures at HMWSSB, they had relatively safe quality and adequate drinking water facilities and services.

The sample case studies in the informal settlements for which the above-mentioned factors were not considered during the decision making procedures at HMWSSB did not have adequate quality and quantity of drinking water.

The involvement of slum residents (S3) led to acquiring socio-economic (S1) information, requirement analysis and planning (T2). The requirements analysis and planning were performed through the active involvement of the internal and external stakeholders (i2). Since, the involvement of slum residents in sharing their requirements and concerns were largely dependent on the local associations (external stakeholders) (i2), the prioritisation (O1) in providing facilities and services were given to these slum areas. This implies a positive corresponding relationship between socio-economic (S1), slum residents' involvement (S3), internal and external stakeholders' involvement (i2), requirements analysis and planning (T2) and prioritisation (O1) and quality and quantity of drinking water amongst the sample case studies in the informal settlements.

The corresponding pattern analysis revealed that the factors associated with economic (E) analysis were not considered during the decision making procedures at the HMWSSB and did not influence or determine the availability of adequate quality and quantity of drinking water facilities and services throughout the sample case studies in the informal settlements in the Hyderabad city region. Despite of the non-consideration given to the economic (E) analysis during the decision making procedures at HMWSSB, there were certain sample case studies in the informal settlements with an adequate quantity and safe quality drinking water. This implies a negative corresponding relationship between economic (E) analysis and the quality and quantity of drinking water amongst the sample case studies in the informal settlements.

A closer look at the corresponding pattern analysis revealed that consideration was given to the analysis pertaining to resource analysis and planning (T1) and engineering and innovation (T3) and there was no consideration given to the analysis pertaining to health conditions (S2), damage costs (E1), preventive costs (E2) and willingness to accept and pay (E3) during the decision making procedures which do not show any corresponding relationships with quality and quantity of drinking water across the sample case studies in the informal settlements.

Despite of consideration given to the resource analysis and planning (T1) and engineering and Innovation (T3) and the lack of consideration given to the health conditions (S2), damage costs (E1), preventive costs (E2) and willingness to accept and pay (E3) aspects, the corresponding pattern analysis showed that there were variations in terms of the availability of adequate quantity and safe quality of drinking water amongst the sample case studies in the informal settlements in the Hyderabad city region. This was due to the availability or non-availability of the drinking water facilities and services which were not influenced by the decision making procedures which showed partial compliance to social (S) aspects and non-compliance to economic (E) aspects. The consideration that was given to the health conditions (S2) and economic (E) aspects in the decision making processes, though essential, were not mandatory for the HMWSSB.

The availability (or non-availability) of drinking water facilities and services was not influenced by the decision making procedures which were compliant with the technical (T) aspects. The consideration given to the technical (T) aspects in the decision making processes were mandatory. Therefore, any plans or proposals that were submitted for improving or provisioning the drinking water facilities and services in the slum areas will have to undergo consideration of resource analysis and planning and analysis of engineering and innovation aspects.

However, the provision of drinking water facilities and services were largely dependent on other factors such as social (S) and institutional (I). This implies a negative corresponding relationship between resource analysis and planning (T1), engineering and innovation (T3), health conditions (S2), damage costs (E1), preventive costs (E2) and willingness to accept and pay (E3) and the quality and quantity of drinking water amongst the sample case studies in the informal settlements.

The following table 72 illustrates the level of factors that were considered during the decision making procedures and the quality and quantity aspects of the drinking water amongst the sample case studies in the informal settlements of the Hyderabad city region.

Table 72: Relationship between independent and dependent variables

Variables		Independent													Dependent	
Indicators		Social			Institutional			Technical			Economic			-	Quantity	Quality
Sub Indicators		S1	S2	S3	I1	I2	I3	T1	T2	T3	E1	E2	E3	O1	-	-
Slum areas	#	-												-	-	-
C 1-S A	1	P	N	P	P	P	P	Y	P	Y	N	N	N	N	N	N
C 1-S B	2	P	N	Y	P	Y	P	Y	P	Y	N	N	N	P	N	N
C 2-S A	3	P	N	Y	P	Y	P	Y	P	Y	N	N	N	P	Y	Y
C 2-S B	4	Y	N	Y	P	Y	P	Y	Y	Y	N	N	N	Y	Y	Y
C 3-S A	5	Y	N	Y	P	Y	P	Y	Y	Y	N	N	N	Y	Y	Y
C 3-S B	6	Y	N	Y	P	P	P	Y	Y	Y	N	N	N	P	Y	Y
C 4-S A	7	Y	N	Y	P	Y	P	Y	Y	Y	N	N	N	P	Y	Y
C 4-S B	8	P	N	P	P	P	P	Y	P	Y	N	N	N	N	Y	N
C 5-S A	9	P	N	P	P	P	P	Y	P	Y	N	N	N	N	N	N
C 5-S B	10	P	N	P	P	P	P	Y	P	Y	N	N	N	N	N	N
C 6-S A	11	P	N	P	P	P	P	Y	P	Y	N	N	N	P	N	N
C 6-S B	12	Y	N	Y	P	Y	P	Y	Y	Y	N	N	N	P	Y	Y
C 7-S A	13	P	N	Y	P	Y	P	Y	P	Y	N	N	N	P	Y	N
C 7-S B	14	P	N	Y	P	Y	P	Y	P	Y	N	N	N	Y	Y	Y
C 8-S A	15	P	N	P	P	P	P	Y	P	Y	N	N	N	P	N	N
C 8-S B	16	P	N	Y	P	Y	P	Y	P	Y	N	N	N	P	Y	N
C 9-S A	17	Y	N	Y	P	Y	P	Y	Y	Y	N	N	N	P	Y	N
C 9-S B	18	P	N	Y	P	Y	P	Y	P	Y	N	N	N	P	Y	N
C 10-S A	19	P	N	Y	P	Y	P	Y	P	Y	N	N	N	P	Y	Y
C 10-S B	20	Y	N	Y	P	Y	P	Y	Y	Y	N	N	N	P	Y	N
C 11-S A	21	Y	N	Y	P	Y	P	Y	Y	Y	N	N	N	P	Y	N
C 11-S B	22	P	N	P	P	P	P	Y	P	Y	N	N	N	N	Y	N
C 12-S A	23	P	N	Y	P	Y	P	Y	P	Y	N	N	N	N	N	N
C 12-S B	24	Y	N	Y	P	Y	P	Y	Y	Y	N	N	N	Y	Y	Y
C 14-S A	27	Y	N	Y	P	Y	P	Y	Y	Y	N	N	N	Y	Y	Y

Variables		Independent													Dependent	
Indicators		Social			Institutional			Technical			Economic			-	Quantity	Quality
Sub Indicators		S1	S2	S3	I1	I2	I3	T1	T2	T3	E1	E2	E3	O1	-	-
C 14-S B	28	P	N	P	P	P	P	Y	P	Y	N	N	N	N	N	N
C 15-S A	29	P	N	P	P	P	P	Y	P	Y	N	N	N	N	N	N
C 15-S B	30	P	N	P	P	P	P	Y	P	Y	N	N	N	N	N	N
C 16-S A	31	P	N	Y	P	Y	P	Y	P	Y	N	N	N	P	N	N
C 16-S B	32	P	N	P	P	P	P	Y	P	Y	N	N	N	N	N	N
C 17-S A	33	P	N	P	P	P	P	Y	P	Y	N	N	N	N	N	N
C 17-S B	34	P	N	Y	P	Y	P	Y	P	Y	N	N	N	N	N	Y
C 18-S A	35	Y	N	Y	P	P	P	Y	Y	Y	N	N	N	Y	Y	Y
C 18-S B	36	Y	N	Y	P	Y	P	Y	Y	Y	N	N	N	Y	Y	Y

Legend: Y (Compliant), P (Partially compliant), N (Non-compliant)

In summary, the overall corresponding pattern analysis between the factors considered during the decision making process in providing drinking water facilities and services and the quality and quantity aspects of drinking water amongst the sample case studies in the informal settlements, indicated that the amount of consideration that was given to the analysis of socio-health aspects, institutional aspects and technical aspects resulting in availability of adequate quantity and safe quality drinking water facilities and services. In addition to these, the priority analysis also played a positive role and the amount of consideration that was given to the socio-health aspects, institutional aspects and technical aspects during the decision making procedures to provide drinking water facilities and services.

Currently, the analysis of economic aspects was not taken into consideration during the decision making procedures in order to provide drinking water facilities and services to the sample case studies in the informal settlements in the Hyderabad city region.

Considering this corresponding analysis which displayed the factors which were considered during the decision making processes that influenced the provision of quality and quantity of drinking water facilities and services, the research study further focused on determining the factors that needed to be considered in a systematic and integrated decision making framework in order to provide a safe quality and adequate quantity of drinking water to the sample case studies in the informal settlements in the Hyderabad city region.

d. Main research question: *What factors influence, positively (or negatively), in the systematic and integrated decision making framework to provide safe quality and adequate quantity of drinking water facilities and services for the urban poor population*

In retrospect of the details specified in chapter 7 on the relationship analysis of quality and quantity of drinking water and the decision making framework to provide drinking water facilities and services revealed that there was a positive influence of analysis pertaining to socio-health (S), institutional (I) and priority (O1) during the decision making procedures regarding the availability of an adequate quantity and safe quality drinking water throughout the sample case studies in the informal settlements of the Hyderabad city region.

Thus, the sample case studies in the informal settlements for which these aspects were considered during the decision making processes had an adequate quantity and safe quality drinking water. It was observed from the relationship analysis that for all of the sample case studies in the informal settlements the analysis of the technical aspects were considered, and the analysis of the economic aspects were not considered in the decision making processes in order to provide drinking water facilities and services.

However, the aspects pertaining to technical (T) and economic (E) analysis in the decision making procedures to provide drinking water facilities and services had a neutral influence or no influence on the availability of an adequate quantity and safe quality of drinking water throughout the sample case studies in the informal settlements of the Hyderabad city region. This meant that the sample case studies from the informal settlements for which the technical aspects were considered during the decision making processes, were unable to fulfil their objectives of producing an adequate quantity and safe quality drinking water and the sample case studies in the informal settlements for which the economic aspects were considered during the decision making process had an adequate quantity and safe quality drinking water.

In summary, it can be concluded that the aspects that were considered in the systematic and integrated decision making framework that positively influenced the quality and quantity of drinking water facilities and services in the informal settlements of the Hyderabad city region were socio-health (S), institutional (I), prioritisation (O1); and the aspects that were neutral or did not influence the quality and quantity of drinking facilities and services in the informal settlements of the Hyderabad city region were technical (T) and economic (E) aspects of the systematic and integrated decision making framework.

7.3. Reflections on Conceptual Framework and Limitations

The current research study used a retroductive approach as the research strategy, which was the combination of a deductive approach that was used to formulate the conceptual framework and an inductive approach in order to confirm or modify the conceptual framework which were based on the ground realities. The research was initiated by developing a systematic and integrated valuation (decision making) framework called “S.I.T.E valuation” which combined different proven theories and ideas. In retrospect, the conceptual framework showed that it was vital to consider the analysis of socio-health, institutional, technical and economic aspects during the decision making procedures in a systematic and integrated fashion to provide safe and adequate drinking water facilities to the urban poor population.

The "socio-health" aspects to include consideration of socio-economic conditions, health conditions, and involvement of slum residents in the decision making procedures. Further, the "institutional" aspects to include the analysis of policies, regulatory frameworks, and procedures, involvement of internal and external stakeholders, and capacities and enforcements. Also, the analysis of "technical" aspects to include the analysis and planning of resources, requirements, engineering, and innovation, and followed by consideration of the analysis of "economic" aspects to include the damage costs, preventive costs, and willingness to accept and pay for the facilities and services.

The current research study which formulated the above stated conceptual (valuation) framework to provide safe and adequate drinking water facilities was deduced by combining various theories and concepts together, the ones that best suited the requirements to treat the proliferating drinking water challenges within the slum areas.

However, considering the inductive approach to understand the ground realities and the existing decision making procedures by the HMWSSB in order to provide drinking water facilities and services to the urban poor population in the Hyderabad city region, qualitative data was collected through household interviews and focus group discussions in the sample case study areas, the slum areas in the Hyderabad city region and stakeholders' interviews and focus group discussions.

Using an iterative process to understand the qualitative results and data from the different sources, such as rule books at HMWSSB, perception analysis of households' on factors considered for decision making through household interviews and focus group discussions at sample study areas, slum area level, stakeholders' interviews and focus group discussions at HMWSSB level, led to understanding and helped to significantly support the development of the position to explain the existing decision making procedures. The qualitative analysis of the existing decision making procedures revealed that the existing decision making procedures limited the amount of consideration that was given to the analysis pertaining to socio-health aspects, institutional aspects and economic aspects. The existing procedures considered the analysis pertaining to technical aspects for taking any decisions in order to provide facilities and services to the urban poor communities in the Hyderabad city region.

The interplay between the conceptual framework and the qualitative analysis led to certain interpretations. Comparing the factors that were considered by the (conceptual framework) systematic and integrated valuation (decision making) framework called "S.I.T.E valuation" and the existing decision making framework followed by HMWSSB to provide drinking water facilities and services, there were certain similarities and dissimilarities. As explained earlier, it was observed that the differential factors included the limited amount of consideration that was given to the socio-health aspects, institutional aspects, economic aspects and priority aspects. The commonalities included the amount of consideration given to technical aspects.

The following table 73 illustrates the commonalities and differentials between all of the factors related to (conceptual) S.I.T.E valuation framework and (existing) HMWSSB's decision making framework (followed by the HMWSSB to provide drinking water facilities and services).

Table 73: Comparison between S.I.T.E valuation framework and HMWSSB decision making framework

Factors/ Sub-Factors	S.I.T.E valuation framework	HMWSSB's decision making framework
Socio-Health (S)		
Socio-economic (S1)	Y	P
Health conditions (S2)	Y	N
Slum residents' involvement (S3)	Y	P
Institutional (I)		
Policies, regulations, procedures (I1)	Y	P
Internal and External stakeholders (I2)	Y	P
Capacities and Enforcements (I3)	Y	P
Technical (T)		
Resource analysis and planning (T1)	Y	Y
Requirements analysis and planning (T2)	Y	Y
Engineering and Innovation (T3)	Y	Y
Economic (E)		
Damage costs (E1)	Y	N
Preventive costs (E2)	Y	N
Willingness/ Ability to Accept/ Pay (E3)	Y	N
Others (O)		
Priority analysis (O1)	N	Y

Legend: Y – Applicable, P – Partially applicable, N – Not applicable

As In the HMWSSB's decision making framework the provision of drinking water facilities and services was treated as a technical activity which also included a minimal amount of external influences, the qualitative data that was collected regarding the existing quality and quantity of drinking water facilities and services revealed that the conditions were not good and there were disparities found amongst the slum areas in the Hyderabad city region. Besides realising the importance of the amount of consideration given to the technical aspects in order to provide drinking water facilities and services, it was clear that the amount of consideration given to priority analysis in the decision making procedures led to disparities in providing adequate drinking water facilities and services throughout all of the urban poor communities, which meant that the HMWSSB's decision making processes were not totally transparent, which led to inequality in providing adequate facilities and services.

Although there were certain limitations or partialities, the amount of consideration given to the socio-health aspects and institutional aspects were not a new consideration in the existing decision making framework at HMWSSB in order to provide drinking water facilities and services to the urban poor communities. However, the importance of considering these aspects in the decision making process was noticeable. From the qualitative analysis, it was revealed that in the areas where there was a significant amount of consideration given to socio-health aspects and institutional aspects, the quality and quantity of drinking water facilities and services were relatively better.

In particular, the analysis of the health aspects which was part of the socio-health aspects, were completely neglected during the decision making procedures. The amount of consideration given to the analysis pertaining to health aspects of the slum residents suggests the prevailing water quality challenges within communities. Apart from regular drinking water quality testing at community level and household level which required an adequate number of resources, such as laboratories, man-power and finance, understanding the perceptions of the households in terms of the quality of the drinking water from the different sources, prevailing water borne diseases, the frequency and how long the water was available for would provide a better introspection to the water related challenges.

In the current research study, which focused on both the analysis of the perceptions of the slum households and laboratory testing, referred to as the expert's judgement analysis, pertaining to the quality of drinking water from the different sources revealed that there were differences of opinions between these two sources, the peoples' perceptions and the laboratory test results regarding the quality of drinking water.

Based on the qualitative analysis, it was observed that the quality of drinking water in certain sample case studies in the slum areas was unsatisfactory, whereas the laboratory testing of drinking water samples from these samples met the Indian water quality standards. It was also observed that the quality of drinking water in certain sample case studies in the slum areas was satisfactory, whereas the results of the laboratory testing of the drinking water samples from these samples did not meeting the required quality standards.

Therefore, it was vital to understand and analyse the perceptions of households on the quality of drinking water at household and community level in conjunction with periodic laboratory testing of the quality of the drinking water. It was clear that the amount of consideration given to socio-health and institutional aspects play a significant role in the decision making procedures.

The amount of consideration given to analysis of the economic aspects, analysis of the damage costs, preventive costs and willingness to pay for better quality and quantities of drinking water was completely negligible in the existing decision making procedures. It was evident from the qualitative analysis that there were significant variations amongst the slum areas pertaining to availability of safe quality and adequate quantity of drinking water. This resulted in extra burdens to the slum population.

The focus group discussions held at slum area level revealed that the slum residents due to inadequate quantities and unsafe qualities of drinking water facilities and services that were provided by the HMWSSB incurred huge damage costs in terms of: Loss of productivity, Loss of health, Loss of life, Medical expenses, Extra expenses for addition drinking water sources, Preventive costs in terms of extra expenses for filtering mechanisms etc.

Discussions with the slum residents revealed that they were willing and had the ability to pay any additional costs for the drinking water facilities and services that are provided by HMWSSB, subject to their satisfaction levels. The slum residents also revealed that since they were anyway incurring overheads in terms of damage costs and preventive costs due to the present unsatisfactory drinking water conditions, they were not hesitant to pay more for better facilities and services which were in line with rest of the population in the Hyderabad city region.

The focus group discussions and household interviews in the slum areas also revealed that there was water related solutions, programmes and projects that had been developed and implemented by the HMWSSB which were not useful and delivered unsatisfactory levels of water.

For example, HMWSSB is currently investing huge resources with an aim to provide drinking water facilities and services 24/7 to the residents of the Hyderabad city region. It was however unclear if the slum residents were included in this initiative. Nevertheless, the requirements of the slum residents were different. It was revealed from the focus group discussions and household interviews that all they would require would be regularity and equity in drinking water supply and better infrastructure at the community and household levels.

Considering the above-mentioned arguments, it was clear that if consideration was given to the economic aspects, it will not only improve the assessment on return on investments to the Service providers, but at the same juncture, it will have a buy-in (acceptance) and the satisfaction from the users (in this case slum households), which will lead the project to a success.

Based on the above stated arguments, the author takes an affirmative standpoint in confirming the factors that should be included in a systematic and integrated decision making framework which should include Socio-health, Institutional, Technical, and Economic aspects. The following figure 12 illustrates the finalized valuation framework.

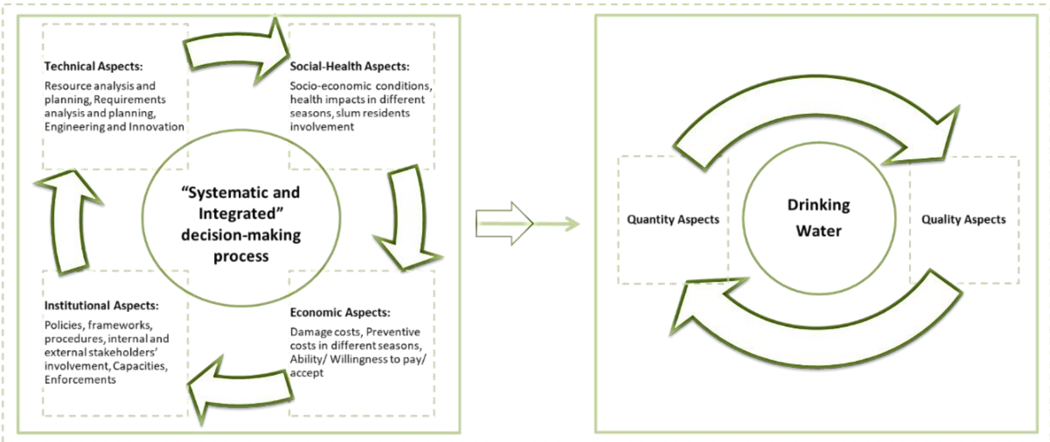

Figure 12: Factors to be included in a systematic and integrated decision making framework

The wide range of perspectives empower the study of conceivable links, or embedding this "new" approach into the existing decision making process in a systematic and integrated way, which includes:

- **Social perspective**. Analyzing the impacts of existing or future policies and strategies and peoples' participatory role in decision making process
- **Institutional perspective**. Analyzing the existing institutional processes and structures
- **Technical perspective**. Analyzing the quality and quantity aspects of the any infrastructure facilities and services
- **Economic perspective**. Analyzing the monetary values of infrastructure related challenges.

Although the current study was exhaustive, there is always a scope to improve. Considering the resource constraints, the current research study excluded certain aspects. The following section highlights the limitations of the study.

Limitations to the research study.

Although this research study was able to arrive at the key findings to address the research questions and develop a novel systematic and integrated decision making framework for the water sector, there were certain constraints and conditions which are worth mentioning.

The availability of the secondary data was the first limitation of this current research study. The current research which primarily focused on studying the slum areas in the informal settlements in the Hyderabad city region had difficulties in collecting updated list of slum areas or informal settlements from the departments. However, the list that was shared by the concerned departments in the Hyderabad city region after rigorous perusal and with great difficulty, which took almost 3 months to get access to list of slum areas of the Hyderabad city region. The current research did not conduct a validation exercise of the lists that was provided by the concerned agencies in the Hyderabad city region.

Further, in order to arrive at the sample case studies from the complete list of informal settlements in the Hyderabad city region, the current research study applied selection criteria on parameters such as status of slum area as notified slum, availability of drinking water facilities and services, agency responsible for providing drinking water facilities and services, etc. The secondary data pertaining to status of slum areas, availability of drinking water facilities and services, agency responsible, etc. was shared by the concerned government departments in the Hyderabad city region after rigorous perusal and with great difficulty, which took almost 3 months to get access to this data. Moreover, with regard to the secondary data such as demographic details, water infrastructure facilities and services, etc. for certain slum areas was limited. This limitation caused dropping out of the slum areas from the selection criteria analysis. However, the current research did not perform any validation exercise on this information pertaining to slum areas provided by the concerned agencies.

Going forward, in order to select the sample case studies for the current research study, in addition to the shortlisting criteria that was applied to the complete list of slum areas, the selection was also based on spatial distribution patterns of the slum areas in the Hyderabad city region. In order to select the sample case studies based on spatial distribution patterns, detailed location maps for the complete list of slum areas was a pre-requisite. These spatial data pertaining to the complete list of slum areas was shared by the concerned government departments in the Hyderabad city region after rigorous perusal and with great difficulty and took almost 2 months to get access to this data. The current research study did not conduct any validation exercise on this spatial information pertaining to the slum areas provided by the concerned agencies.

Despite the difficulties in accessing the secondary data, the current research successfully achieved a reasonable analysis and managed to select sample case studies. However, as a recommendation, the government agencies should devote more resources to update the information on a periodic basis and improve the public accessibility to such information, this would be an extended support to the academic societies and relevant research agencies.

To obtain the authorisation to be able to conduct a field study for primary data collection in each of the sample case studies in the informal settlements was another difficulty encountered during the research study. As water related issues in the slum areas of the Hyderabad city region are considered sensitive issues, there were restrictions in conducting household interviews and making focus group discussions to understand the quality and quantity aspects of drinking water from different sources of drinking water and quality of decision making procedures followed by HMWSSB in providing drinking water facilities and services. After rigorous follow-ups for a month with the concerned agencies in order to acquire permission to conduct primary data collections in these slum areas it was granted, with the understanding that the field researcher would be accompanied by an authorised area representative from the concerned government agency during all of the field visits. The authorised area representative was not part of any household interviews and focus group discussions. The authorised area representative only played a role in introducing the field researcher to the community.

The researcher only had limited access to certain slum areas and letting slum residents participate in household interviews and focus group discussions. This limitation caused dropping out of the slum areas from the sample case studies and replacing with other case studies in the informal settlements. In addition, since there was only one field researcher (myself) responsible for conducting all of the interviews at household level and focus group discussions at community level to understand water related issues and decision making procedures related issues. It was time consuming and took several weeks to organise formal meetings with the case study participants in the informal settlements and in collecting primary data through interviews and focus group discussions.

The current research focused on assessing the quantity of drinking water through household interviews and focus group discussions pertaining to the number of litres of drinking water that had been collected by the slum residents, and the number of days for which the collected drinking water was stored. It was not possible to perform any physical verification of the details that were provided by the slum households during the interviews and focus group discussions.

The current research also focused on assessing the quantity of drinking water through taking the water samples from the sample case studies in the informal settlements. Only one sample of drinking water from all of the sources of drinking water from half of the total number of sample case study areas was collected and given to the laboratory in order to test the quality of the drinking water. This was due to the financial resource constraints; the current research study could not afford to collect representative water samples from all of the sources of drinking water from all of the sample case studies in the informal settlements in the Hyderabad city region.

Although the current research primarily focused on assessing the quality and quantity of drinking water at the community level, the analysis pertaining to the existing conditions of the water related infrastructure facilities within the neighbourhood and in the city, and the analysis pertaining to the existing natural resources were not part of the current research study.

Further, the current research study also focused on assessing the decision making framework through stakeholders’ interviews and focus group discussions at HMWSSB. Although the analysis met the required objectives of the research, the concerned stakeholders were difficult to meet in order to conduct interviews and focus group discussions. It was only after rigorous follow-ups, which included frequent visits to the HMWSSB for a month with the concerned stakeholders in the HMWSSB for acquiring dedicated time to participate in interviews, required stakeholders spared some time in parts over few days. This means a single interview with one stakeholder which was supposed to happen on a single day for 1-2 hours, due to the busy schedules of the stakeholder, the interview was spread over 2-3 days with half hour time for interview on each day.

The same was the case with bringing the concerned stakeholders together for focus group discussions. This was also highly challenging. After rigorous follow-up letters and visits that took place over months the concerned stakeholders in the HMWSSB for acquiring dedicated time of all the concerned stakeholders to participate in focus group discussion, required stakeholders organised a few appointments where all of the stakeholders gathered for focus group discussions.

Even though it was challenging to organise discussions with all the concerned stakeholders that participated in the interviews and focus group discussions, they were able to provide the required details pertaining to decision making frameworks in order to providing drinking water facilities and services and they also cooperated in sharing their secondary data which was very useful.

The current study did not perform any validation analysis of the information that was provided by the concerned stakeholders which included the capacities and skills of the concerned stakeholders who participated in the interviews and focus group discussions and the organisational analysis.

The current research focused on obtaining what factors were considered during the decision making procedures in order to provide drinking water facilities and services and it also looked at the stakeholders involved at various stages during the decision making processes. The current research did not focus on the analysis of the stakeholders’ skills and capacities that were involved in the decision making process.

7.4. Recommendations to policymakers and decision-makers

The Hyderabad Metropolitan Water Supply and Sewerage Board (HMWSSB) is one of the youngest institutions (at least in Hyderabad city region) and the key stakeholder responsible for planning, designing, construction, organizing, executing, and managing water supply system, and provide adequate and safe drinking water facilities and services to the residents in the Hyderabad city region. Referring back to the qualitative analysis detailed in chapter 6, though the Institution is running with a goal to provide safe and adequate drinking water to 100% of the population of the Hyderabad city region which is predominately based on National Water Policy formulated by the Ministry of Water Resources (MoWR) and National Urban Policy formulated by the Ministry of Urban Development (MoUD), the decision making procedures defined in “rules of law” that are associated with HMWSSB in providing drinking water facilities and services are abstract and output oriented.

The stakeholders in the existing decision making framework who were involved in formulating any policies and strategies were made up of the State government bureaucrats and State government officials, there were no public representatives in the form of the general public or a parastatal agency, which led to a compromise in the administrative independence and non-transparency of the decision making processes.

Although there were certain e-governance initiatives which were implemented by the HMWSB, these were typically to collect and rectify operational and maintenance issues but did not take into account information regarding the required facilities and services. The e-governance initiatives were not user friendly to the slum population in the Hyderabad city region.

All the Requirements pertaining to drinking water services and improvements were requested by the public or resident welfare associations to the local representatives or to the officials of the HMWSSB. However, this workflow or the distribution of duties was not dictated by any official rule books or procedures of HMWSSB, or any other parastatal agencies. It took the form of informal arrangements. This was also prone to no obligations by the officials of the HMWSSB to take any action on the requirements received through these informal routes and channels which were not defined in any of the rule books of the HMWSSB. After receiving a request of the requirements from the various sources, the HMWSSB prepared detailed technical and financial feasibility reports in order to make decisions. Despite the clear mandates, the HMWSSB did not have any administrative powers or budgetary autonomy, which affected the financial status of the Board.

Although the notion behind the introduction of water tariffs was to make the public aware of the economic value of water, the water in Hyderabad is treated as a social good. Thus, restricting the Board's revenues and because of the lack of funds making it difficult to provide adequate infrastructure.

Any proposals by the water board for a revision of the water tariffs were strongly opposed by the political actors. The political actors also proposed to treat water as a common good and to provide it free of charge. Partly due to these factors, it is not surprising that Water Board's service levels have been declining over the past few years, especially in the slum areas of the metropolitan region.

It was argued that the HMWSSB, whose primary and major income is through user charges and partly through grants-in-aid, was not financially self-sustainable and was limited to making improvements in the services to the poor. Given the administrative and financial status of the HMWSSB and the availability of limited water resources in and around the Hyderabad city region, the external influences have played a significant role in the decision making process at the HMWSSB especially in choosing what actions to take in order to provide drinking water facilities and services to the whole of the Hyderabad city region including the slum neighbourhoods of the Hyderabad city region.

The provision of adequate drinking water facilities and services to the residents in Hyderabad city region has become a techno-bureaucratic activity, which is lacking in institutional (service provider) strengths, participation of slum population and estimations of their requirements. This combined with treating water as social good in the decision making processes has led to despair and disparities in the availability of safe quality and adequate quantity of drinking water facilities and services within the slum areas in the Hyderabad city region can be evidently perceived.

Reviewing the conceptual framework, the qualitative analysis of the stakeholders' interviews and the focus group discussions and bearing in mind the perceptions of the slum households regarding the factors that were considered in the decision making procedures in providing drinking water facilities and services to the slum areas in Hyderabad city region, it revealed that the HMWSSB limited itself in considering technical aspects, priority analysis, partially took into consideration the socio-health and institutional aspects, and not take into consideration the economic aspects.

Within these limited considerations of various factors or aspects, there are disparities in considering these factors or aspects amongst the slum areas. The above-mentioned procedures and consideration (non-consideration) of certain factors in the decision making processes in certain slum areas they had significant good results and the HMWSSB managed to provide a relatively adequate quantity and quality of drinking water facilities and services. This was further validated by the qualitative analysis regarding the perceptions of the households and the expert's judgement analysis in the slum areas regarding the quality and quantity of drinking water facilities and services.

Therefore, the decision making procedures impacted the quality and quantity of drinking water services and facilities in the slum neighbourhoods of the Hyderabad city region. The researcher recommends that the rules of law that the HMWSSB follows should include social, institutional, technical and economic analysis in a more definitive and implementable nature.

Considering the above-mentioned shortcomings, the HMWSSB may consider revising their decision making procedures in a more systematic and integrated approach, in an easy to implement form that moves away from *despair and disparity of drinking water facilities and services* to *adequate quality and safe quality of drinking water facilities and services to all the users* particularly amongst the slum areas in the Hyderabad city region. In order to do so, the researcher recommends that the HMWSSB should change their existing decision making framework by taking the following steps.

***Embrace the analysis of socio-health aspects through household interviews, focused group discussions, or surveys*.**

The existing decision making framework already considers the analysis of socio-economic conditions such as demographic patterns, income and expenditure details and housing conditions. It also indirectly involves the slum residents in order to analyse of their concerns and requirements of drinking water facilities and services. The indirect involvement of slum residents was completely dependent on the availability of local or welfare associations at slum area level. In the case of slum areas without local welfare associations, there was no indirect involvement of the slum residents. This is a point that should be addressed in order to have a systematic and integrated decision making processes.

The existing decision making procedure has to not just consider the analysis of socio-economic conditions of the slum residents, but also include analyzing the health aspects of the slum residents such as perceptions of households on illness caused due to drinking water from different sources, the different types of illness caused due to drinking water, duration and frequency of illness or diseases caused, and to understand the seasonal variations, etc. This should be done through household level interviews, surveys or focus group discussions. Slum residents need to be involved in the procedures in order to understand and analyse their concerns and requirements pertaining to drinking water facilities and services through household level interviews, surveys, or focus group discussions. The slum residents should be part of any decision making procedures, irrespective of the availability and non-availability of local or welfare associations at the slum area level.

Replace priority analysis with the analysis of economic aspects through household interviews, focused group discussions, or surveys.

The existing decision making framework considers priority analysis depending on the financial conditions, availability of natural resources and external influences such as political affiliations, power of the local or welfare associations. However, this has resulted in disparities in providing drinking water facilities and services amongst the slum areas in the Hyderabad city region. This is the area that needs to be addressed in order to have a systematic and integrated decision making process.

In order to bring equality and transparency in providing drinking water facilities and services to the slum residents of the Hyderabad city region, it is vital to include the analysis of the economic aspects such as damage and preventive costs that the slum residents already pay and their willingness to pay for regular accessibility to clean drinking water. This information could be collected through household interviews, focus group discussions and surveys.

The analysis of damage costs should reflect the loss of productivity and medical expenses that were incurred due to ill-health which was caused from the existing drinking water facilities and services. The analysis of preventive costs should reflect on the how much money was given out towards water purifying methods and the various sources of drinking water that the slum residents must buy in order to meet their daily needs.

This information could be acquired through household level interviews, surveys, or focus group discussions. By doing this analysis it will provide the HMWSSB with an understanding of the amount of money that the slum residents were incurring due to the current unsafe and inadequate drinking water facilities and services and the amount of money that can be realised in order to provide better facilities and services.

Streamline the analysis of Technical and Institutional aspects.

The existing decision making framework in providing drinking water facilities and services to the slum residents in the Hyderabad city region partially considers the technical and institutional aspects. This partial consideration is resulting in disparities in providing drinking water facilities and services amongst the slum areas in the Hyderabad city region. This is the pain area, which has to be addressed in order to have a systematic and integrated decision making process.

The technical and institutional aspects need to include the resource analysis and planning reflecting on the natural resources, man-made resources, man-power resources and financial resources. The technical analysis also needs to include the requirements analysis and planning which could be collected through household interviews, focus group discussions or surveys. As part of technical analysis, the elements pertaining to engineering and innovation which reflect the detailed technical assessments, engineering drawings, innovative technologies, local resources and information technology, need to be analysed and considered during the decision making processes.

In order to carry out the analysis of the Institutional aspects, consideration needs to be given to the following procedures - policies, regulatory frameworks, and procedures reflecting on existing policies, city development plans, sectoral plans, laws, regulations, standards, vision and mission statements of the Service provider, State and National level, Involvement of internal staff of the service provider, and the external players such as central government, state government agencies, non-governmental agencies, local/ welfare associations, local representatives, etc. Last but not the least, the analysis should also consider the capacities and enforcements reflecting on the analysis of institutional staff capacities in developing, implementing and monitoring the projects, programs, schemes, etc. and the analysis of enforcements to capture inputs on implementation options, monitoring and evaluation options, etc.

Based on the above-mentioned suggestions, the process flow in Annex 8A illustrates the existing decision making framework which has resulted in despair and disparities in providing drinking water facilities and services, which needs to be reconsidered and reconstructed to the proposed decision making framework to provide adequate quality and safe quality of drinking water facilities and services to all the users.

The following alterations were suggested to improve the existing decision making procedures which are currently followed by the HMWSSB to provide drinking water facilities.

a. Firstly, ***in terms of consideration of socio-health aspects***, in the existing decision making framework there was only the consideration of analysis pertaining to socio-economic conditions, and indirect involvement of slum residents to capture the water related concerns and requirements. However, in the proposed decision making framework take into consideration the analysis pertaining to socio-economic conditions, health conditions in different seasons, and slum resident's involvement in order to collect water related concerns and requirements.

b. Secondly***, in terms of consideration of technical aspects***, in the existing decision making framework take into consideration the analysis pertaining to resource analysis and planning, variations in requirements analysis and planning amongst the slum areas, and analysis of engineering and innovation aspects; however, in the proposed decision making framework there is consideration of resource analysis and planning, requirements analysis and planning without any variations amongst the slum areas, and analysis of engineering and innovation aspects.

c. Thirdly, ***in terms of consideration of institutional aspects***, in the existing decision making framework, there is consideration of analysis pertaining to policies, frameworks, procedures, variations in internal and external stakeholders' involvement amongst the slum areas, and analysis of capacities and enforcements;

however, in the proposed decision making framework, there is consideration of analysis pertaining to policies, frameworks, procedures, involvement of internal and external stakeholders without any variations, and analysis of capacities and enforcements.

d. Lastly, in the existing decision making framework, there was an amount of consideration given to the Priority analysis based on availability of funds and external influences; however, in the proposed decision making framework, consideration will be given to the analysis pertaining to economic aspects such as damage costs, preventive costs, and willingness or ability to pay for drinking water and services.

The transformation from the existing to proposed decision making procedures as per the above-mentioned guidelines will result in a better understanding of the water related challenges from a multi-dimensional perspectives in order to arrive at suitable solutions as per the requirements of citizens and at the same time reducing the externalities caused due to unsafe and inadequate drinking water. The amount of consideration given to the socio-health aspects provides information on the perspectives of citizens and their economic positions, including their prevailing health conditions, or issues due to the water quality and quantities. It will also involve the citizens in the decision making process. The amount of consideration given to the institutional aspects provides information on the perspectives of the organisations, rules of law and capacities and involvement of multi-actors in the decision making process. The amount of consideration given to the technical aspects provides information on the perspectives of resources and requirements, engineering feasibilities aspects and related options in providing services and facilities. The amount of consideration given to the economic aspects provides information on the perspectives of the damage and preventive costs that need to be nullified and foresees the willingness of the citizens to pay for various water related solutions and gives an insight on the ability of the citizens to pay for the services and facilities in order to make the efforts a success. Having these multiple perspectives to water related challenges results in moving away from the various variations in the provision of drinking water and unsafe and inadequate drinking water to adequate and safe drinking water to all users in cost-effective ways.

Based on the above stated proposed decision making framework and the advantages in embedding the same framework into the existing decision making processes to reduce the persistent drinking water challenges and improve the service delivery in an equitable and transparent fashion amongst the slum areas in the Hyderabad city region, the existing decision making process may be redesigned to consider the socio-health aspects, institutional aspects, technical aspects and economic aspects.

Annex 8B describes a step-by-step description of the proposed (to-be design) decision making processes including all of the concern stakeholders to be involved during the process, the inputs to be considered at different levels to perform the different activities, the activities to be performed by the concern stakeholders during the process and the outputs or outcomes of the activities, for HMWSSB to consider for implementation.

1. **Prepares representations or proposals.** This activity in the proposed decision making procedures remains unchanged from the existing decision making procedures. Refer section 5.1.4 for activity description.

2. **Submit representations or proposals.** This activity in the proposed decision making procedures remains unchanged from the existing decision making procedures. Refer section 5.1.4 for activity description.

3. **Raise concerns about O&M of drinking water facilities and services.** This activity in the proposed decision making procedures remains unchanged from the existing decision making procedures. Refer section 5.1.4 for activity description.

4. **Submit applications for new household water supply connections.** This activity in the proposed decision making procedures remains unchanged from the existing decision making procedures. Refer section 5.1.4 for activity description.

5. **Check for completeness and authenticity of the applications received for new water supply connections.** This activity in the proposed decision making procedures remains unchanged from the existing decision making procedures. Refer section 5.1.4 for activity description.

6. **Receive concerns about O&M of drinking water facilities and services.** This activity in the proposed decision making procedures remains unchanged from the existing decision making procedures. Refer section 5.1.4 for activity description.

7. **Access the proposals or representations or applications.** This activity in the proposed decision making procedures remains unchanged from the existing decision making procedures. Refer section 5.1.4 for activity description.

8. **Instructions to the concerned teams of HMWSSB.** This activity in the proposed decision making procedures remains unchanged from the existing decision making procedures. Refer section 5.1.4 for activity description.

9. **Instructions to the concerned teams of HMWSSB.** This activity in the proposed decision making procedures remains unchanged from the existing decision making procedures. Refer section 5.1.4 for activity description.

10. **Instructions to the concerned teams of HMWSSB.** This activity in the proposed decision making procedures remains unchanged from the existing decision making procedures. Refer section 5.1.4 for activity description.

11. **Instructions to the concerned teams of HMWSSB.** This activity in the proposed decision making procedures remains unchanged from the existing decision making procedures. Refer section 5.1.4 for activity description.

12. **Instructions to the concerned teams of HMWSSB.** This activity in the proposed decision making procedures remains unchanged from the existing decision making procedures. Refer section 5.1.4 for activity description.

13. **Field verifications to verify the concerns or requests raised.** This activity in the proposed decision making procedures remains unchanged from the existing decision making procedures. Refer section 5.1.4 for activity description.

14. **Drinking water quality testing and reporting.** This activity in the proposed decision making procedures remains unchanged from the existing decision making procedures. Refer section 5.1.4 for activity description.

15. **Verify preliminary field inspection reports**. This activity in the proposed decision making procedures remains unchanged from the existing decision making procedures. Refer section 5.1.4 for activity description.

16. **Verify preliminary field inspection reports.** This activity in the proposed decision making procedures remains unchanged from the existing decision making procedures. Refer section 5.1.4 for activity description.

17. **Instructions to the concerned teams of HMWSSB.** This activity in the proposed decision making procedures remains unchanged from the existing decision making procedures. Refer section 5.1.4 for activity description.

18. **Instructions to the concerned teams of HMWSSB.** This activity in the proposed decision making procedures remains unchanged from the existing decision making procedures. Refer section 5.1.4 for activity description.

19. **Concludes the false concerns or requirements with no action.** This activity in the proposed decision making procedures remains unchanged from the existing decision making procedures. Refer section 5.1.4 for activity description.

20. **Prepare feasibility reports.** The stakeholders for this activity shall include: the concerned officers, Projects or Operations or Technical at Circle level, HMWSSB. The officers at Circle level in consultation with the divisional or area level staff prepare the detailed technical and financial feasibility reports to address the concerns or requirements pertaining to drinking water services and infrastructure facilities. These detailed technical and financial feasibility reports consider the inputs from the analysis of the following:
    a. Internal staff capacities (Departmental staff capacities and capabilities to design, develop, implement and monitor or manage projects and programs)[97];
    b. Enforcements (availability of procedures and mechanisms to impose the rules and regulations);
    c. Socio-economic conditions (socio-economic conditions of the slum residents through household interviews, surveys and focused group discussions);
    d. Health conditions (prevailing health conditions of the slum residents through household interviews, surveys and focused group discussions);
    e. Resource analysis and planning (to understand the natural resources availability and other man-made infrastructure facilities, man-power, etc.);
    f. Requirements analysis and planning (services and facilities' needs assessment and gap identifications based on surveys, household interviews, focused group discussions and expert judgement);
    g. Engineering aspects (existing physical characteristics of the locality, existing quality and quantity aspects collected through primary household interviews or surveys, focused group discussions and secondary information such as QAT reports prepared by concerned agencies, recommendations, implementation plans, engineering drawings, etc.);
    h. Innovation (alternative technology and implementation options); (i) financial analysis (potential funding options, revenue generation, risk analysis, internal financial analysis, etc);
    i. Economic analysis (damage costs, preventive costs, willingness or ability to pay for improved facilities and services through household interviews, surveys, and focused group discussions). The inputs for this particular activity also include instructions and suggestions from the Functional Directors, HMWSSB on the above-mentioned aspects. The output of this activity includes draft feasibility reports.

[97] In the case of non-availability of the adequate staff, the detailed technical and financial reports should be prepared in consultations with third party vendors. In addition, tenders need t be called for selecting contractor or third-party vendors in order to implementing the works. Internal staff need to have adequate skills and capacities to review and monitor the works of the third-party vendors or contractors.

21. **Inputs on Technology options.** This activity in the proposed decision making procedures remains unchanged from the existing decision making procedures. Refer section 5.1.4 for activity description.

22. **Inputs on Implementation options.** This activity in the proposed decision making procedures remains unchanged from the existing decision making procedures. Refer section 5.1.4 for activity description.

23. **Submit feasibility reports.** The stakeholders for this activity include Functional Directors (operations or technical or projects) of the HMWSSB. The Functional Directors include the inputs received regarding the Technology and Implementation options from the concerned teams of HMWSSB into the feasibility reports. Further, the Functional Directors review the feasibility reports, discussed and finalised in consultations with the concerned operational staff. The finalised feasibility reports are then submitted to the Managing Director or Head of the Department, HMWSSB for further action. The inputs to perform this activity include draft feasibility reports and the outputs include the finalised feasibility reports.

24. **Verifies and discusses feasibility reports.** This activity in the proposed decision making procedures remains unchanged from the existing decision making procedures. Refer section 5.1.4 for activity description.

25. **No further action on unfeasible proposals.** The stakeholders for this activity include the Managing Director or the Head of the Department and Functional Directors of the HWMSSB. In case of projects or proposals or plans that are technically and financially (including the economic analysis of services or facilities and willingness to pay and accept) not feasible, the Managing Director in consultations with the Functional Directors, from the HMWSSB shall conclude the case with no further action. The inputs include feasibility reports and the outputs include instructions for no further actions.

26. **Approve the projects or proposals or plans for further actions.** In the case that the projects or proposals or plans are technically and financially feasible and the estimated value of each project or plan or scheme falls within the approval limits of US$ 1.5 million, the Managing Director shall approve all the projects or plans or schemes and prioritise them, in the order of implementation, based on the severity of the concerns or requirements at slum area level and the willingness to pay or accept facilities or services by the slum residents. The inputs for this particular activity include feasibility reports and the outputs include the approvals of the projects or schemes or plans and the list of the same in the order of execution.

27. **Discussions with Board of Directors and/ or State Assembly.** In case of projects or proposals or plans that are technically and financially feasible and the estimated value of each project or plan or scheme is above US$ 1.5 million, the State Assembly, Board of Directors and the Managing Director shall have consultations on the feasibility reports. The inputs to perform this activity include feasibility reports and the value of the projects or schemes or plans should be more than US$ 1.5 million.

28. **Approve the projects or proposals or plans for further actions.** During the discussions with Board of Directors and/ or State Assembly, the concerned stakeholders provide the required approvals and prioritise them in the order of implementation based on the severity of the concerns or requirements. The inputs to perform this activity include feasibility reports and the outputs include the approvals of the projects or schemes or plans and the list of the them in the order of execution.

29. **Procurement and project implementation procedures.** As per the list of approved projects or schemes or plans, in the order of implementation, the Managing Director or Head of the Department instructs the concerned Functional Directors and Operational staff to initiate the tendering, implementation and monitoring procedures. The inputs for this particular activity include an approved list of projects or schemes or plans and the outputs include instructions to the concerned staff.

30. **Publishing the projects or schemes or plans' details.** This activity in the proposed decision making procedures remains unchanged from the existing decision making procedures. Refer section 5.1.4 for activity description.

7.5. Value added to existing literature

Water related challenges across the world were proliferating, especially in emerging nations like India and as a consequence the human health, economies, growth and development were affected in disparities. In order to address these burgeoning water challenges, there were huge investments made in development water related infrastructure (NITI Aayog, 2018; Citi Research, 2017; Panjabi, 2014; Chakraborty and Mukhopadhyay, 2014; Chakraborty, 2017; Planning Commission, 2013; Lloyds, 2010).

However, it can largely be concluded that the real challenge is not with the water related systems, but the traditional water governance and management approaches which had a limited water problem solving efficiency (Teisman et al., 2013; OECD, 2011; OECD, 2015). Thus, the water crisis is not solely an engineering or technical problem, but a governance problem. This was acknowledged widely by the rise of water governance and management approaches that ponder on the public administration angle in dealing with water related challenges across the world and also in emerging economics like India (Sabatier et al., 2005;

van der Brugge et al., 2009; van Buuren et al., 2012; Teisman et al., 2013; OECD, 2015; OECD, 2011; Rijswick et al., 2014).

The importance of governance and management increased with the alarming uncertain conditions such as population growth, health, incomes and expenditures, lifestyles changes, economic development, water availability, demands, consumptions and competitions, climatic changes and ecological changes (Kathpalia and Kapoor, 2002; Fishman, 2011; Panjabi, 2014; Shiklomanov and Rodda, 2003; Bigas, 2012; Vaux, 2012; Solomon, 2010; Tucci, 2008; Johnston et al., 2012).

The positive human growth and economic development was tagged to well-governed and managed waters and at the same time, the hindrance to growth and development was associated with badly governed and managed waters. This led to call for the treatment of multifaceted domains, functions, institutions, actors and its integration in the governance and management framework across the world in order to treat water related challenges (Rijswick et al., 2014; Lubell and Edelenbos, 2013; Borchardt et al., 2013; Biswas, 2004; Hering and Ingold 2012; Margerum, 1999; Lubell and Lippert, 2011).

However, in view of what has been learned regarding the drawbacks of the widely accepted Integrated Water Resource Management (IWRM) frameworks, it was challenging for water governance and management to cope with a multitude of functions, domains and institutions. and was daring to establish a comprehensive, systematic and integral approach which is suits the contextual conditions and at the same juncture adaptable in nature (OECD, 2015; Lubell and Edelenbos, 2013; Edelenbos et al., 2013; Teisman et al., 2013; Lubell and Lippert, 2011; Castells, 2000; Sabatier et al., 2005; Tropp, 2007; Leach and Pelkey, 2001; Edelenbos and Teisman, 2011; Edelenbos, 2010; van Schie, 2010; Biswas, 2005).

Considering the necessity and urgency, it was important to develop a water governance and management framework in a systematic and integrated fashion, which was easy to implement and at the same time it moved away from water to other domains or functions in order to actually deal with water related issues to achieve the Sustainable Development Goals (OECD, 2015; Lubell and Edelenbos, 2013; Rijswick et al., 2014; Bellie, 2011).

Insights on relevant aspects to consider in water governance framework.

Considering the above stated literature gaps, the current research study has provided insights into relevant aspects to achieve a systematic and integrated water governance framework, focusing on a multi-dimensional, multi-functional and multi-actors approach in an implementable fashion and context specific, especially for urban poor communities. Based on the empirical analysis in the current research study, it is evident that in addition to the technical aspects, the other perspectives such as social, health, economic and institutional analysis play a significant role in dealing with water related challenges. This multi-disciplinary and multi-dimensional framework comprising of the following four perspectives: social-health, institutional, technical and economic, which were context-specific and citizen-centric in the decision making procedures in order to provide drinking water facilities and services in a cost-effective way.

Figure 13 illustrates the relevant aspects that need to be considered in the water governance framework in a systematic and integrated approach in order to handle water related challenges and provide safe quality and an adequate quantity of drinking water facilities and services to the urban poor communities.

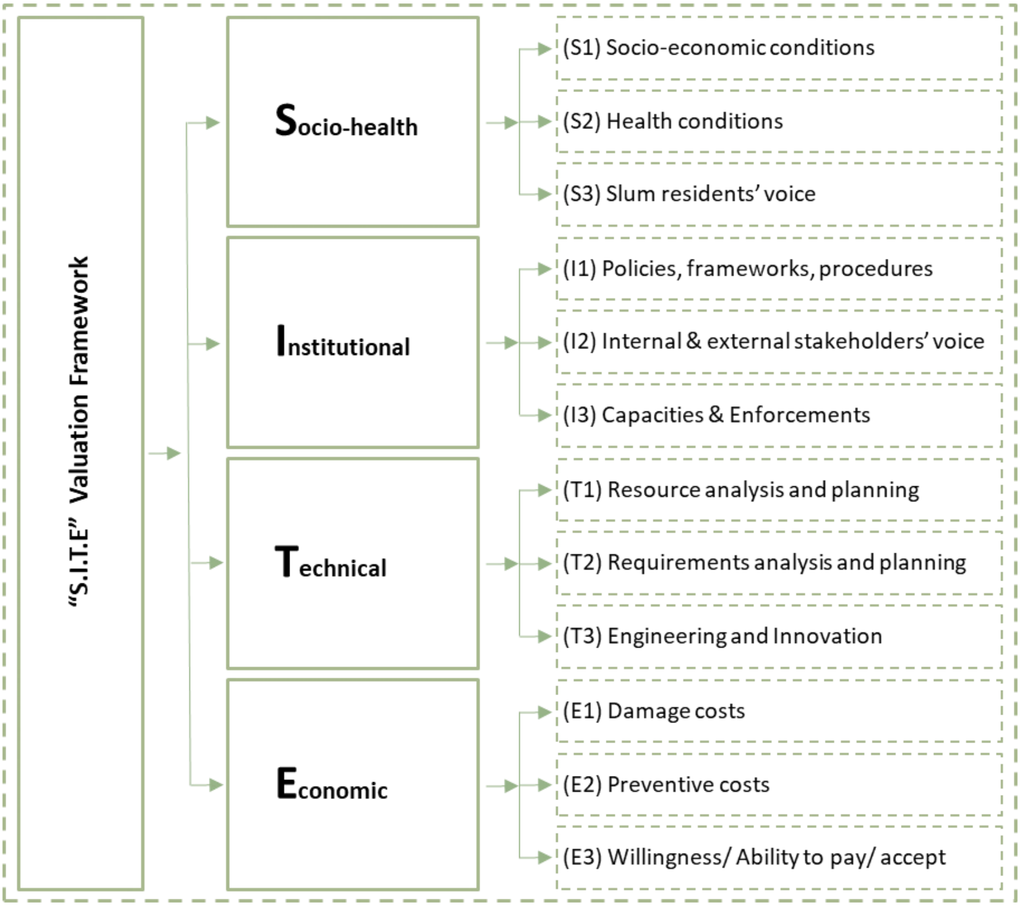

Figure 13: S.I.T.E valuation framework

In summary, the four perspectives of the water governance valuation framework include socio-health aspects comprising socio-economic conditions, health conditions, and slum resident's involvement, followed by institutional aspects comprising policies, frameworks, procedures, internal and external stakeholder's involvement, and capacities and enforcements. In addition to technical aspects comprising resources and requirements analysis and planning, and engineering and innovation, the valuation framework (or the water governance framework) include economic aspects comprising damage and preventive costs, and willingness or ability to pay and accept. The following description provides the in-depth description of all four perspectives of the systematic and integrated water governance framework to provide drinking water facilities and services.

Perspective 1. Analysing the Socio-health conditions through the interactive approach with the users. To that effect, the decision making frameworks and tools should include:

a. **(S1) Socio-economic conditions** – The analysis should at minimum consider the demographic details such as Household sizes, population, income levels, expenditure patterns, Households with employment, type of occupation, type of expenditures, etc. at community level. This can be accomplished through household interviews, focused group discussions, or household surveys. The purpose of this analysis is to provide a preliminary understanding of the population sets that need to be dealt with during the decision making process in providing facilities and services

b. **(S2) Health conditions** – The analysis should at minimum consider the analysis of health conditions of the target population by capturing the perceptions of the household on different type of illness, duration of illness, frequency of illness, seasonal variations of illness, etc. prevailing at community level. This can be achieved through household interviews, focused group discussions, or household surveys. In addition to capturing the perceptions of the households, analysis of documentary evidences and interactions with medical practitioners, doctors at local clinics and hospitals should be considered to understand the causes of health-related issues and to validate the perceptions of the households. The purpose of this analysis is to provide a preliminary understanding of the health conditions and the sources or causes of water borne diseases that are commonly found at the community level, which need to be considered during decision making processes in order to solve the correct challenges.

c. **(S3) Slum residents’ voice** – The analysis should at minimum consider the perceptions of the slum residents in the targeted communities to collect the details pertaining to the existing quality and quantity of drinking water facilities and services, satisfaction levels of the existing drinking water facilities and services, drinking water facilities and services requirements, impacts of previously implemented projects, schemes and programmes at the community level through household interviews, focus group discussions and household surveys. The purpose of this analysis is to provide the understanding and inputs from slum residents in order to pertain their perceptions of the existing facilities and services and requirements pertain what they require in the future so that the information can be used during the decision making processes to provide the required facilities and services.

Perspective 2. Analysing the Institutional aspects through thorough coordination of stakeholders. To that effect, the decision making frameworks and tools should include:

a. **(I1) Policies, regulatory frameworks, procedures** – The analysis should at minimum consider the existing functions, vision statements, objectives, policies, strategies, regulations, and procedures (in practice), etc. pertaining to drinking water facilities and services through thorough interactions with all the relevant stakeholders and subject matter experts and documentary analysis. The purpose of this analysis is to bring all the decisions, or the proposed solutions in harmony with the overarching policies, regulations and procedures during the decision making processes.

b. **(I2) Internal and external stakeholders' involvement** – The analysis should at minimum consider the roles and responsibilities of various stakeholders like involvement of management teams, operational teams, local associations, public representatives, consultants and subject matter experts. This can be done through focused group discussions and individual consultations on various subject matters. The purpose of this activity is to be bring the expert opinions of all the concerned stakeholders together in order to develop wider viewpoints to bring to the decision making process.

c. **(I3) Capacities and enforcements** – The analysis should at minimum consider the aspects pertaining to Stakeholders' capacities, implementation frameworks, monitoring frameworks and procurement guidelines. This is done primarily through documentary analysis and interacting with the key stakeholders who are responsible for each of these activities. The purpose of this activity is to bring what has been learned and how much was money was invested into previously implemented, both successful and unsuccessful, projects, programmes and schemes to understand the implementation and monitoring aspects within decision making process.

Perspective 3. Analysing the Technical aspects to formulate solutions. To that effect, the decision making framework and tools should include:

a. **(T1) Resource analysis and planning** – The analysis should at minimum consider the aspects pertaining to natural resources, man-made infrastructure facilities and services, man-power, financial resources availability and requirements to support the proposed solutions pertaining drinking water facilities and services. This can be achieved through detailed field level analysis, interactions with concerned agencies and experts and documentary analysis. The purpose of this activity understands and analyse the available resources and required resources in order to plan for the proposed solutions in the decision making process.

b. **(T2) Requirements analysis and planning** – The analysis should at minimum consider the aspects pertaining to service needs and requirements to improve the satisfaction levels of the users which can be collected through household interviews, focus group discussions, or household surveys at community levels. The purpose of this activity is to understand and analyse the actual requirements of the users or communities which will be part of the decision making process.

c. **(T3) Engineering and Innovation** – The analysis should at minimum consider the aspects pertaining to existing local conditions, technical feasibilities and engineering drawings. for the proposed solutions to provide the required facilities and services at community level by involving the internal and external experts. Through documentary analysis and interactions with relevant stakeholders and subject matter experts a detailed analysis of the challenges, best practices, innovative ideas, viable alternatives and technology usage can be carried out and that could be included in the proposed solutions. The purpose of this activity is to include the technical and financial feasibility studies and combine them with innovative technologies and knowledge in order to achieve a better outcome during the decision making processes.

Perspective 4. Analysing the Economic aspects of the users. To that effect, the decision making framework and tools should include:

a. **(E1) Damage costs** – The analysis should at minimum consider the aspects caused due to inadequate quantity and unsafe quality of drinking water facilities and services provided to the households or communities pertaining to loss of productivity, medical expenses, expenditure on drinking water services other than the services provided by the government agencies. This can be achieved through household interviews, focus group discussions, or household surveys. The purpose of this activity is to understand the consequences of the poor quality and quantity of drinking water systems and monetary burdens on the poor households or communities during decision making processes.

b. **(E2) Preventive costs** – The analysis should at minimum consider the aspects pertaining to expenditure on filtering mechanisms, etc. caused due to the inadequate quality of drinking water services which are provided to the households or communities. This information can be gained through household interviews, focus group discussions, or household surveys. The purpose of this activity is to understand the consequences of the poor quality of drinking water systems and the monetary impacts on the households or communities during decision making process.

c. **(E3) Willingness or ability to pay and accept** – The analysis should at minimum consider the willingness of the urban poor to pay for a specific set of proposed solutions pertaining to drinking water facilities and services. This information can be collected through household interviews, focus group discussions, opinion polls, or household surveys. The purpose of this activity is to understand the pulse of the public or users of the facilities and services or the beneficiaries of the proposed solutions in order to be able to meet their requirements or satisfaction levels during the decision making processes and before initiating the projects, programmes, or schemes.

***Positive (or negative) relationship between the water governance framework and the drinking water*.**

Taking into consideration what was mentioned above, it can be noted that the systematic and integrated framework primarily focuses on drinking water quality and quantity aspects in the urban poor communities. Considering the literature gaps previously mentioned in this section, it can be noted that the water governance models do not consider the aspects pertaining to quality and quantity of drinking water. The current research not only provides a multi-disciplinary and multi-dimensional governance framework, but it also provides an in-depth relationship between the governance framework and its influence on the quality and quantity of drinking water supplied to the urban communities by the service provider.

The current research's empirical analysis, which focused on both the governance framework and drinking water, provided in-depth relationship between factors comprising of water governance and drinking water quality and quantity. The corresponding patterns between these two variables showed that the slum areas for which the decisions were taken considered Socio-health (S), Institutional (I), Technical (T) and Priority analysis (O) had safe and adequate drinking water facilities and services and the areas for which decisions were taken without considering these aspects did not have safe and adequate drinking water facilities.

The corresponding patterns also showed that the slum areas for which the decisions were taken without considering the factors associated with Economic (E) analysis were unable to determine the availability of adequate quality and quantity of drinking water facilities and services.

***Combination of perception analysis and expert judgement for assessing drinking water quality and quantity*.**

Since this research took into consideration the people as the consumers of drinking water, it was advantageous to have the perception of those people regarding their drinking water quality and quantity. Although many studies just focus on the expert judgements regarding the quality and quantity of drinking water, which were accurate and scientific in nature, understanding the viewpoints of the consumers as well shall complement the results obtained through expert judgements. Because, at the end of the day, it is the public who were affected by the services, in a positive or negative way.

Therefore, the combination of both household perceptions and expert judgement analysis shall have a mutually complimenting effect on the output. The household perceptions collected through household level interviews and focus group discussions aid in understanding the viewpoints of the consumers of the drinking water.

The expert judgement analysis for assessing drinking water quantity is recommended to be carried out by capturing the inputs such as total number of litres of water collected and the total number of days for which the fetched water is stored, through household interviews and focus group discussions. In order to assess the drinking water quality, the water samples from different sources at household and community level shall be collected for laboratory tests. In this way, the assessment of drinking water quality and quantity is not only scientific, but it will also have a human perspective.

Based on this combined approach to assess the drinking water, in the current research study, the household level perception analysis revealed that the quality and quantity of drinking water supplied through different sources was inadequate in some of the slum households in the sample case studies in the slum areas and was adequate in other slum households in a some of the sample case studies in the slum areas.

The overall perception analysis showed that there were variations amongst the sample case studies in the slum areas in terms of quality and quantity of drinking water in the Hyderabad city region. This was further confirmed by the expert's judgement analysis. The drinking water quantity and quality assessment was carried out in each of these sample case studies in the slum areas.

The expert's judgement analysis identified that the quantity of drinking water that was available to the slum households was far below the water quantity standards. However, there were a certain number of sample case studies in the slum areas for which the quantity of drinking water that was available was relatively reasonable compared to the other sample case studies in the slum areas.

Similarly, the expert's judgement analysis showed that the quality of drinking water from the different sources to the slum households was below the water quality standards. However, there were a certain number of sample case studies in the slum areas for which the quality of drinking water that was available met the water quality standards. The overall expert’s judgement analysis showed that there were variations amongst the sample case studies in the slum areas in terms of the availability of safe quality and adequate quantities of drinking water in the Hyderabad city region.

Combination of perception analysis and stakeholder assessment regarding the quality of the decision making procedures.

Since people were the beneficiaries of the decisions taken by the government agencies, it was always advantageous to have the perceptions of the people in the decision making procedures. Though many studies just focus on the stakeholder or institutional assessment in order to understand the decision making procedures, if the viewpoints of the beneficiaries are also taken into account this would complement the results obtained through stakeholder consultations at the Institutional level.

The household perceptions collected through household level interviews and focus group discussions aided in understanding the views of the consumers on the aspects considered during the decision making procedures, especially regarding the provision of drinking water facilities and services. The stakeholders’ analysis in order to understand the decision making procedures was carried out by interviewing the relevant actors at institutional level through personal interviews and focus group discussions.

In the current research study, the qualitative analysis of the stakeholders’ interviews and focus group discussions at HMWSSB level made it possible to understand the factors that were considered during the decision making procedures to provide drinking water facilities and services to the sample case studies in the Hyderabad city region. It revealed that there was only a partial amount of consideration given to the social-health aspects (S) and institutional aspects (I). However, there was a significant level of consideration given to the analysis of technical aspects (T) and completely no consideration given to the economic aspects (E) during the decision making procedures at HMWSSB.

The priority analysis (O1) was carried out to prioritise or shortlist the neighbourhoods in order to provide drinking water facilities and services. The qualitative analysis in the decision making procedures of each sample case study in the slum areas showed that there were variations amongst the sample case studies in the slum areas in terms of the amount of consideration that was paid to the analysis of socio-health (S), Institutional (I), Technical (T) aspects and Prioritisation (O). The analysis revealed a positive corresponding relationship between socio-health (S), institutional (I), technical (T) and priority analysis (O1), i.e. higher the level of involvement of institutional aspects (I), the higher the level of involvement of social-health aspects (S) and eventually the higher the level of involvement of technical aspects (T) during the decision making procedures.

This was further confirmed by the perception analysis of households in the sample case studies in the slum areas. The perception analysis of the households in the sample case studies in the slum areas in the Hyderabad city region was carried out to understand the quality of the decision making procedures that were followed by the HMWSSB and to understand which factors were considered during the decision making procedures from the view point of slum households. Similar results were revealed to what was observed in the qualitative analysis of the stakeholders' interviews and focus group discussions at the HMWSSB.

7.6. Future Research

It could have just been another PhD research study with stakeholder consultations at the government agencies and household interviews in the informal settlements of Hyderabad city region, India, to understand the prevailing conditions of drinking water quality and quantity and the factors that were considered in water governance and management. The consultations revealed the particulars about the scarce drinking water resources in the Hyderabad city region in general, and the variations in availability (or despair conditions) of drinking water facilities and services amongst the informal settlements and the techno-bureaucratic approach which was followed by the HMWSSB (service provider) in providing drinking water facilities and services to these informal settlements.

Some of the neighbourhoods were pleased with the drinking water availability on a regular basis and were able to meet their household requirements. But, some of the neighbourhoods were in anguish due to irregular, inadequate and unsafe drinking water facilities and services. It was a known fact that any interviews or focus group discussions were unable to be restricted to a 3-page questionnaire or a checklist (used to collect information applicable to the PhD research study only).

During the interviews and focus grouped discussions, occasionally, the discussions took an altered tangent to broadly understand the consequences of good or bad quality and quantity of drinking water facilities and services. An example of this occurring was when the residents started complaining about loss of lives, loss of health, loss of productivity, loss of time, loss of education, medical expenses, water purification expenses and expenses towards drinking water.

The residents were not only dealing with inadequate and unsafe water, but it also affected their livelihoods. A part of the population felt that they had been abandoned and lived in desperate conditions. When I first heard these claims, thoughts started to take over the, till then, fairly pleasant mind. I began to notice the variations in the provision of drinking water facilities and services to different neighbourhoods and I became conscious of the consequences of the variations in the availability of the quality and quantity of drinking water in and around me.

I began to ponder, if this was the situation and the government agencies really did discriminate due to the prevailing governance and management frameworks in providing drinking water facilities and services in these localities, what would be the consequences on the health and economic positions of the residents living in already impoverished localities and marginal incomes? Was this worse that I could imagine? Was this true? I was uncertain.

As a consequence, certain questions emerged which were identified and left unaddressed during my PhD journey: (a) What were the consequences of variations in providing drinking water facilities and services across the city region?, (b) How is it possible to have good or poor quality drinking water that is supplied in disparities between localities which affects the health and economic positions?, (c) How is it possible to have good or poor quantity drinking water that is supplied in disparities between localities which affects the health and economic positions?

This trigger further research in order to investigate these pondering questions to explain the consequences of the disparities in providing drinking water facilities and services and its linkage with governance and management frameworks and drinking water quality and quantity, especially in the informal settlements in the Hyderabad city region. In view of the above mentioned points, the future research may focus on: (a) assessing the availability of quality and quantity of drinking water, (b) assessing the consequences, in term of health and economic positions of citizens which is caused due to good or poor quality and quantity of drinking water, (c) explaining the relationship between the governance (decision making) framework, quality and quantity of drinking water, (d) investigating the consequences caused due to the quality and quantity of drinking water.

The further research may take-off from the current Ph.D. research analysis, which focused on determining the systematic and integrated water governance and management (decision making) framework to provide safe quality and adequate quantity of drinking water to the urban poor population. The future research may start from briefly citing the current PhD research findings regarding the lack of integral frameworks which were followed in the study area, that were responsible for the prevailing disparities of drinking water quality and quantity amongst the slum areas and the factors such as "social", "institutional", "technical" and "economic" would be considered to have a systematic and integral water governance and management (decision making) to provide adequate quantity and safe quality of drinking water facilities and services in the Hyderabad city region.

Going forward, the future research shall further analyse the regional variations, for example, the perception of the slum households on the consequences of good or poor quantity and quality drinking water on the prevailing health conditions, which shall include the types of illness, frequency of illness, duration of illness and seasonal variation, which were caused due to the quality and quantity of drinking water supplied by the institution (Service provider).

The study shall further analyse the regional variations, the perceptions of the households regarding the consequences of good or poor quantity and quality drinking water on an economic scale, which shall include loss of productivity, loss of health, loss of time, medical expenses, purification expenses and expenses due to additional sources of drinking water.

Based on the analysis findings on the quality and quantity of drinking water and the consequences of good or poor drinking water, the future research may further identify and explain the relationship between the variables within the governance framework, drinking water quality and quantity and consequences (health and economic positions of citizens) due to good or poor drinking water using the Structural equation model (SEM), combining factor analysis and regression analysis.

The quantitative analysis may further be supported and strengthened by qualitative analysis of slum household perceptions of the relations between the governance framework, drinking water (quality and quantity) and consequences (health and economic positions of citizens). Based on the mixed (qualitative and quantitative) analysis, the study may confirm or modify the conceptual framework involving decision making procedure, quality and quantity of drinking water and consequences (health and economic positions of citizens) due to good or poor drinking water and append any other aspects identified during the future research study.

Given the complex nature of the future research study, broadly, the researcher may consider the epistemological positions "positivism or post-positivism", "interpretivism" which will focus on the ontological positions' "objectivism" and "constructivism". Considering the complex nature of the research, which is dealing with a wide range of elements, demands both rational and perceptional discernments, the researcher's epistemological and ontological assumptions which would be set out herein and would be positioned in the "shared criteria" or "collective knowledge" between positivism or post-positivism, objectivism, interpretivism and constructivism.

The researcher may take the position of both "interpretist" (primary position) and "positivist" (secondary position) and by switching between these two roles depending on what the situation demanded in order to acquire the requirements for the derivation of the knowledge.

The future research study would involve a mixed methodology, a combination of qualitative and quantitative methods, and the research position would be a mutually influencing and contributing process to strengthen the research study and increase the methods validity and reliability.

A literature and empirical research may be conducted simultaneously, in a mutually influencing and contributing process. Based on the above mentioned, the future research would consider the interplay of theories or concepts and data or evidence in a retroductive approach. Which would include a combination of a deductive approach to start with formulating the conceptual framework and followed by an inductive approach for confirming or modifying the conceptual framework based on the ground realities, the data or evidence.

To further to epistemological considerations and mixed methodology positions, the Case Study approach may be used as the research strategy. The case study approach for the proposed research would be more directed to specific boundaries, which will help with the collection of primary and secondary data.

The selection of case studies however shall be based on a detailed selection criterion suiting the requirements of the future research goals. The Research methods involves both qualitative and quantitative analysis that primarily involves statistical methods such as perception analysis, corresponding pattern analysis, factor or variable analysis and regression analysis using structure equation model. This analysis however requires the involvement questionnaire-based interviews and focus group discussions with a representative sample of the population in the selected case study areas.

Based on the above, the future research may take the following sequential research methodological steps: (a) Developing a water governance and management framework through a literature review, (b) Assessing the quality and quantity aspects of drinking water comprising of both qualitative and quantitative data which will be collected through personal interviews at household level, focus group discussions at community level, water sample collection at household and community level from different sources, such as individual taps, public taps, bore wells, hand pumps and water tankers, of drinking water and laboratory testing of the drinking water samples, (c) Assessing the consequences. which will include both the health and economic positions of the citizens, of good or poor quality and quantity drinking water comprising of both qualitative and quantitative data which would be collected through personal interviews at household level and focus group discussions at community level, (d) Testing the theoretical model, systematic and integral water governance frameworks effecting drinking water quality and quantity and in turn effects on the economic and health positions of citizens, using Structural Equation Model and analyse the patterns, (e) The patterns and insights drawn from the quantitative analysis would then further lead to a qualitative follow-up to deepen the understanding of the relationship found in the statistical research through personal interviews at the household level and focus group discussions at the community level.

As mentioned previously in the research content description of this study, there has been a lot of literature produced and much recent research on water governance and management frameworks and quality of decision making (OECD, 2015; Rijswick et al., 2014). However, in addition to not having systematic and integrated water governance frameworks which could be easy to implement, empirical analysis was also missing. The literature and research studies mainly pose conceptual frameworks without an actual application capability or actual analysis that has been put into practice, especially in urban slums.

The prevailing literature and studies do not really go beyond the assessment of water quality and quantity, which include assessments regarding economic and health positions of people living in urban slums. Therefore, the future research may combine various disciplines, such as public administration, governance, water economics, health care and hydrology in order to assess the quality and quantity of the water in a given area. The future study may combine beta and gamma sciences aiming to give an interdisciplinary character to water governance and management so that it would be possible to have evidence-based policymaking.

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Annexures

Annexure 1 I Selection criteria

a. Total number of slum areas in Hyderabad city region

The table 74 below illustrates the total number of slum areas in each circle (Administrative boundary) in Hyderabad city region.

Table 74: Number of slum areas in Hyderabad city region

Circle No.	Circle Name	No. of Slums
	East Zone	
1	Kapra	48
2	Uppal	28
3	L.B. Nagar	84
	Sub-total (A)	**160**
	South Zone	
4	Charminar (Erstwhile Circle – I)	214
5	Charminar (Erstwhile Circle – II)	95
6	Rajendra Nagar	45
	Sub-total (B)	**354**
	Central Zone	
7	Khairatabad (Erstwhile Circle – IV)	148
8	Abids (Erstwhile Circle – VI)	36
9	Abids (Erstwhile Circle – III)	180
10	Khairatabad (Erstwhile Circle – V)	161
	Sub-total (C)	**525**
	West Zone	
11	Sherilingampally (S)	26
12	Sherilingampally (N)	32
13	Ramachandra puram & Patan Chervu	12
14	Kukatpally	68
	Sub-total (D)	**138**
	North Zone	
15	Quthbullapur	63
16	Alwal	52
17	Malkajgiri	42
18	Secunderabad	132
	Sub-total (E)	**289**
	Grand Total (A+B+C+D+E)	**1466**

b. Number of Notified and Non-notified slum areas in Hyderabad city region

The table 75 below illustrates the total number of notified and non-notified slum areas in each circle (Administrative boundary) in Hyderabad city region.

Table 75: Number of Notified and Non-notified slum areas in Hyderabad city region

Circle #	Circle Name	Total No. of Slums	No. of Notified Slums	No. of Non-Notified Slums
East Zone				
1	Kapra	48	44	4
2	Uppal	28	26	2
3	L.B. Nagar	84	57	27
	Sub-total (A)	**160**	**127**	**33**
South Zone				
4	Charminar (Erstwhile Circle – I)	214	175	39
5	Charminar (Erstwhile Circle – II)	95	85	10
6	Rajendra Nagar	45	38	7
	Sub-total (B)	**354**	**298**	**56**
Central Zone				
7	Khairatabad (Erstwhile Circle – IV)	148	115	33
8	Abids (Erstwhile Circle – VI)	36	28	8
9	Abids (Erstwhile Circle – III)	180	144	36
10	Khairatabad (Erstwhile Circle – V)	161	101	60
	Sub-total (C)	**525**	**388**	**137**
West Zone				
11	Sherilingampally (S)	26	24	2
12	Sherilingampally (N)	32	10	22
13	Ramachandra puram & Patan Chervu	12	0	12
14	Kukatpally	68	42	26
	Sub-total (D)	**138**	**76**	**62**
North Zone				
15	Quthbullapur	63	63	0
16	Alwal	52	51	1
17	Malkajgiri	42	38	4
18	Secunderabad	132	114	18
	Sub-total (E)	**289**	**266**	**23**
	Grand Total (A+B+C+D+E)	**1466**	**1155**	**311**

c. Number of Notified slum areas with agency responsible for providing infrastructure

The following table 76 illustrates the number of slums according to the agencies responsible for providing the required infrastructure facilities and services.

Table 76: Number of notified slum areas with agency responsible for providing infrastructure

Circle No.	Circle Name	No. of Notified Slums	Responsibility of GHMC & HMWSSB
	East Zone		
1	Kapra	44	44
2	Uppal	26	26
3	L.B. Nagar	57	57
	Sub-total (A)	**127**	**127**
	South Zone		
4	Charminar (Erstwhile Circle – I)	175	175
5	Charminar (Erstwhile Circle – II)	85	85
6	Rajendra Nagar	38	38
	Sub-total (B)	**298**	**298**
	Central Zone		
7	Khairatabad (Erstwhile Circle – IV)	115	115
8	Abids (Erstwhile Circle – VI)	28	28
9	Abids (Erstwhile Circle – III)	144	144
10	Khairatabad (Erstwhile Circle – V)	101	101
	Sub-total (C)	**388**	**388**
	West Zone		
11	Sherilingampally (S)	24	24
12	Sherilingampally (N)	10	10
13	Ramachandra puram & Patan Chervu	0	0
14	Kukatpally	42	42
	Sub-total (D)	**76**	**76**
	North Zone		
15	Quthbullapur	63	63
16	Alwal	51	51
17	Malkajgiri	38	38
18	Secunderabad	114	114
	Sub-total (E)	**266**	**266**
	Grand Total (A+B+C+D+E)	**1155**	**1155**

d. Number of Notified slum areas with public or local representatives

The following table 77 illustrates the number of slums with the presence of public or local representatives.

Table 77: Number of notified slum areas with public or local representatives

Circle No.	Circle Name	No. of Notified Slums	Availability of Public and Local representatives
East Zone			
1	Kapra	44	44
2	Uppal	26	26
3	L.B. Nagar	57	57
	Sub-total (A)	**127**	**127**
South Zone			
4	Charminar (Erstwhile Circle – I)	175	175
5	Charminar (Erstwhile Circle – II)	85	85
6	Rajendra Nagar	38	38
	Sub-total (B)	**298**	**298**
Central Zone			
7	Khairatabad (Erstwhile Circle – IV)	115	115
8	Abids (Erstwhile Circle – VI)	28	28
9	Abids (Erstwhile Circle – III)	144	144
10	Khairatabad (Erstwhile Circle – V)	101	101
	Sub-total (C)	**388**	**388**
West Zone			
11	Sherilingampally (S)	24	24
12	Sherilingampally (N)	10	10
13	Ramachandra puram & Patan Chervu	0	0
14	Kukatpally	42	42
	Sub-total (D)	**76**	**76**
North Zone			
15	Quthbullapur	63	63
16	Alwal	51	51
17	Malkajgiri	38	38
18	Secunderabad	114	114
	Sub-total (E)	**266**	**266**
	Grand Total (A+B+C+D+E)	**1155**	**1155**

e. Number of Notified slum areas with tenable status

The following table 78 illustrates the number of slums with tenable status.

Table 78: Number of notified slum areas with tenable status

Circle No.	Circle Name	No. of Notified Slums	No. of Tenable Slums
	East Zone		
1	Kapra	44	44
2	Uppal	26	26
3	L.B. Nagar	57	57
	Sub-total (A)	**127**	**127**
	South Zone		
4	Charminar (Erstwhile Circle – I)	175	173
5	Charminar (Erstwhile Circle – II)	85	85
6	Rajendra Nagar	38	38
	Sub-total (B)	**298**	**296**
	Central Zone		
7	Khairatabad (Erstwhile Circle – IV)	115	115
8	Abids (Erstwhile Circle – VI)	28	28
9	Abids (Erstwhile Circle – III)	144	144
10	Khairatabad (Erstwhile Circle – V)	101	100
	Sub-total (C)	**388**	**387**
	West Zone		
11	Sherilingampally (S)	24	24
12	Sherilingampally (N)	10	10
13	Ramachandra puram & Patan Chervu	0	0
14	Kukatpally	42	42
	Sub-total (D)	**76**	**76**
	North Zone		
15	Quthbullapur	63	63
16	Alwal	51	51
17	Malkajgiri	38	37
18	Secunderabad	114	113
	Sub-total (E)	**266**	**264**
	Grand Total (A+B+C+D+E)	**1155**	**1150**

f. Number of Notified slum areas with access to different sources of drinking water

The table below 79 illustrates the spatial distribution of the notified and tenable slum areas with access to different sources of water.

Table 79: Number of slum areas with access to different sources of drinking water

Circle No.	Circle Name	No. of Notified & Tenable Slums	No. of slums with access to					
			Individual taps	Public taps	Water tankers/ Bottled water	Open wells	Tube well/ hand pump/ borewell	Tank/ pond/ river/ canal/ lake/ springs
East Zone								
1	Kapra	44	44	40	9	4	42	0
2	Uppal	26	26	20	17	12	21	0
3	L.B. Nagar	57	55	50	16	12	57	0
	Sub-total (A)	**127**	**125**	**110**	**42**	**28**	**120**	**0**
South Zone								
4	Charminar (Erstwhile Circle – I)	173	172	94	109	109	159	0
5	Charminar (Erstwhile Circle – II)	85	71	76	47	7	83	0
6	Rajendra Nagar	38	37	31	25	16	37	0
	Sub-total (B)	**296**	**280**	**201**	**181**	**132**	**279**	**0**
Central Zone								
7	Khairatabad (Erstwhile Circle – IV)	115	91	105	72	2	78	0
8	Abids (Erstwhile Circle – VI)	28	28	28	4	3	28	0
9	Abids (Erstwhile Circle – III)	144	120	78	37	6	110	0
10	Khairatabad (Erstwhile Circle – V)	100	100	89	36	3	91	0
	Sub-total (C)	**387**	**339**	**300**	**149**	**14**	**307**	**0**
West Zone								
11	Sherilingampally (S)	24	24	24	3	24	24	0
12	Sherilingampally (N)	10	10	10	4	10	10	0
13	Ramachandra puram & Patan Chervu	0	0	0	0	0	0	0

14	Kukatpally	42	42	42	12	10	15	0
	Sub-total (D)	**76**	**76**	**76**	**19**	**44**	**49**	**0**
	North Zone							
15	Quthbullapur	63	63	48	46	12	60	0
16	Alwal	51	51	48	29	14	50	0
17	Malkajgiri	37	36	37	33	16	36	0
18	Secunderabad	113	99	98	30	64	113	0
	Sub-total (E)	**264**	**249**	**231**	**138**	**106**	**259**	**0**
	Grand Total (A+B+C+D+E)	**1150**	**1069**	**918**	**529**	**324**	**1014**	**0**

It has to be noted that the above stated statistics does not imply households/ population in each of 1069 slum areas have 100% access to individual tap connections, public taps, water tankers, bottled water, open wells, tube wells, hand pump, and bore well. It can otherwise be stated that having infrastructure facilities does not imply having services. These numbers only signify the access to different sources of water in different slum areas. Further, it also needs to be noted that having access to different sources of water does not imply availability of standard/ required quality and quantity of water.

Individual/ household taps: The maximum number of slums with individual/ household tap facilities are located in circle no. 4 and the least number of slums are located in circle no. 12. Further, the Central zone of the GHMC area is having the maximum share of total number of slums with individual/ household tap facilities, i.e., 31.7%, followed by South zone with 26% and the North zone with 23%. The East zone is a land to 11.7% of total number of slum areas with individual/ household tap facilities whereas the West zone is with the least share, i.e., 7%. A closer analysis reveals that the core area (otherwise known as erstwhile Municipal Corporation of Hyderabad (MCH) area) has the maximum number of slums with access to individual/ household drinking water tap connections (54%) and the remaining (46%) are spread across the surrounding municipalities within GHMC boundary.

Public/ community taps: Similar to the observations stated for the distribution of slums with individual/ household taps, the slum areas with public/ community taps follow the same trend. The maximum number of slum areas with public/ community tap facilities are located in circle no. 7 and the least number of slums are located in circle no. 12. Further, the Central zone of the GHMC area is having the maximum share of total number of slums with public/ community taps, i.e., 33%, followed by North zone with 25% and the South zone with 22%. The East zone is a land to 12% of total number of slum areas with individual/ household tap facilities whereas the West zone is with the least share, i.e., 8%. A closer analysis reveals that the core area (otherwise known as erstwhile Municipal Corporation of Hyderabad (MCH) area) and the surrounding municipalities within GHMC boundary are equally (almost) distributed with number of slums with public/ community drinking water tap connections, i.e., 51% and 49% respectively.

Water tankers/ bottled water: It can be noted that the maximum number of slums which are facilitated with water tankers and bottled water for drinking water purposes are located in circle no. 7 and the least number of slums with such services are located in circle no. 1. Further, it can also be observed that the South zone of the GHMC area is having the maximum share of total number of slums which uses water tankers and bottled water for fetching drinking water, i.e., 34%, followed by Central zone with 28% and the North zone with 26%. The East zone is a land to 8% of the total number of slum areas with water tankers and bottled water facilities whereas the West zone is with the least share, i.e., 3.6%. A closer analysis reveals that the core area (otherwise known as erstwhile Municipal Corporation of Hyderabad (MCH) area) has the maximum number of slum areas who are using the facilities of water tankers and bottled water for regular drinking water purposes (58%) and the remaining (42%) are spread across the surrounding municipalities within GHMC boundary.

Open wells: It can be noted that the maximum number of slums which have access to open wells are located in circle no. 4 and the least number of slums with such facility are located in circle no. 7. Further, it can also be observed that the South zone of the GHMC area is having the maximum share of the total number of slums which have access to open wells, i.e., 40.7%, followed by North zone with 32.7% and the West zone with 13.6%. The East zone is a land to 5% of the total number of slum areas with open wells facilities, whereas the Central zone is with the least share, i.e., 3%. A closer analysis reveals that the surrounding municipalities of the core area (otherwise known as erstwhile Municipal Corporation of Hyderabad (MCH) area) has the maximum number of slum areas with access to open well facilities (60%) and the remaining (40%) are within the core area.

Tube well/ hand pump/ borewell: The under-ground water is generally used for non-potable purposes such as bathing, cleaning, washing, and so on. According to Pollution control board (CPCB, 2013) the threshold limits of pollution in the under-ground water is not acceptable for human consumption purposes. However, in Hyderabad region, the under-ground water is fetched and utilized for drinking purposes after various purification processes at household level. Based on the statistical information provided, it can be noted that the maximum number of slums those have facilities pertaining to tube wells/ hand pumps/ bore wells to draw water from under-ground are located in circle no. 4 and the least number of slums with such facilities are located in circle no. 12. Further, it can also be observed that the Central zone of the GHMC area is having the maximum share of the total number of slum areas with facilities such tube wells, hand pumps and bore wells, i.e., 30%, followed by the South zone with 27.5% and the North zone with 25.5%. The East zone is a land to 12% of the total number of slum areas with tube wells, hand pumps and bore well facilities, whereas the West zone is with the least share, i.e., 4%. A closer analysis reveals that the core area (otherwise known as erstwhile Municipal Corporation of Hyderabad (MCH) area) has the maximum number of slums with access to these facilities

(54%) and the remaining (46%) are spread across the surrounding municipalities within GHMC boundary.

g. Number of Notified slum areas with access to all sources of drinking water

The table 80 below illustrates the number of notified and tenable slum areas with access to all sources of water such as individual tap connections, public tap connections, borewells, handpumps, and water tankers.

Table 80: Number of notified slum areas with access to all drinking water sources

Circle No.	Circle Name	No. of Notified & Tenable Slums	No. of slums with access to all sources of drinking water
East Zone			
1	Kapra	44	9
2	Uppal	26	12
3	L.B. Nagar	57	15
	Sub-total (A)	**127**	**36**
South Zone			
4	Charminar (Erstwhile Circle – I)	173	73
5	Charminar (Erstwhile Circle – II)	85	47
6	Rajendra Nagar	38	23
	Sub-total (B)	**296**	**143**
Central Zone			
7	Khairatabad (Erstwhile Circle – IV)	115	35
8	Abids (Erstwhile Circle – VI)	28	4
9	Abids (Erstwhile Circle – III)	144	26
10	Khairatabad (Erstwhile Circle – V)	100	28
	Sub-total (C)	**387**	**93**
West Zone			
11	Sherilingampally (S)	24	3
12	Sherilingampally (N)	10	4
13	Ramachandra puram & Patan Chervu	0	0
14	Kukatpally	42	7
	Sub-total (D)	**76**	**14**
North Zone			
15	Quthbullapur	63	42
16	Alwal	51	26
17	Malkajgiri	37	32
18	Secunderabad	113	15
	Sub-total (E)	**264**	**115**
	Grand Total (A+B+C+D+E)	**1150**	**401**

h. Number of slums with BPL population

The table 81 below illustrates the number of slum areas with Below Poverty Line (BPL) population.

Table 81: Number of slum areas with BPL population

Circle No.	Circle Name	No. of slums with access to all sources of drinking water	No. of slums with BPL population
East Zone			
1	Kapra	9	7
2	Uppal	12	11
3	L.B. Nagar	15	13
	Sub-total (A)	**36**	**31**
South Zone			
4	Charminar (Erstwhile Circle – I)	73	43
5	Charminar (Erstwhile Circle – II)	47	47
6	Rajendra Nagar	23	22
	Sub-total (B)	**143**	**112**
Central Zone			
7	Khairatabad (Erstwhile Circle – IV)	35	35
8	Abids (Erstwhile Circle – VI)	4	4
9	Abids (Erstwhile Circle – III)	26	22
10	Khairatabad (Erstwhile Circle – V)	28	28
	Sub-total (C)	**93**	**89**
West Zone			
11	Sherilingampally (S)	3	3
12	Sherilingampally (N)	4	4
13	Ramachandra puram & Patan Chervu	0	0
14	Kukatpally	7	4
	Sub-total (D)	**14**	**11**
North Zone			
15	Quthbullapur	42	41
16	Alwal	26	19
17	Malkajgiri	32	30
18	Secunderabad	15	11
	Sub-total (E)	**115**	**101**
	Grand Total (A+B+C+D+E)	**401**	**344**

i. Number of slums with above average population/ households

The table 82 below illustrates the number of slum areas with above average population or households.

Table 82: Number of slums areas with above average population/ households

Circle No.	Circle Name	No. of slums	Total Population	Average Population	Total Households	Average Households	Total No. of slums with above average population and households
East Zone							
1	Kapra	7	15323	2189	3784	541	5
2	Uppal	11	29442	2677	7387	672	10
3	L.B. Nagar	13	28508	2193	6635	510	11
	Sub-total (A)	**31**	**73273**	**7059**	**17806**	**1723**	**26**
South Zone							
4	Charminar (Erstwhile Circle – I)	43	96317	2240	20205	470	17
5	Charminar (Erstwhile Circle – II)	47	59040	1256	12087	257	15
6	Rajendra Nagar	22	39593	1800	8499	386	11
	Sub-total (B)	**112**	**194950**	**5296**	**40791**	**1113**	**43**
Central Zone							
7	Khairatabad (Erstwhile Circle – IV)	35	43056	1230	9535	272	12
8	Abids (Erstwhile Circle – VI)	4	4436	1109	1199	300	4
9	Abids (Erstwhile Circle – III)	22	41583	1890	9047	411	19
10	Khairatabad (Erstwhile Circle – V)	28	43233	1544	10210	365	11
	Sub-total (C)	**89**	**132308**	**5773**	**29991**	**1348**	**46**
West Zone							
11	Sherilingampally (S)	3	17143	5714	4210	1403	2
12	Sherilingampally (N)	4	6740	1685	1581	395	3
13	Ramachandrapuram & Patan Chervu	0	0	0	0	0	0

Circle No.	Circle Name	No. of slums	Total Population	Average Population	Total Households	Average Households	Total No. of slums with above average population and households
14	Kukatpally	4	18037	4509	4141	1035	3
	Sub-total (D)	**11**	**41920**	**11908**	**9932**	**2833**	**8**
North Zone							
15	Quthbullapur	41	137795	3361	33778	824	39
16	Alwal	19	24926	1312	6244	329	9
17	Malkajgiri	30	57273	1909	14856	495	15
18	Secunderabad	11	18737	1703	4573	416	9
	Sub-total (E)	**101**	**238731**	**8285**	**59451**	**2064**	**73**
	Grand Total (A+B+C+D+E)	**344**	**681182**	**38321**	**157971**	**9081**	**196**

j. Names of the selected slum areas

The table 83 below illustrates the names of the slum areas selected based on the selection criteria for the current study.

Table 83: Names of the selected slum areas for the current study

Circle No.	Circle Name	Total No. of Slums	No. of selected slum areas	Name of selected slum areas
East Zone				
1	Kapra	5	2	1. Sairam Nagar 2. B.J.R. Colony
2	Uppal	10	2	3. Manikesav Nagar (O U Campus) 4. Gandhi Nagar
3	L.B. Nagar	11	2	5. Rajiv Gandhi Nagar 6. Dr.Ambedkar Nagar
South Zone				
4	Charminar (Erstwhile Circle – I)	17	2	7. Shivaji Nagar 8. Sai Baba Nagar
5	Charminar (Erstwhile Circle – II)	15	2	9. Fatima Nagar 10. Farooq Nagar
6	Rajendra Nagar	11	2	11. Wadi - E – Mahamood 12. Indira Nagar
Central Zone				
7	Khairatabad (Erstwhile Circle – IV)	12	2	13. Vivekananda Nagar 14. Indira Nagar (13-6) (Gudimalkapur)
8	Abids (Erstwhile Circle – VI)	4	2	15. Pool Bhaugh 16. Band Line
9	Abids (Erstwhile Circle – III)	19	2	17. Indira Nagar-I 18. Bapu Nagar (Amberpet)
10	Khairatabad (Erstwhile Circle – V)	11	2	19. Devarakonda Basti 20. Ambedkar Nagar
West Zone				
11	Sherilingampally (S)	2	2	21. Prem Nagar 22. Marthanda Nagar
12	Sherilingampally (N)	3	2	23. Izzatnagar Weaker Section 24. Maktha Mahaboobpet
13	Ramachandra puram & Patan Chervu	-	-	There are no notified slums in this Circle
14	Kukatpally	3	2	25. Rajiv Ghandhi Nagar (Allapur) 26. Yellamma Banda
North Zone				
15	Quthbullapur	39	2	27. Shiridi Saibaba Nagar 28. Kaiser Nagar

Circle No.	Circle Name	Total No. of Slums	No. of selected slum areas	Name of selected slum areas
16	Alwal	9	2	29. Turkapally Bollaram
				30. Bharat Nagar
17	Malkajgiri	15	2	31. I N Nagar
				32. B J R Nagar
18	Secunderabad	9	2	33. Hamal Basthi Phase-I
				34. Hamalbasthi P-II
	Total	196	34	-

k. Names of the selected slum areas with naming convention

The table 84 below illustrates the names of the selected slum areas with codes used for the current study.

Table 84: Names of the selected slum areas with naming codes

#.	Circle No. and Name	Slum Name	Slum Code	#
1.	Circle 1, Kapra	Sairam Nagar	Circle 1 _ Slum A	1
2.		B.J.R. Colony	Circle 1 _ Slum B	2
3.	Circle 2, Uppal	Manikesav Nagar (O U Campus)	Circle 2 _ Slum A	3
4.		Gandhi Nagar	Circle 2 _ Slum B	4
5.	Circle 3, L.B. Nagar	Rajiv Gandhi Nagar	Circle 3 _ Slum A	5
6.		Dr Ambedkar Nagar	Circle 3 _ Slum B	6
7.	Circle 4, Charminar (Erstwhile Circle – I)	Shivaji Nagar	Circle 4 _ Slum A	7
8.		Sai Baba Nagar	Circle 4 _ Slum B	8
9.	Circle 5, Charminar (Erstwhile Circle – II)	Fatima Nagar	Circle 5 _ Slum A	9
10.		Farooq Nagar	Circle 5 _ Slum B	10
11.	Circle 6, Rajendra Nagar	Wadi - E – Mahamood	Circle 6 _ Slum A	11
12.		Indira Nagar	Circle 6 _ Slum B	12
13.	Circle 7, Khairatabad (Erstwhile Circle – IV)	Vivekananda Nagar	Circle 7 _ Slum A	13
14.		Indira Nagar (13-6) (Gudimalkapur)	Circle 7 _ Slum B	14
15.	Circle 8, Abids (Erstwhile Circle – VI)	Pool Bhaugh	Circle 8 _ Slum A	15
16.		Band Line	Circle 8 _ Slum B	16
17.	Circle 9, Abids (Erstwhile Circle – III)	Indira Nagar-I	Circle 9 _ Slum A	17
18.		Bapu Nagar (Amberpet)	Circle 9 _ Slum B	18
19.	Circle 10, Khairatabad (Erstwhile Circle – V)	Devarakonda Basti	Circle 10 _ Slum A	19
20.		Ambedkar Nagar	Circle 10 _ Slum B	20
21.	Circle 11, Sherilingampally (S)	Prem Nagar	Circle 11 _ Slum A	21
22.		Marthanda Nagar	Circle 11 _ Slum B	22
23.	Circle 12, Sherilingampally (N)	Izzatnagar Weaker Section	Circle 12 _ Slum A	23
24.		Maktha Mahaboobpet	Circle 12 _ Slum B	24
25.	Circle 14, Kukatpally	Rajiv Ghandhi Nagar (Allapur)	Circle 14 _ Slum A	27
26.		Yellamma Banda	Circle 14 _ Slum B	28
27.	Circle 15, Quthbullapur	Shiridi Saibaba Nagar	Circle 15 _ Slum A	29
28.		Kaiser Nagar	Circle 15 _ Slum B	30
29.	Circle 16, Alwal	Turkapally Bollaram	Circle 16 _ Slum A	31
30.		Bharat Nagar	Circle 16 _ Slum B	32
31.	Circle 17, Malkajgiri	I N Nagar	Circle 17 _ Slum A	33
32.		B J R Nagar	Circle 17 _ Slum B	34
33.	Circle 18, Secunderabad	Hamal Basthi Phase-I	Circle 18 _ Slum A	35
34.		Hamalbasthi P-II	Circle 18 _ Slum B	36

Annexure 2 | Spatial boundaries and location of study area

a. Map of Hyderabad city region

Map (refer figure 14) showing the boundaries of HMDA (Hyderabad Metropolitan Development Area), GHMC (Greater Hyderabad Municipal Corporation area), erstwhile MCH (Municipal Corporation of Hyderabad), CDA (Cyberabad Development Authority area), HADA (Hyderabad Airport Development Authority area), and major road and railway networks. The current research is focused on GHMC region, considering that the slum areas are defined only for Municipal region, and not for Metropolitan region. The notified slums are located within the Hyderabad Municipal Corporation boundary/ area.

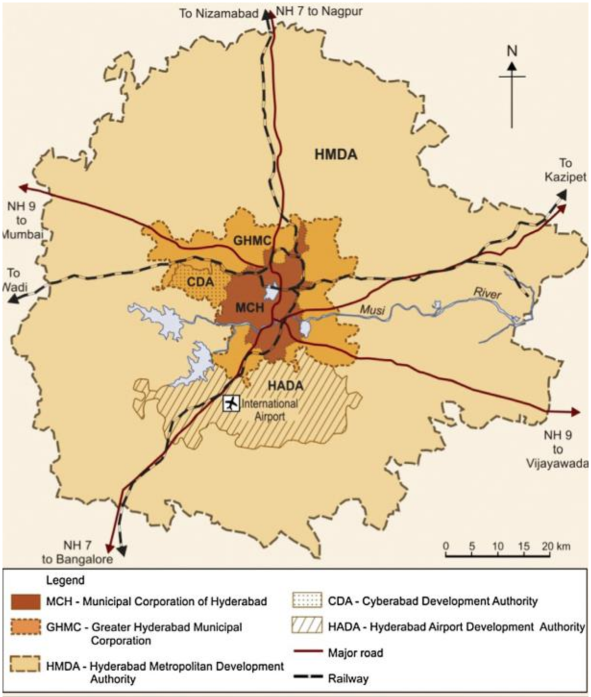


Figure 14: Map showing the Hyderabad city region

b. Base map of Hyderabad city

Base map (figure 15) showing the Hyderabad city and circle boundaries (Administrative boundaries) and names.

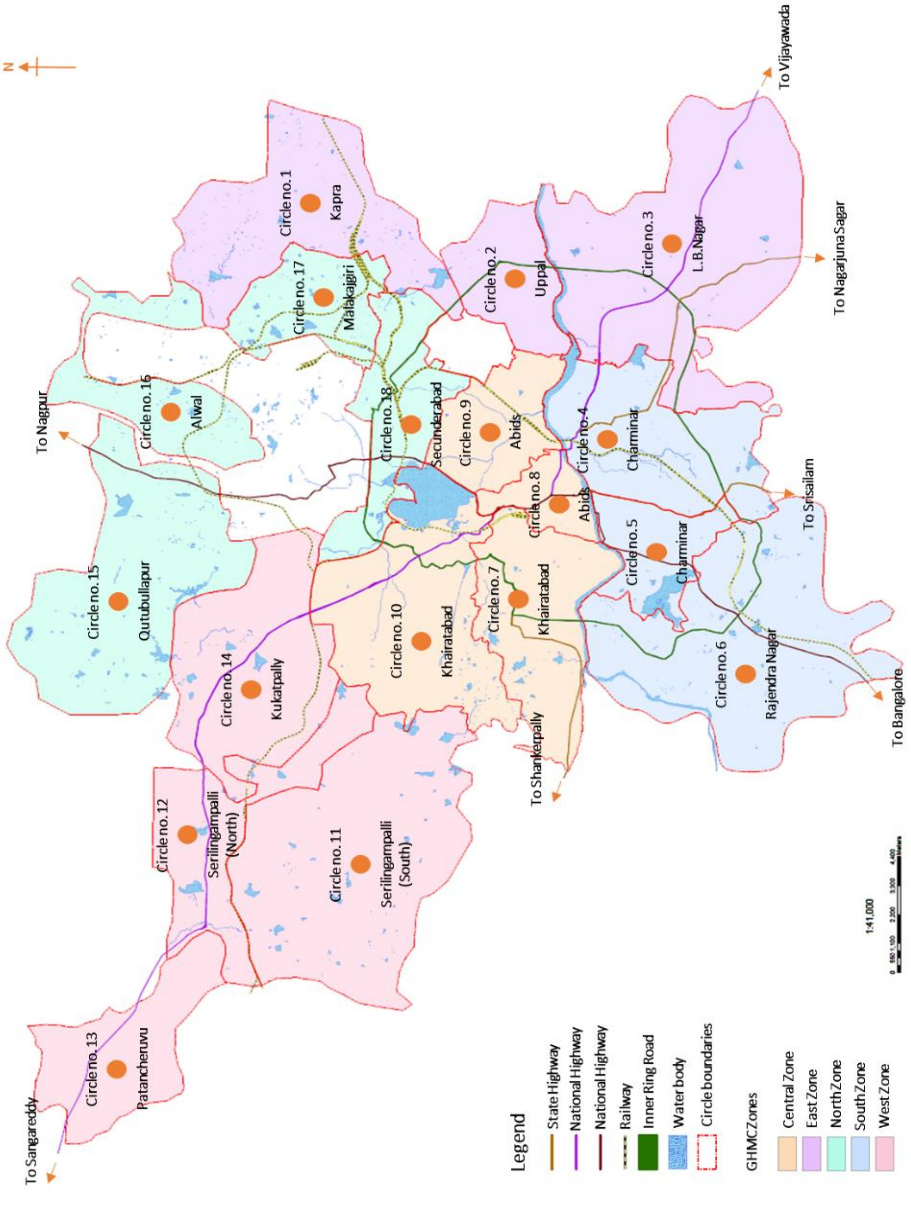


Figure 15: Base map of Hyderabad city along with circles boundaries and names

c. Base map of Hyderabad city and Slum areas

Base map (figure 16) showing the boundaries of Hyderabad city and slum areas within the city limits.

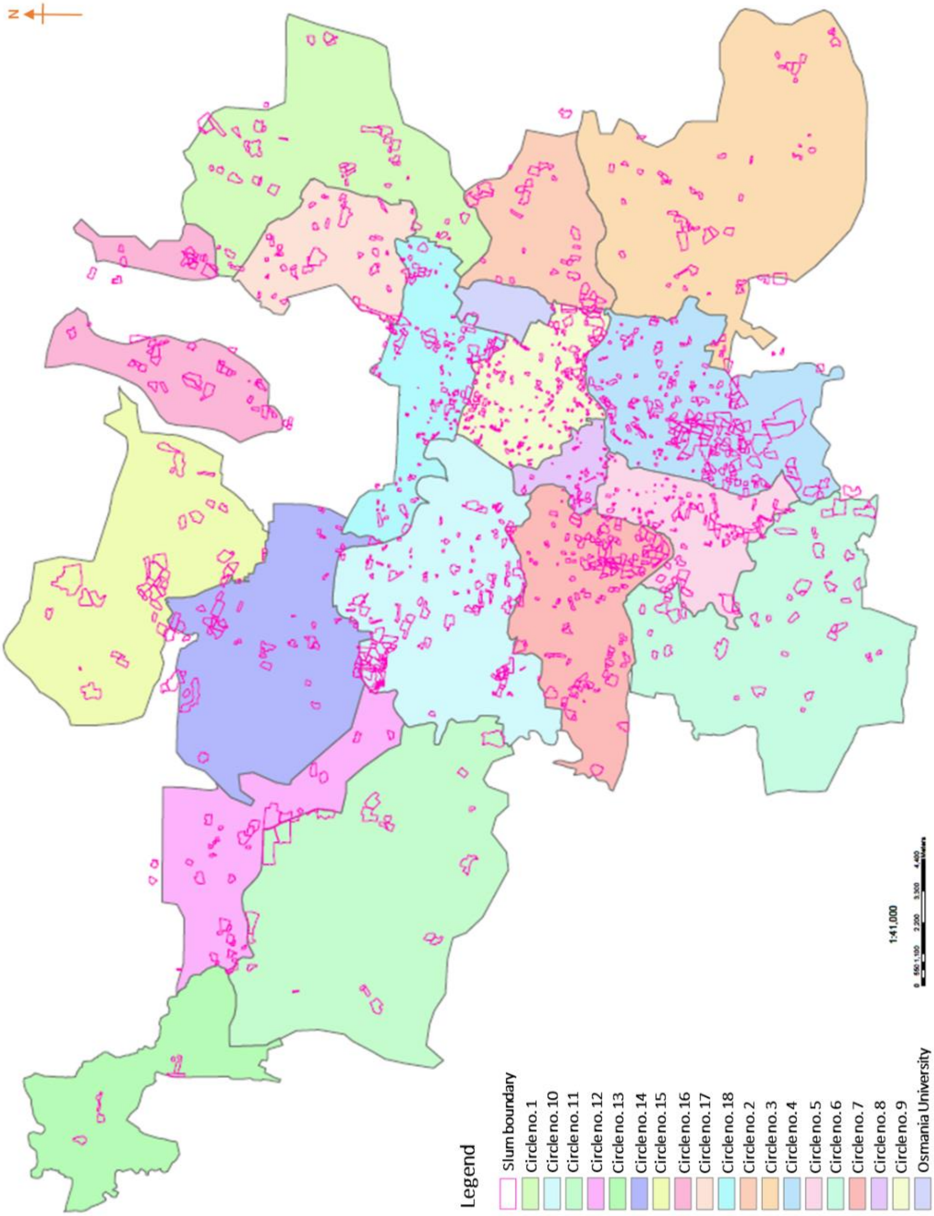


Figure 16: Map showing the boundaries of slum areas in Hyderabad city

d. Location of selected slum areas for the current study

Map (figure 17) showing the location of all the slum areas identified through selection criteria for the current study.

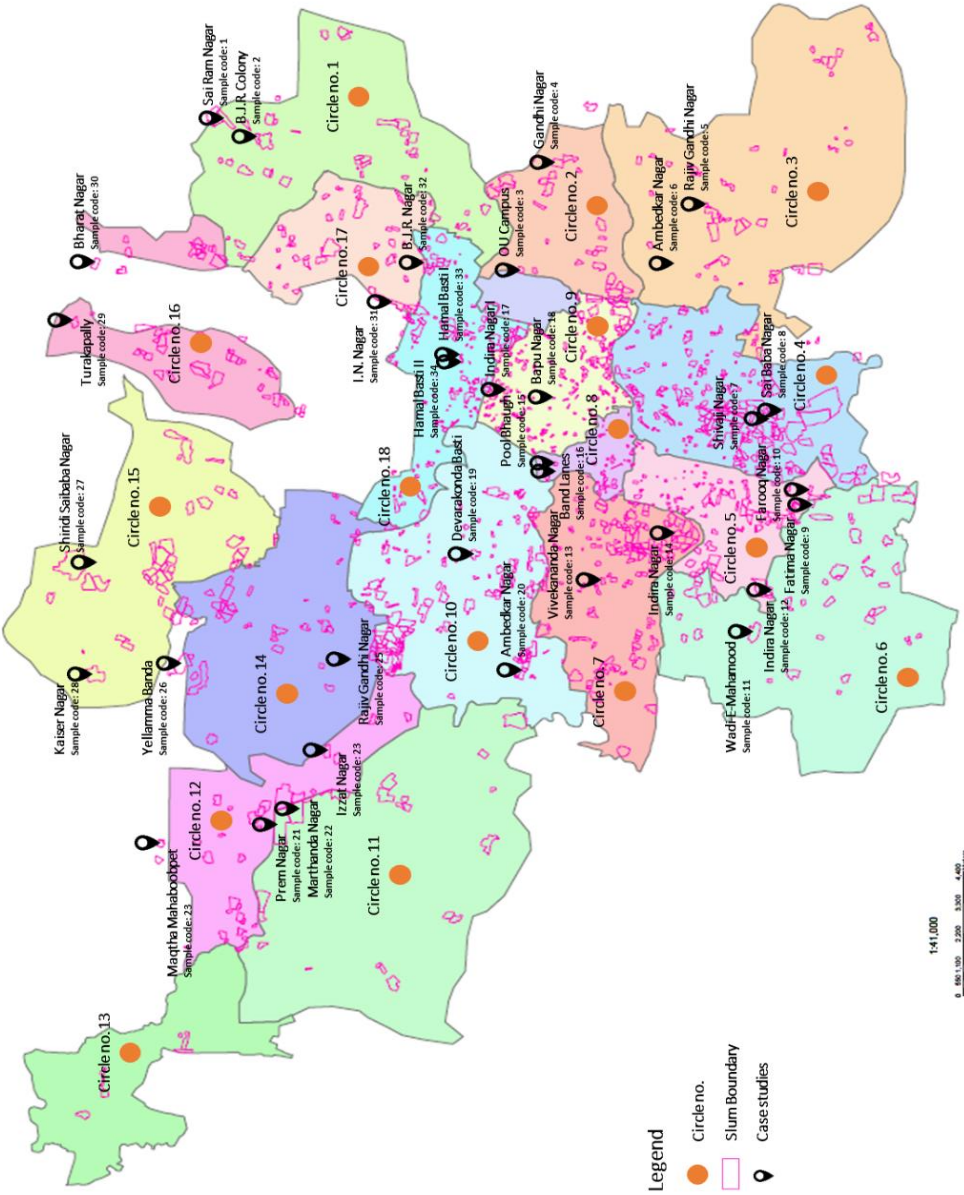


Figure 17: Map showing the location of selected slum areas for the current study

Annexure 3 | Profiling of selected slum areas

1. Sairam Nagar (Circle 1_Slum A)

Sairam Nagar is one of the identified sample case studies geographically positioned in the North-East direction of the Hyderabad city region in the Kapra Municipal circle boundary. The following figure 19 displays the location of this case study area in the Kapra circle boundary (to the left), and the satellite image (to the right) of the Sairam Nagar. This section further showcases the general particulars (refer box 13) and pictographical representation (figure 18) of the Sairam Nagar slum area.

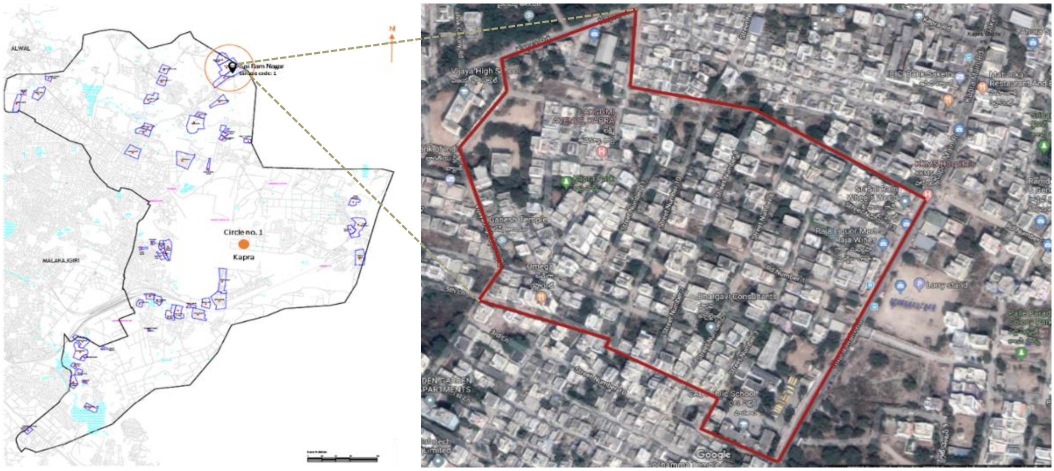


Figure 19: (Left) Map showing the location of Sairam Nagar in Kapra circle boundary; (Right) Satellite image of Sairam Nagar

Slum Name:	Sairam Nagar
Slum Code:	Circle 1_Slum A
Municipality Name:	Kapra municipal circle
Zone Name:	East Zone
City Name:	Hyderabad, Telangana State, India
Population:	2103
Households:	555
Age of the Slum:	>30 years

Structures in slum: The structures (or the buildings) in the slum area typically permanent in nature and are significantly used for residential purpose only.

Drinking water systems: This slum area is equipped with drinking water facilities and services such as household level individual taps, community level public taps, borewells, handpumps, water tankers, etc. The facilities and services are provided by HMWSSB.

Box 13: (Left) Brief profiling of Sairam Nagar

Figure 18: (Right) Pictographs of Sairam Nagar captured during field visits

2. BJR Colony (Circle 1_Slum B)

B.J.R Colony is one of the identified sample case studies geographically positioned in the North-East direction of the Hyderabad city region in the Kapra Municipal circle boundary. The following figure 21 displays the location of this case study area in the Kapra circle boundary (to the left), and the satellite image (to the right) of the B.J.R. Colony. This section further showcases the general particulars (refer box 14) and pictographical representation (figure 20) of the B.J.R. Colony slum area.

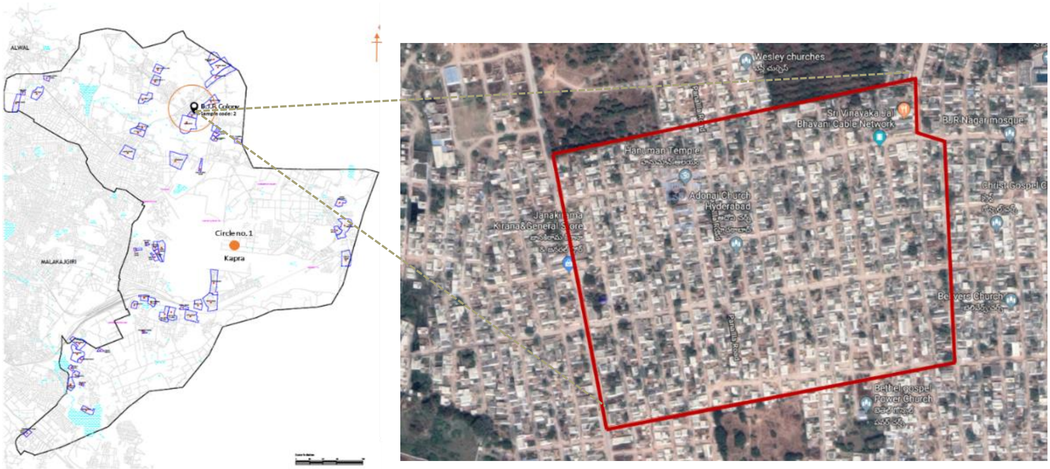


Figure 21: (Left) Map showing the location of BJR Colony in Kapra circle boundary; (Right) Satellite image of BJR Colony

Slum Name:	B.J.R. Colony
Slum Code:	Circle 1_Slum B
Municipality Name:	Kapra municipal circle
Zone Name:	East Zone
City Name:	Hyderabad, Telangana State, India
Population:	1439
Households:	359
Age of the Slum:	>30 years

Structures in slum: The structures (or the buildings) in the slum area typically permanent in nature and are significantly used for residential purpose only.

Drinking water systems: This slum area is equipped with drinking water facilities and services such as household level individual taps, community level public taps, borewells, handpumps, water tankers, etc. The facilities and services are provided by HMWSSB.

Box 14: (Left) Brief profiling of BJR Colony

Figure 20: (Right) Pictographs of BJR Colony captured during field visits

3. Manikesav Nagar (Circle 2_Slum A)

Manikesav Nagar is one of the identified sample case studies geographically positioned in the East direction of the Hyderabad city region in the Uppal municipal circle boundary. The following figure 23 displays the location of this case study area in the Uppal circle boundary (to the left), and the satellite image (to the right) of the Manikesav Nagar. This section further showcases the general particulars (refer box 15) and pictographical representation (figure 22) of the Manikesav Nagar slum area.

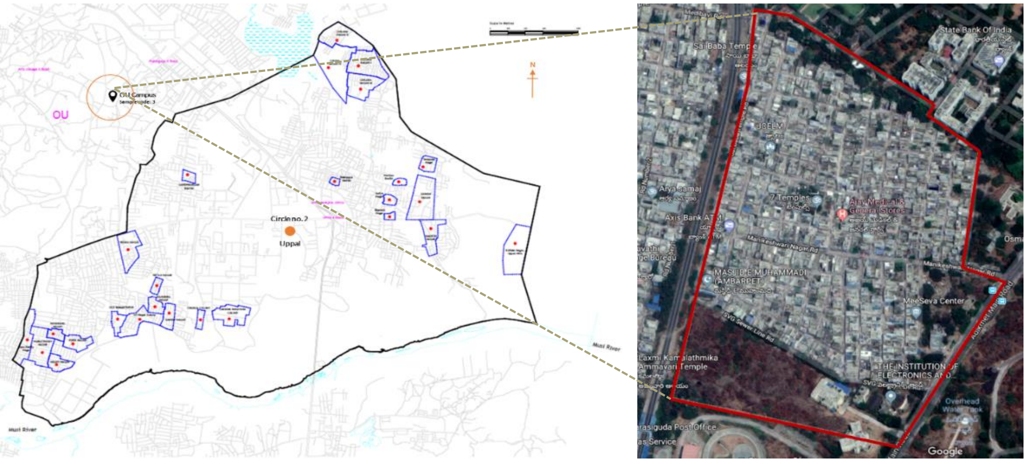


Figure 23: (Left) Map showing the location of MK Nagar in Uppal circle boundary; (Right) Satellite image of MK Nagar

Slum Name: Manikesav Nagar (M.K. Nagar)
Slum Code: Circle 2_Slum A
Municipality Name: Uppal municipal circle
Zone Name: East Zone
City Name: Hyderabad, Telangana State, India
Population: 2141
Households: 525
Age of the Slum: >30 years
Structures in slum: The structures (or the buildings) in the slum area typically permanent in nature and are significantly used for residential purpose only.
Drinking water systems: This slum area is equipped with drinking water facilities and services such as household level individual taps, community level public taps, borewells, handpumps, water tankers, etc. The facilities and services are provided by HMWSSB.

Box 15: (Left) Brief profiling of MK Nagar

Figure 22: (Right) Pictographs of MK Nagar captured during field visits

4. Gandhi Nagar (Circle 2_Slum B)

Gandhi Nagar is one of the identified sample case studies geographically positioned in the East direction of the Hyderabad city region in the Uppal municipal circle boundary. The following figure 25 displays the location of this case study area in the Uppal circle boundary (to the left), and the satellite image (to the right) of the Gandhi Nagar. This section further showcases the general particulars (refer box 16) and pictographical representation (figure 24) of the Gandhi Nagar slum area.

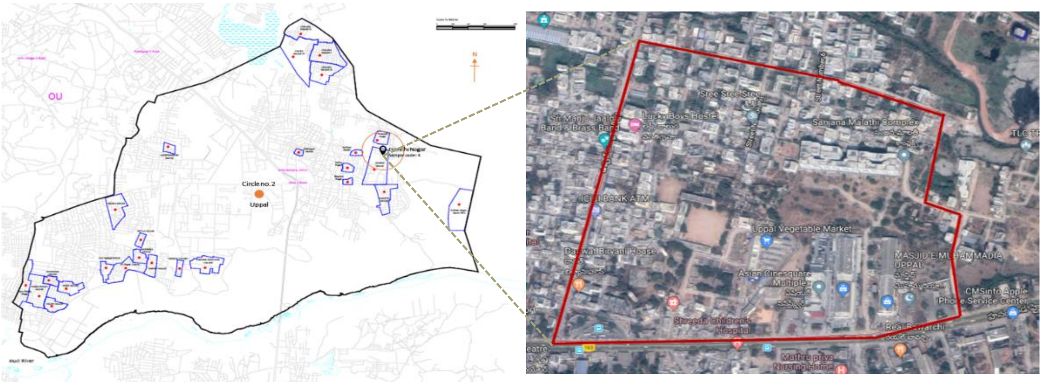


Figure 24: (Left) Map showing the location of Gandhi Nagar in Uppal circle boundary; (Right) Satellite image of Gandhi Nagar

Slum Name: Gandhi Nagar
Slum Code: Circle 2_Slum B
Municipality Name: Uppal municipal circle
Zone Name: East Zone
City Name: Hyderabad, Telangana State, India
Population: 1967
Households: 495
Age of the Slum: >30 years
Structures in slum: The structures (or the buildings) in the slum area typically permanent in nature and are significantly used for residential purpose only.
Drinking water systems: This slum area is equipped with drinking water facilities and services such as household level individual taps, community level public taps, borewells, handpumps, water tankers, etc. The facilities and services are provided by HMWSSB.

Box 16: (Left) Brief profiling of Gandhi Nagar

Figure 25: (Right) Pictographs of Gandhi Nagar captured during field visits

5. Rajiv Gandhi Nagar (Circle 3_Slum A)

Rajiv Gandhi Nagar is one of the identified sample case studies geographically positioned in the South-East direction of the Hyderabad city region in the L.B. Nagar municipal circle boundary. The following figure 27 displays the location of this case study area in the L.B. Nagar circle boundary (to the left), and the satellite image (to the right) of the Rajiv Gandhi Nagar. This section further showcases the general particulars (refer box 17) and pictographical (figure 26) representation of the Rajiv Gandhi Nagar slum area.

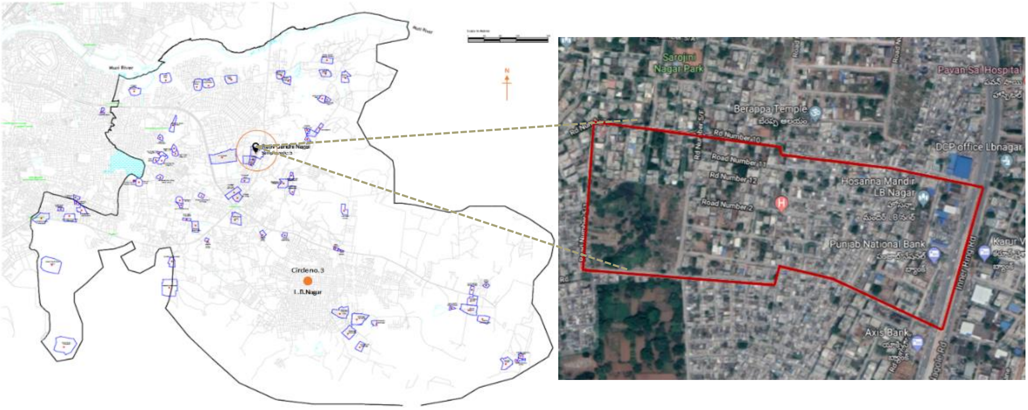


Figure 26: (Left) Map showing the location of Rajiv Gandhi Nagar in L.B. Nagar circle boundary; (Right) Satellite image of Rajiv Gandhi Nagar

Slum Name: Rajiv Gandhi Nagar
Slum Code: Circle 3_Slum A
Municipality Name: L.B. Nagar
Zone Name: East Zone
City Name: Hyderabad, Telangana State, India
Population: 1774
Households: 404
Age of the Slum: >30 years
Structures in slum: The structures (or the buildings) in the slum area typically permanent in nature and are significantly used for residential purpose only.
Drinking water systems: This slum area is equipped with drinking water facilities and services such as household level individual taps, community level public taps, borewells, handpumps, water tankers, etc. The facilities and services are provided by HMWSSB.

Box 17: (Left) Brief profiling of Rajiv Gandhi Nagar

Figure 27: (Right) Pictographs of Rajiv Gandhi Nagar captured during field visits

6. Ambedkar Nagar (Circle 3_Slum B)

Ambedkar Nagar is one of the identified sample case studies geographically positioned in the South-East direction of the Hyderabad city region in the L.B. Nagar municipal circle boundary. The following figure 28 displays the location of this case study area in the L.B. Nagar circle boundary (to the left), and the satellite image (to the right) of the Ambedkar Nagar. This section further showcases the general particulars (refer box 18) and pictographical representation (figure 29) of the Ambedkar Nagar slum area.

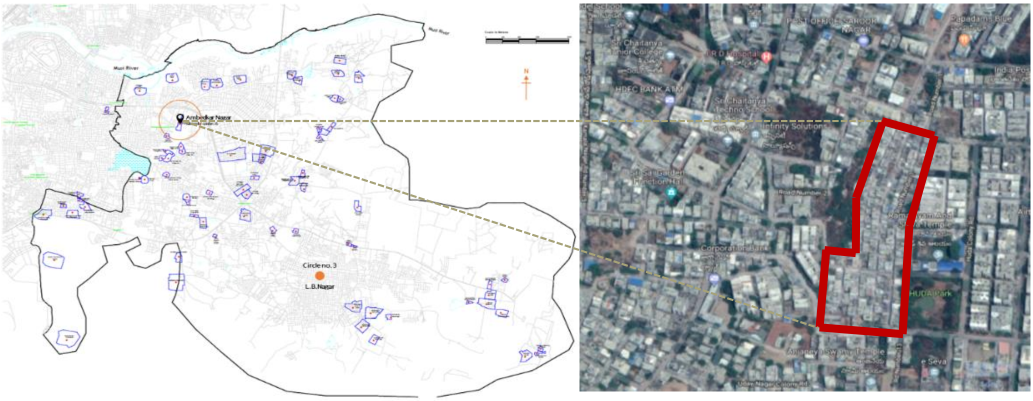


Figure 28: (Left) Map showing the location of Ambedkar Nagar in L.B. Nagar circle boundary; (Right) Satellite image of Ambedkar Nagar

Slum Name: Dr. Ambedkar Nagar
Slum Code: Circle 3_Slum B
Municipality Name: L.B. Nagar
Zone Name: East Zone
City Name: Hyderabad, Telangana State, India
Population: 1777
Households: 398
Age of the Slum: >30 years
Structures in slum: The structures (or the buildings) in the slum area typically permanent in nature and are significantly used for residential purpose only.
Drinking water systems: This slum area is equipped with drinking water facilities and services such as household level individual taps, community level public taps, borewells, handpumps, water tankers, etc. The facilities and services are provided by HMWSSB.

Box 18: (Left) Brief profiling of Ambedkar Nagar

Figure 29: (Right) Pictographs of Ambedkar Nagar captured during field visits

7. Shivaji Nagar (Circle 4_Slum A)

Shivaji Nagar is one of the identified sample case studies geographically positioned in the South direction of the Hyderabad city region in the Charminar municipal circle boundary. The following figure 30 displays the location of this case study area in the Charminar circle boundary (to the left), and the satellite image (to the right) of the Shivaji Nagar. This section further showcases the general particulars (ref box 19) and pictographical representation (figure 31) of the Shivaji Nagar slum area.

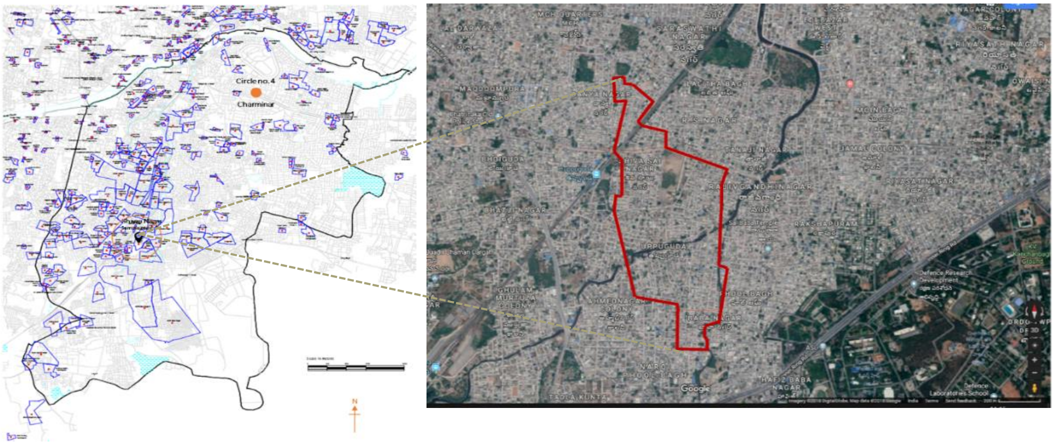


Figure 30: (Left) Map showing the location of Shivaji Nagar in Charminar circle boundary; (Right) Satellite image of ShivajiNagar

Slum Name: Shivaji Nagar
Slum Code: Circle 4_Slum A
Municipality Name: Charminar
Zone Name: South Zone
City Name: Hyderabad, Telangana State, India
Population: 2252
Households: 528
Age of the Slum: >30 years
Structures in slum: The structures (or the buildings) in the slum area typically permanent in nature and are significantly used for residential purpose only.
Drinking water systems: This slum area is equipped with drinking water facilities and services such as household level individual taps, community level public taps, borewells, handpumps, water tankers, etc. The facilities and services are provided by HMWSSB.

Box 19: (Left) Brief profiling of Shivaji Nagar

Figure 31: (Right) Pictographs of Shivaji Nagar captured during field visits

8. Sai Baba Nagar (Circle 4_Slum B)

Sai Baba Nagar is one of the identified sample case studies geographically positioned in the South direction of the Hyderabad city region in the Charminar municipal circle boundary. The following figure 32 displays the location of this case study area in the Charminar circle boundary (to the left), and the satellite image (to the right) of the Sai Baba Nagar. This section further showcases the general particulars (refer box 20) and pictographical (figure 33) representation of the Sai Baba Nagar slum area.

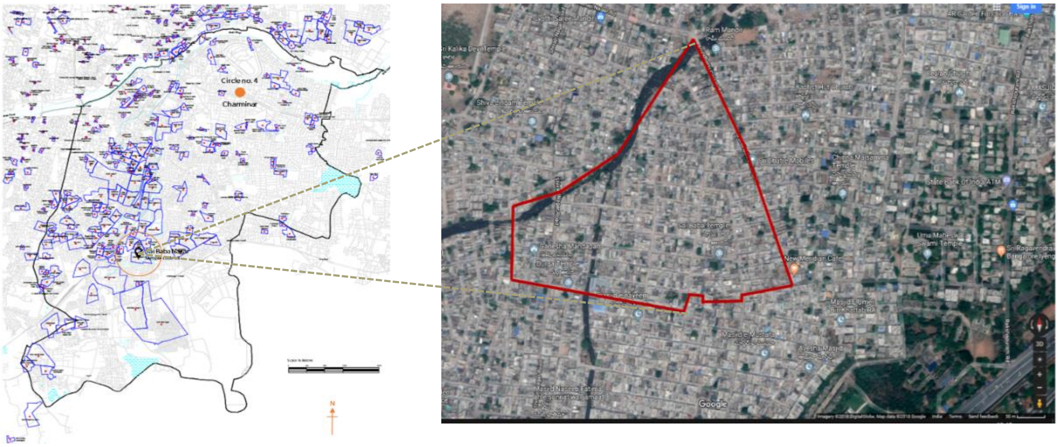


Figure 32: (Left) Map showing the location of Sai Baba Nagar in Charminar circle boundary; (Right) Satellite image of Sai Baba Nagar

Slum Name: Sai Baba Nagar
Slum Code: Circle 4_Slum B
Municipality Name: Charminar
Zone Name: South Zone
City Name: Hyderabad, Telangana State, India
Population: 1793
Households: 422
Age of the Slum: >30 years
Structures in slum: The structures (or the buildings) in the slum area typically permanent in nature and are significantly used for residential purpose only.
Drinking water systems: This slum area is equipped with drinking water facilities and services such as household level individual taps, community level public taps, borewells, handpumps, water tankers, etc. The facilities and services are provided by HMWSSB.

Box 20: (Left) Brief profiling of Sai Baba Nagar

Figure 33: (Right) Pictographs of Sai Baba Nagar captured during field visits

9. Fatima Nagar (Circle 5_Slum A)

Fatima Nagar is one of the identified sample case studies geographically positioned in the South direction of the Hyderabad city region in the Charminar municipal circle boundary. The following figure 34 displays the location of this case study area in the Charminar circle boundary (to the left), and the satellite image (to the right) of the Fatima Nagar. This section further showcases the general particulars (refer box 21) and pictographical representation (figure 35) of the Fatima Nagar slum area.

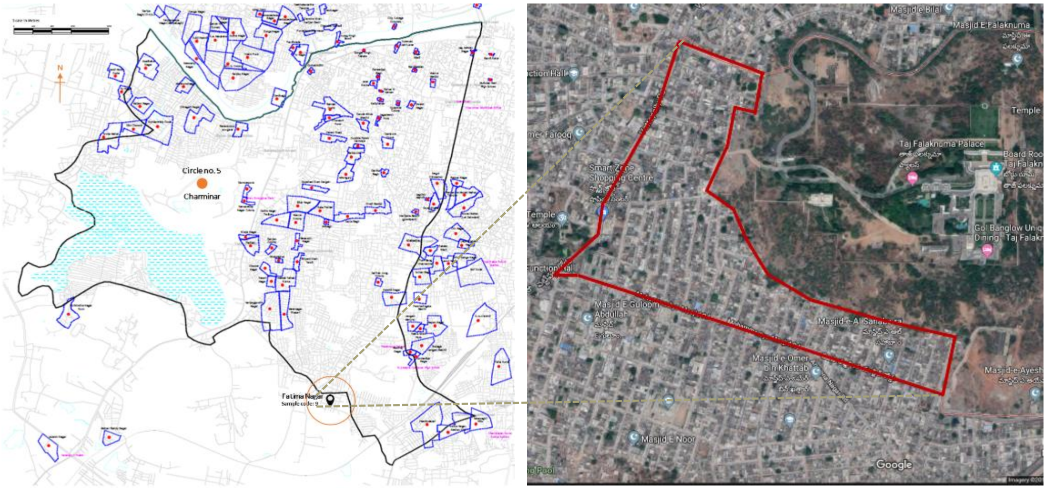


Figure 34: (Left) Map showing the location of Fatima Nagar in Charminar circle boundary; (Right) Satellite image of Fatima Nagar

Slum Name: Fatima Nagar

Slum Code: Circle 5_Slum A

Municipality Name: Charminar

Zone Name: South Zone

City Name: Hyderabad, Telangana State, India

Population: 1405

Households: 302

Age of the Slum: >30 years

Structures in slum: The structures (or the buildings) in the slum area typically permanent in nature and are significantly used for residential purpose only.

Drinking water systems: This slum area is equipped with drinking water facilities and services such as household level individual taps, community level public taps, borewells, handpumps, water tankers, etc. The facilities and services are provided by HMWSSB.

Box 21: (Left) Brief profiling of Fatima Nagar

Figure 35: (Right) Pictographs of Fatima Nagar captured during field visits

10. Farooq Nagar (Circle 5_Slum B)

Farooq Nagar is one of the identified sample case studies geographically positioned in the South direction of the Hyderabad city region in the Charminar municipal circle boundary. The following figure 37 displays the location of this case study area in the Charminar circle boundary (to the left), and the satellite image (to the right) of the Farooq Nagar. This section further showcases the general particulars (refer box 22) and pictographical (figure 36) representation of the Farooq Nagar slum area.

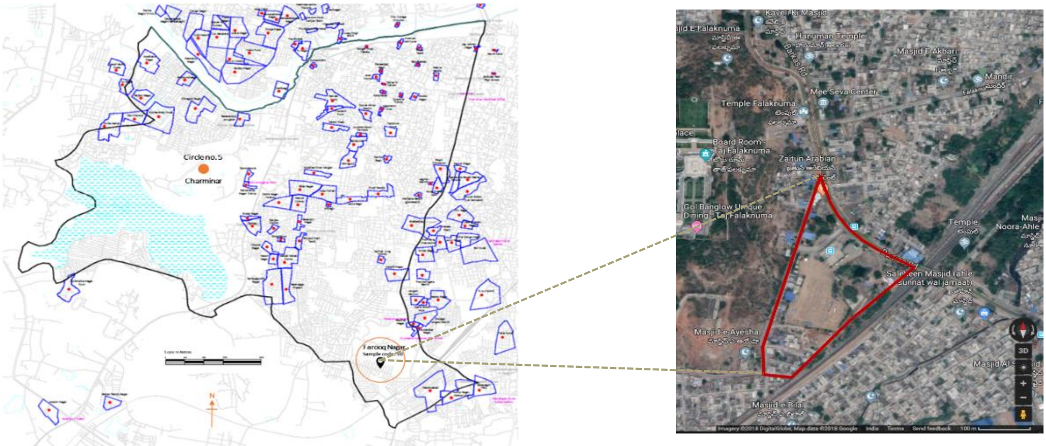


Figure 37: (Left) Map showing the location of Farooq Nagar in Charminar circle boundary; (Right) Satellite image of Farooq Nagar

Slum Name: Farooq Nagar
Slum Code: Circle 5_Slum B
Municipality Name: Charminar
Zone Name: South Zone
City Name: Hyderabad, Telangana State, India
Population: 1133
Households: 208
Age of the Slum: >30 years
Structures in slum: The structures (or the buildings) in the slum area typically permanent in nature and are significantly used for residential purpose only.
Drinking water systems: This slum area is equipped with drinking water facilities and services such as household level individual taps, community level public taps, borewells, handpumps, water tankers, etc. The facilities and services are provided by HMWSSB.

Box 22: (Left) Brief profiling of Farooq

Figure 36: (Right) Pictographs of Farooq Nagar captured during field visits

11. Wadi-E-Mohamood (Circle 6_Slum A)

Wadi-E-Mohamood is one of the identified sample case studies geographically positioned in the South-West direction of the Hyderabad city region in the Rajendra Nagar municipal circle boundary. The following figure 39 displays the location of this case study area in the Rajendra Nagar circle boundary (to the left), and the satellite image (to the right) of the Wadi-E-Mahamood. This section further showcases the general particulars (refer box 23) and pictographical representation (figure 38) of the Wadi-E-Mahamood slum area.

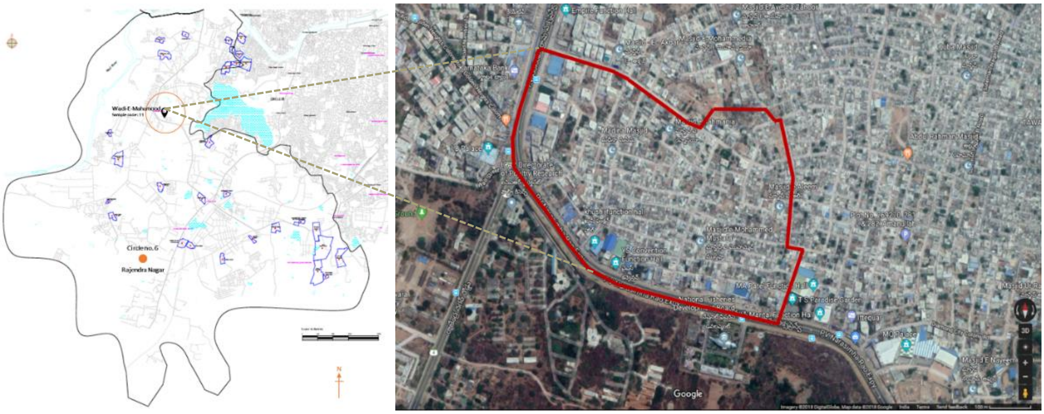


Figure 39: (Left) Map showing the location of Wadi-E-Mohamood in Rajendra Nagar circle boundary; (Right) Satellite image of Wadi-E-Mohamood

Slum Name:	Wadi-E-Mohamood
Slum Code:	Circle 6_Slum A
Municipality Name:	Rajendra Nagar
Zone Name:	South Zone
City Name:	Hyderabad, Telangana State, India
Population:	2479
Households:	474
Age of the Slum:	>30 years

Structures in slum: The structures (or the buildings) in the slum area typically permanent in nature and are significantly used for residential purpose only.

Drinking water systems: This slum area is equipped with drinking water facilities and services such as household level individual taps, community level public taps, borewells, handpumps, water tankers, etc. The facilities and services are provided by HMWSSB.

Box 23: (Left) Brief profiling of Wadi-E-Mohamood

Figure 38: (Right) Pictographs of Wadi-E-Mohamood captured during field visits

12. Indira Nagar (Circle 6_Slum B)

Indira Nagar is one of the identified sample case studies geographically positioned in the South-West direction of the Hyderabad city region in the Rajendra Nagar municipal circle boundary. The following figure 41 displays the location of this case study area in the Rajendra Nagar circle boundary (to the left), and the satellite image (to the right) of the Indira Nagar. This section further showcases the general particulars (refer box 24) and pictographical representation (figure 40) of the Indira Nagar slum area.

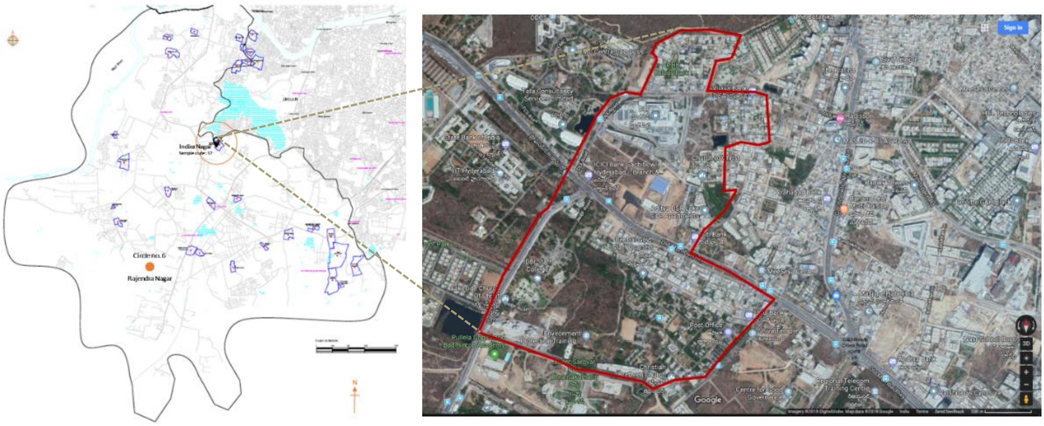


Figure 41: (Left) Map showing the location of Indira Nagar in Rajendra Nagar circle boundary; (Right) Satellite image of Indira Nagar

Slum Name: Indira Nagar
Slum Code: Circle 6_Slum B
Municipality Name: Rajendra Nagar
Zone Name: South Zone
City Name: Hyderabad, Telangana State, India
Population: 2851
Households: 542
Age of the Slum: >30 years
Structures in slum: The structures (or the buildings) in the slum area typically permanent in nature and are significantly used for residential purpose only.
Drinking water systems: This slum area is equipped with drinking water facilities and services such as household level individual taps, community level public taps, borewells, handpumps, water tankers, etc. The facilities and services are provided by HMWSSB.

Box 24: (Left) Brief profiling of Indira Nagar

Figure 40: (Right) Pictographs of Indira Nagar captured during field visits

13. Vivekananda Nagar (Circle 7_Slum A)

Vivekananda Nagar is one of the identified sample case studies geographically positioned in the West direction of the Hyderabad city region in the Khairatabad municipal circle boundary. The following figure 43 displays the location of this case study area in the Khairatabad circle boundary (to the left), and the satellite image (to the right) of the Vivekananda Nagar. This section further showcases the general particulars (refer box 25) and pictographical representation (figure 42) of the Vivekananda Nagar slum area.

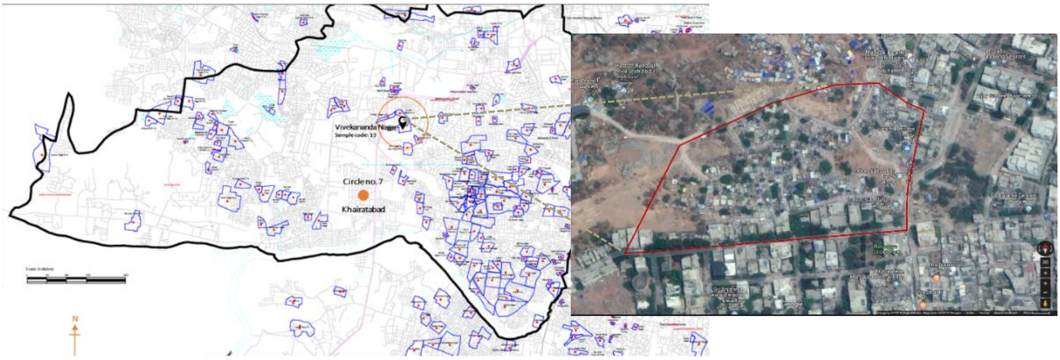


Figure 43: (Left) Map showing the location of Vivekananda Nagar in Khairatabad circle boundary; (Right) Satellite image of Vivekananda Nagar

Slum Name:	Vivekananda Nagar
Slum Code:	Circle 7_Slum A
Municipality Name:	Khairatabad
Zone Name:	Central Zone
City Name:	Hyderabad, Telangana State, India
Population:	2197
Households:	527
Age of the Slum:	>30 years

Structures in slum: The structures (or the buildings) in the slum area typically permanent in nature and are significantly used for residential purpose only.

Drinking water systems: This slum area is equipped with drinking water facilities and services such as household level individual taps, community level public taps, borewells, handpumps, water tankers, etc. The facilities and services are provided by HMWSSB.

Box 25: (Left) Brief profiling of Vivekananda Nagar

Figure 42: (Right) Pictographs of Vivekananda Nagar captured during field visits

14. Indira Nagar (13-6) (Circle 7_Slum B)

Indira Nagar (13-6) is one of the identified sample case studies geographically positioned in the West direction of the Hyderabad city region in the Khairatabad municipal circle boundary. The following figure 45 displays the location of this case study area in the Khairatabad circle boundary (to the left), and the satellite image (to the right) of the Indira Nagar (13-6). This section further showcases the general particulars (refer box 26) and pictographical representation (figure 44) of the Indira Nagar (13-6) slum area.

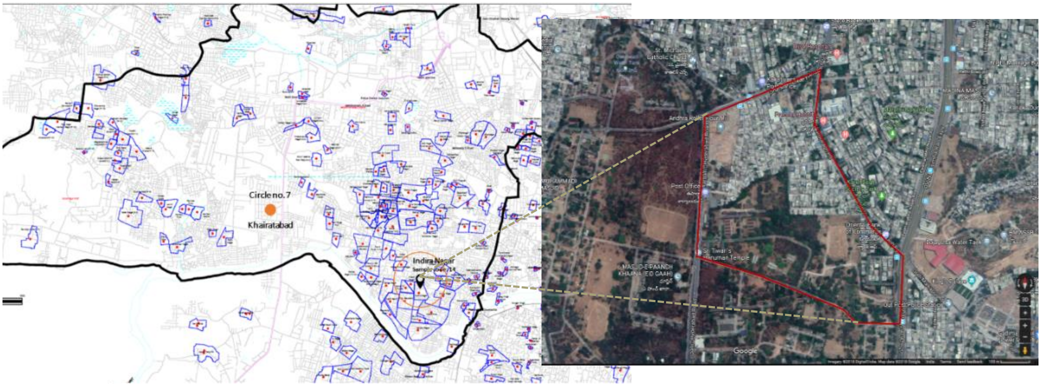


Figure 45: (Left) Map showing the location of Indira Nagar (13-6) in Khairatabad circle boundary; (Right) Satellite image of Indira Nagar (13-6)

Slum Name: Indira Nagar (13-6)
Slum Code: Circle 7_Slum B
Municipality Name: Khairatabad
Zone Name: Central Zone
City Name: Hyderabad, Telangana State, India
Population: 1353
Households: 329
Age of the Slum: >30 years
Structures in slum: The structures (or the buildings) in the slum area typically permanent in nature and are significantly used for residential purpose only.
Drinking water systems: This slum area is equipped with drinking water facilities and services such as household level individual taps, community level public taps, borewells, handpumps, water tankers, etc. The facilities and services are provided by HMWSSB.

Box 26: (Left) Brief profiling of Indira Nagar (13-6)

Figure 44: (Right) Pictographs of Indira Nagar (13-6) captured during field visits

15. Pool Bhaugh (Circle 8_Slum A)

Pool Bhaugh is one of the identified sample case studies geographically positioned amidst of the Hyderabad city region in the Abids municipal circle boundary. The following figure 47 displays the location of this case study area in the Abids circle boundary (to the left), and the satellite image (to the right) of the Pool Bhaugh. This section further showcases the general particulars (refer box 46) and pictographical representation (figure 45) of the Pool Bhaugh slum area.

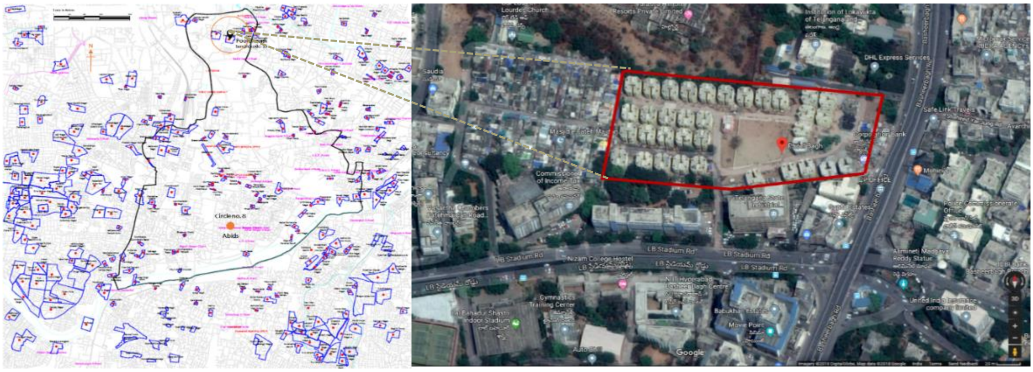


Figure 46: (Left) Map showing the location of Pool Bhaugh in Abids circle boundary; (Right) Satellite image of Pool Bhaugh

Slum Name: Pool Bhaugh
Slum Code: Circle 8_Slum A
Municipality Name: Abids
Zone Name: Central Zone
City Name: Hyderabad, Telangana State, India
Population: 2329
Households: 664
Age of the Slum: >30 years
Structures in slum: The structures (or the buildings) in the slum area typically permanent in nature and are significantly used for residential purpose only.

Drinking water systems: This slum area is equipped with drinking water facilities and services such as household level individual taps, community level public taps, borewells, handpumps, water tankers, etc. The facilities and services are provided by HMWSSB.

Box 27: (Left) Brief profiling of Pool Bhaugh

Figure 47: (Right) Pictographs of Pool Bhaugh captured during field visits

16. Band Lanes (Circle 8_Slum B)

Band Lanes is one of the identified sample case studies geographically positioned amidst of the Hyderabad city region in the Abids municipal circle boundary. The following figure 49 displays the location of this case study area in the Abids circle boundary (to the left), and the satellite image (to the right) of the Band Lanes. This section further showcases the general particulars (refer box 48) and pictographical representation (figure 47) of the Band Lanes slum area.

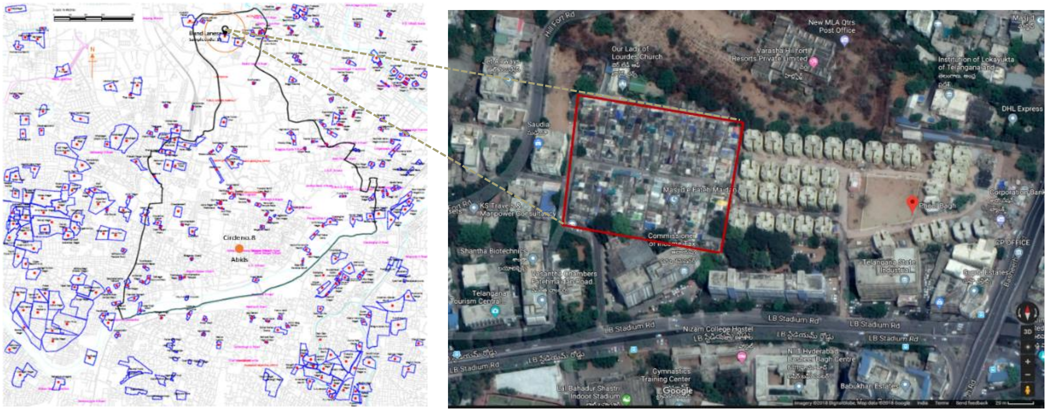


Figure 49: (Left) Map showing the location of Band Lanes in Abids circle boundary; (Right) Satellite image of Band Lanes

Slum Name: Band Lanes
Slum Code: Circle 8_Slum B
Municipality Name: Abids
Zone Name: Central Zone
City Name: Hyderabad, Telangana State, India
Population: 1042
Households: 258
Age of the Slum: >30 years
Structures in slum: The structures (or the buildings) in the slum area typically permanent in nature and are significantly used for residential purpose only.
Drinking water systems: This slum area is equipped with drinking water facilities and services such as household level individual taps, community level public taps, borewells, handpumps, water tankers, etc. The facilities and services are provided by HMWSSB.

Box 28: (Left) Brief profiling of Band Lanes

Figure 48: (Right) Pictographs of Band Lanes captured during field visits

17. Indira Nagar (I) (Circle 9_Slum A)

Indira Nagar (I) is one of the identified sample case studies geographically positioned amidst of the Hyderabad city region in the Abids municipal circle boundary. The following figure 51 displays the location of this case study area in the Abids circle boundary (to the left), and the satellite image (to the right) of the Indira Nagar (I). This section further showcases the general particulars (refer box 50) and pictographical representation (figure 49) of the Indira Nagar (I) slum area.

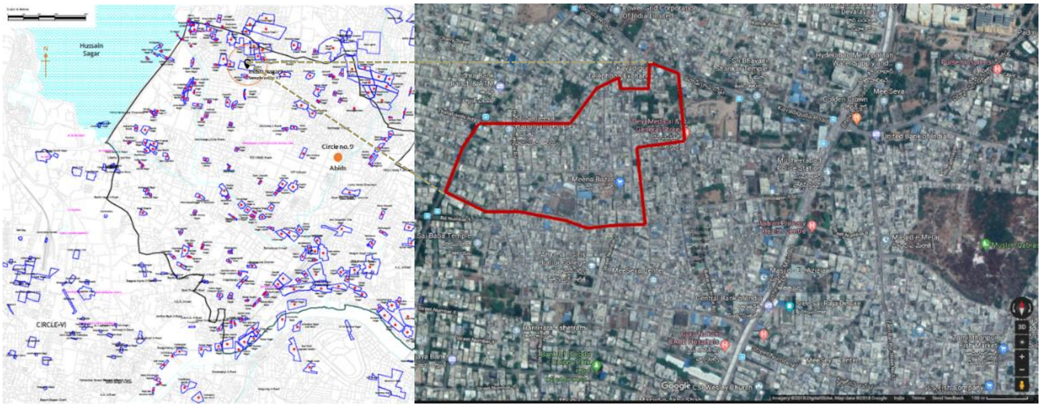


Figure 51: (Left) Map showing the location of Indira Nagar (I) in Abids circle boundary; (Right) Satellite image of Indira Nagar (I)

Slum Name: Indira Nagar (I)
Slum Code: Circle 9_Slum A
Municipality Name: Abids
Zone Name: Central Zone
City Name: Hyderabad, Telangana State, India
Population: 2259
Households: 478
Age of the Slum: >30 years
Structures in slum: The structures (or the buildings) in the slum area typically permanent in nature and are significantly used for residential purpose only.
Drinking water systems: This slum area is equipped with drinking water facilities and services such as household level individual taps, community level public taps, borewells, handpumps, water tankers, etc. The facilities and services are provided by HMWSSB.

Box 29: (Left) Brief profiling of Indira Nagar (I)

Figure 50: (Right) Pictographs of Indira Nagar (I) captured during field visits

18. Bapu Nagar (Circle 9_Slum B)

Bapu Nagar is one of the identified sample case studies geographically positioned amidst of the Hyderabad city region in the Abids municipal circle boundary. The following figure 53 displays the location of this case study area in the Abids circle boundary (to the left), and the satellite image (to the right) of the Bapu Nagar. This section further showcases the general particulars (refer box 30) and pictographical representation (figure 52) of the Bapu Nagar slum area.

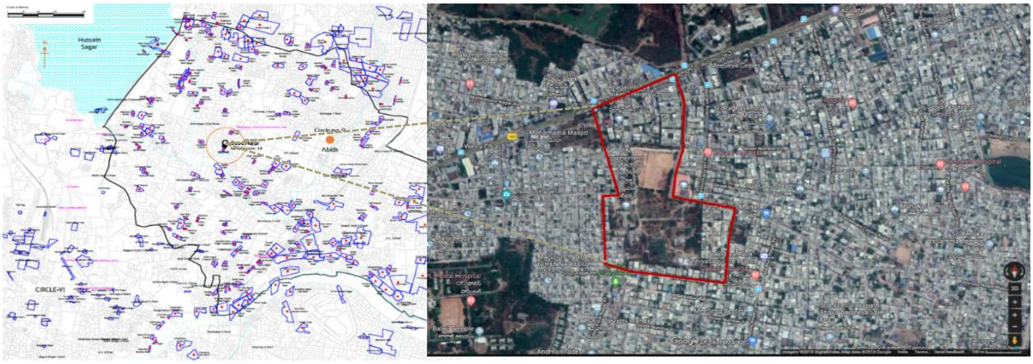


Figure 53: (Left) Map showing the location of Bapu Nagar in Abids circle boundary; (Right) Satellite image of Bapu Nagar

Slum Name:	Bapu Nagar (Amberpet)
Slum Code:	Circle 9_Slum B
Municipality Name:	Abids
Zone Name:	Central Zone
City Name:	Hyderabad, Telangana State, India
Population:	3400
Households:	680
Age of the Slum:	>30 years

Structures in slum: The structures (or the buildings) in the slum area typically permanent in nature and are significantly used for residential purpose only.

Drinking water systems: This slum area is equipped with drinking water facilities and services such as household level individual taps, community level public taps, borewells, handpumps, water tankers, etc. The facilities and services are provided by HMWSSB.

Box 30: (Left) Brief profiling of Bapu Nagar

Figure 52: (Right) Pictographs of Bapu Nagar captured during field visits

19. Devarakonda Basti (Circle 10_Slum A)

Devarakonda Basti is one of the identified sample case studies geographically positioned amidst of the Hyderabad city region in the Khairatabad municipal circle boundary. The following figure 55 displays the location of this case study area in the Khairatabad circle boundary (to the left), and the satellite image (to the right) of the Devarakonda Basti. This section further showcases the general particulars (refer box 31) and pictographical representation (figure 54) of the Devarakonda slum area.

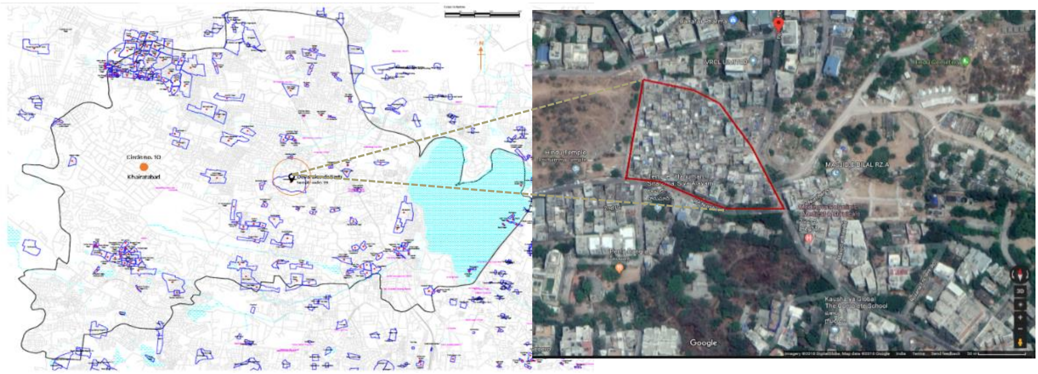


Figure 55: (Left) Map showing the location of Devarakonda Basti in Khairatabad circle boundary; (Right) Satellite image of Devarakonda Basti

Slum Name: Devarakonda Basti
Slum Code: Circle 10_Slum A
Municipality Name: Khairatabad
Zone Name: Central Zone
City Name: Hyderabad, Telangana State, India
Population: 1347
Households: 307
Age of the Slum: >30 years
Structures in slum: The structures (or the buildings) in the slum area typically permanent in nature and are significantly used for residential purpose only.
Drinking water systems: This slum area is equipped with drinking water facilities and services such as household level individual taps, community level public taps, borewells, handpumps, water tankers, etc. The facilities and services are provided by HMWSSB.

Box 31: (Left) Brief profiling of Devarakonda Basti

Figure 54: (Right) Pictographs of Devarakonda Basti captured during field visits

20. Ambedkar Nagar (Circle 10_Slum B)

Ambedkar Nagar is one of the identified sample case studies geographically positioned amidst of the Hyderabad city region in the Khairatabad municipal circle boundary. The following figure 57 displays the location of this case study area in the Khairatabad circle boundary (to the left), and the satellite image (to the right) of the Ambedkar Nagar. This section further showcases the general particulars (refer box 32) and pictographical representation (figure 56) of the Ambedkar Nagar slum area.

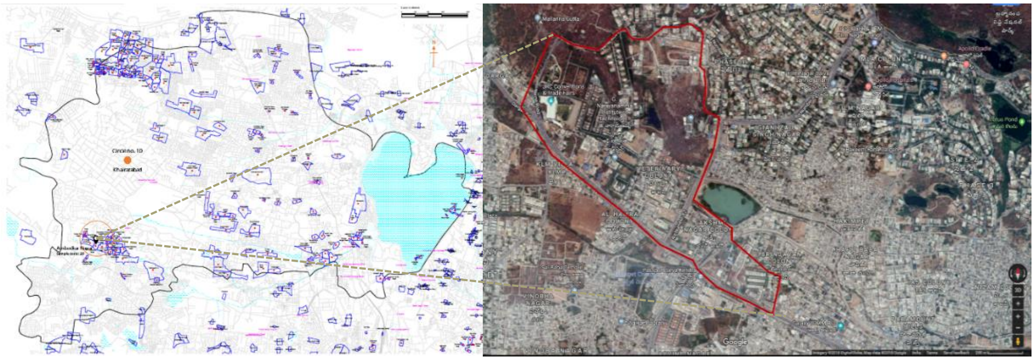


Figure 57: (Left) Map showing the location of Ambedkar Nagar in Khairatabad circle boundary; (Right) Satellite image of Ambedkar Nagar

Slum Name: Ambedkar Nagar
Slum Code: Circle 10_Slum B
Municipality Name: Khairatabad
Zone Name: Central Zone
City Name: Hyderabad, Telangana State, India
Population: 1756
Households: 350
Age of the Slum: >30 years
Structures in slum: The structures (or the buildings) in the slum area typically permanent in nature and are significantly used for residential purpose only.
Drinking water systems: This slum area is equipped with drinking water facilities and services such as household level individual taps, community level public taps, borewells, handpumps, water tankers, etc. The facilities and services are provided by HMWSSB.

Box 32: (Left) Brief profiling of Ambedkar Nagar

Figure 56: (Right) Pictographs of Ambedkar Nagar captured during field visits

21. Prem Nagar (Circle 11_Slum A)

Prem Nagar is one of the identified sample case studies geographically positioned in the North-West direction of the Hyderabad city region in the Sherilingampally (S) municipal circle boundary. The following figure 58 displays the location of this case study area in the Sherilingampally (S) circle boundary (to the left), and the satellite image (to the right) of the Prem Nagar. This section further showcases the general particulars (refer box 33) and pictographical representation (figure 59) of the Prem Nagar slum area.

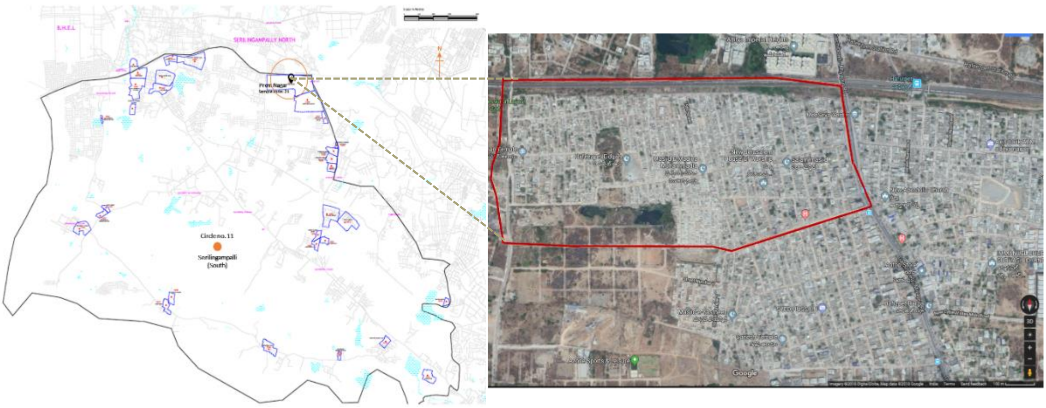
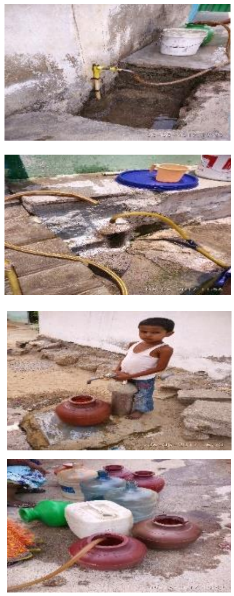


Figure 58: (Left) Map showing the location of Prem Nagar in Sherilingampally (S) circle boundary; (Right) Satellite image of Prem Nagar

Slum Name: Prem Nagar
Slum Code: Circle 11_Slum A
Municipality Name: Sherilingampally (S)
Zone Name: West Zone
City Name: Hyderabad, Telangana State, India
Population: 9699
Households: 2399
Age of the Slum: >30 years
Structures in slum: The structures (or the buildings) in the slum area typically permanent in nature and are significantly used for residential purpose only.

Drinking water systems: This slum area is equipped with drinking water facilities and services such as household level individual taps, community level public taps, borewells, handpumps, water tankers, etc. The facilities and services are provided by HMWSSB.



Box 33: (Left) Brief profiling of Prem Nagar

Figure 59: (Right) Pictographs of Prem Nagar captured during field visits

22. Marthanda Nagar (Circle 11_Slum B)

Marthanda Nagar is one of the identified sample case studies geographically positioned in the North-West direction of the Hyderabad city region in the Sherilingampally (S) municipal circle boundary. The following figure 61 displays the location of this case study area in the Sherilingampally (S) circle boundary (to the left), and the satellite image (to the right) of the Marthanda Nagar. This section further showcases the general particulars (refer box 34) and pictographical representation (figure 60) of the Marthanda Nagar slum area.

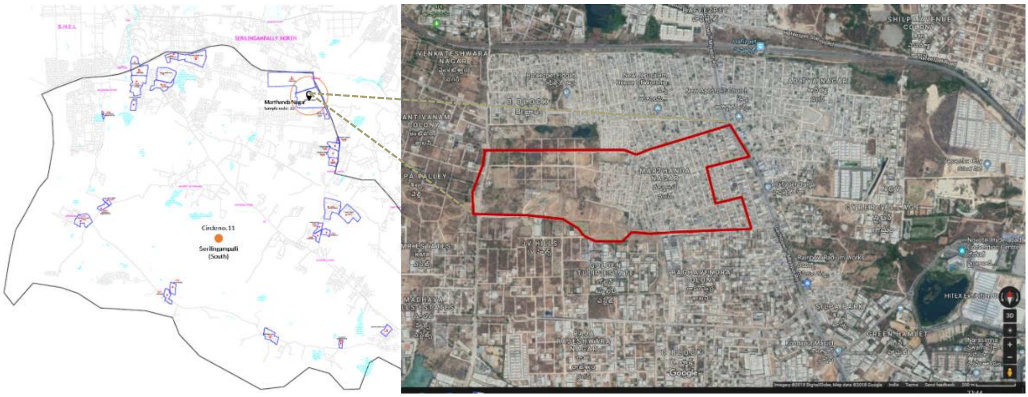


Figure 61: (Left) Map showing the location of Marthanda Nagar in Sherilingampally (S) circle boundary; (Right) Satellite image of Marthanda Nagar

Slum Name: Marthanda Nagar
Slum Code: Circle 11_Slum B
Municipality Name: Sherilingampally (S)
Zone Name: West Zone
City Name: Hyderabad, Telangana State, India
Population: 6418
Households: 1586
Age of the Slum: >30 years
Structures in slum: The structures (or the buildings) in the slum area typically permanent in nature and are significantly used for residential purpose only.
Drinking water systems: This slum area is equipped with drinking water facilities and services such as household level individual taps, community level public taps, borewells, handpumps, water tankers, etc. The facilities and services are provided by HMWSSB.

Box 34: (Left) Brief profiling of Marthanda Nagar

Figure 60: (Right) Pictographs of Marthanda Nagar captured during field visits

23. Izzatnagar Weaker Section (WS) (Circle 12_Slum A)

Izzatnagar WS is one of the identified sample case studies geographically positioned in the North-West direction of the Hyderabad city region in the Sherilingampally (N) municipal circle boundary. The following figure 63 displays the location of this case study area in the Sherilingampally (N) circle boundary (to the left), and the satellite image (to the right) of the Izzatnagar WS. This section further showcases the general particulars (refer box 35) and pictographical representation (figure 62) of the Izzatnagar WS slum area.

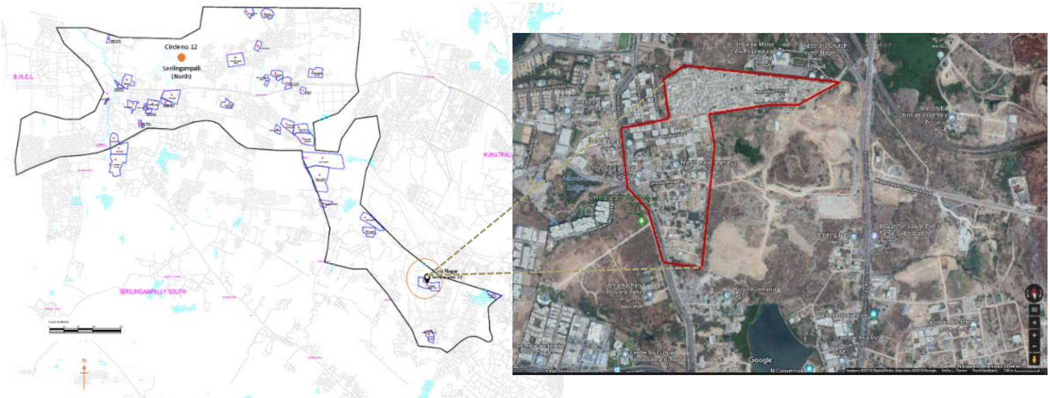


Figure 63: (Left) Map showing the location of Izzatnagar WS in Sherilingampally (N) circle boundary; (Right) Satellite image of Izzatnagar WS

Slum Name: Izzatnagar Weaker Section
Slum Code: Circle 12_Slum A
Municipality Name: Sherilingampally (N)
Zone Name: West Zone
City Name: Hyderabad, Telangana State, India
Population: 2658
Households: 619
Age of the Slum: >30 years
Structures in slum: The structures (or the buildings) in the slum area typically permanent in nature and are significantly used for residential purpose only.
Drinking water systems: This slum area is equipped with drinking water facilities and services such as household level individual taps, community level public taps, borewells, handpumps, water tankers, etc. The facilities and services are provided by HMWSSB.

Box 35: (Left) Brief profiling of Izzatnagar WS

Figure 62: (Right) Pictographs of Izzatnagar WS captured during field visits

24. Maktha Mahaboobpet (Circle 12_Slum B)

Maktha Mahaboobpet is one of the identified sample case studies geographically positioned in the North-West direction of the Hyderabad city region in the Sherilingampally (N) municipal circle boundary. The following figure 64 displays the location of this case study area in the Sherilingampally (N) circle boundary (to the left), and the satellite image (to the right) of the Maktha Mahaboobpet. This section further showcases the general particulars (refer box 36) and pictographical representation (figure 65) of the Maktha Mahaboobpet slum area.

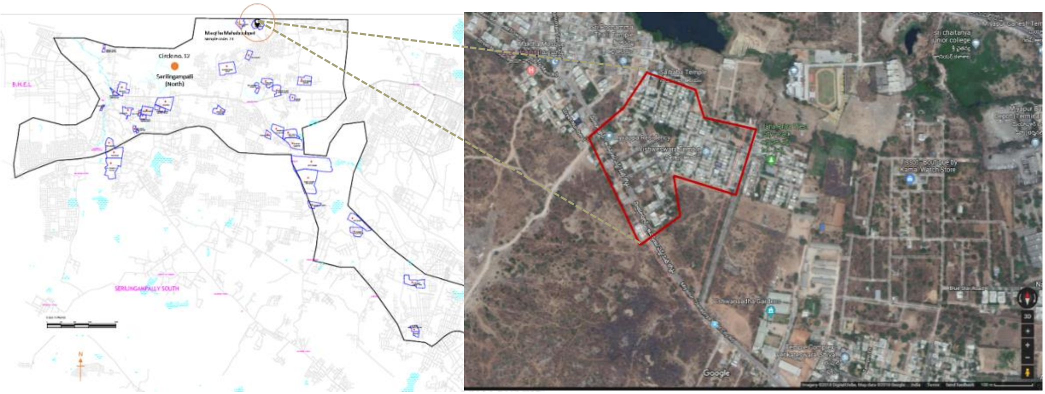


Figure 64: (Left) Map showing the location of Maktha Mahaboobpet in Sherilingampally (N) circle boundary; (Right) Satellite image of Maktha Mahaboobpet

Slum Name: Maktha Mahaboobpet
Slum Code: Circle 12_Slum B
Municipality Name: Sherilingampally (N)
Zone Name: West Zone
City Name: Hyderabad, Telangana State, India
Population: 1574
Households: 427
Age of the Slum: >30 years
Structures in slum: The structures (or the buildings) in the slum area typically permanent in nature and are significantly used for residential purpose only.
Drinking water systems: This slum area is equipped with drinking water facilities and services such as household level individual taps, community level public taps, borewells, handpumps, water tankers, etc. The facilities and services are provided by HMWSSB.

Box 36: (Left) Brief profiling of Maktha Mahaboobpet

Figure 65: (Right) Pictographs of Maktha Mahaboobpet captured during field visits

25. Rajiv Gandhi Nagar (Allapur) (Circle 14_Slum A)

Rajiv Gandhi Nagar (Allapur) is one of the identified sample case studies geographically positioned in the North direction of the Hyderabad city region in the Kukatpally municipal circle boundary. The following figure 67 displays the location of this case study area in the Kukatpally circle boundary (to the left), and the satellite image (to the right) of the Rajiv Gandhi Nagar. This section further showcases the general particulars (refer box 37) and pictographical representation (figure 66) of the Rajiv Gandhi Nagar slum area.

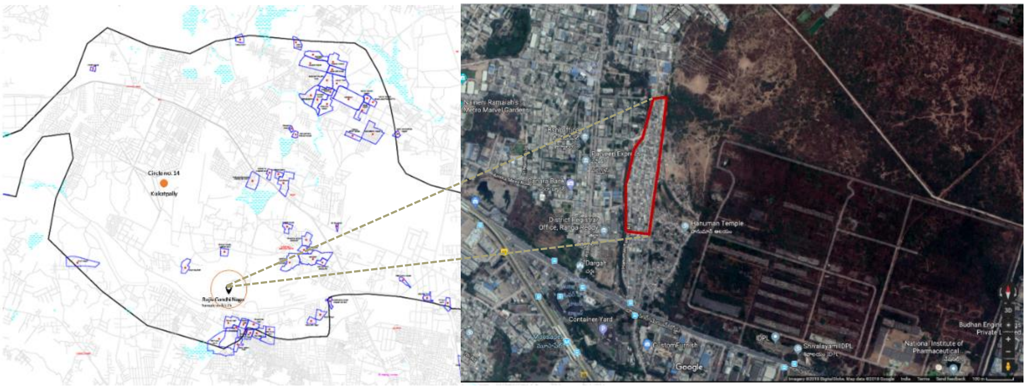


Figure 67: (Left) Map showing the location of Rajiv Gandhi Nagar in Kukatpally circle boundary; (Right) Satellite image of Rajiv Gandhi Nagar

Slum Name: Rajiv Gandhi Nagar (Allapur)
Slum Code: Circle 14_Slum A
Municipality Name: Kukatpally
Zone Name: West Zone
City Name: Hyderabad, Telangana State, India
Population: 4203
Households: 927
Age of the Slum: >30 years
Structures in slum: The structures (or the buildings) in the slum area typically permanent in nature and are significantly used for residential purpose only.
Drinking water systems: This slum area is equipped with drinking water facilities and services such as household level individual taps, community level public taps, borewells, handpumps, water tankers, etc. The facilities and services are provided by HMWSSB.

Box 37: (Left) Brief profiling of Rajiv Gandhi Nagar

Figure 66: (Right) Pictographs of Rajiv Gandhi Nagar captured during field visits

26. Yellamma Banda (Circle 14_Slum B)

Yellamma Banda is one of the identified sample case studies geographically positioned in the North direction of the Hyderabad city region in the Kukatpally municipal circle boundary. The following figure 69 displays the location of this case study area in the Kukatpally circle boundary (to the left), and the satellite image (to the right) of the Yellamma Banda. This section further showcases the general particulars (refer box 38) and pictographical representation (figure 68) of the Yellamma Banda slum area.

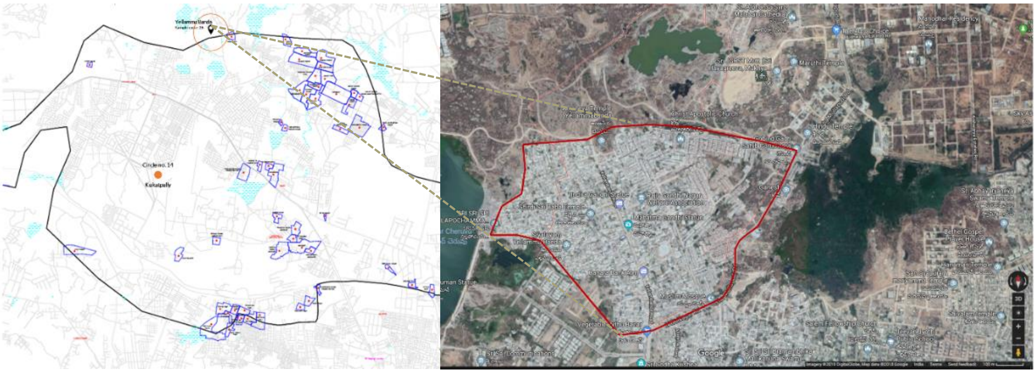


Figure 69: (Left) Map showing the location of Yellamma Banda in Kukatpally circle boundary; (Right) Satellite image of Yellamma Banda

Slum Name: Yellamma Banda
Slum Code: Circle 14_Slum B
Municipality Name: Kukatpally
Zone Name: West Zone
City Name: Hyderabad, Telangana State, India
Population: 8775
Households: 2129
Age of the Slum: >30 years
Structures in slum: The structures (or the buildings) in the slum area typically permanent in nature and are significantly used for residential purpose only.
Drinking water systems: This slum area is equipped with drinking water facilities and services such as household level individual taps, community level public taps, borewells, handpumps, water tankers, etc. The facilities and services are provided by HMWSSB.

Box 38: (Left) Brief profiling of Yellamma Banda

Figure 68: (Right) Pictographs of Yellamma Banda captured during field visits

27. Shiridi Saibaba Nagar (Circle 15_Slum A)

Shiridi Saibaba Nagar is one of the identified sample case studies geographically positioned in the North direction of the Hyderabad city region in the Quthbullapur municipal circle boundary. The following figure 71 displays the location of this case study area in the Quthbullapur circle boundary (to the left), and the satellite image (to the right) of the Shiridi Saibaba Nagar. This section further showcases the general particulars (refer box 39) and pictographical representation (figure 70) of the Shiridi Saibaba Nagar slum area.

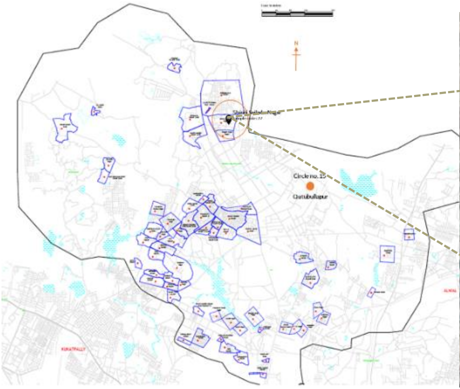



Figure 71: (Left) Map showing the location of Shiridi Saibaba Nagar in Quthbullapur circle boundary; (Right) Satellite image of Shiridi Saibaba Nagar

Slum Name:	Shiridi Saibaba Nagar
Slum Code:	Circle 15_Slum A
Municipality Name:	Quthbullapur
Zone Name:	North Zone
City Name:	Hyderabad, Telangana State, India
Population:	6900
Households:	1755
Age of the Slum:	>30 years

Structures in slum: The structures (or the buildings) in the slum area typically permanent in nature and are significantly used for residential purpose only.

Drinking water systems: This slum area is equipped with drinking water facilities and services such as household level individual taps, community level public taps, borewells, handpumps, water tankers, etc. The facilities and services are provided by HMWSSB.




Box 39: (Left) Brief profiling of Shiridi Saibaba Nagar

Figure 70: (Right) Pictographs of Shiridi Saibaba Nagar captured during field visits

28. Kaiser Nagar (Circle 15_Slum B)

Kaiser Nagar is one of the identified sample case studies geographically positioned in the North direction of the Hyderabad city region in the Quthbullapur municipal circle boundary. The following figure 72 displays the location of this case study area in the Quthbullapur circle boundary (to the left), and the satellite image (to the right) of the Kaiser Nagar. This section further showcases the general particulars (refer box 40) and pictographical representation (figure 73) of the Kaiser Nagar slum area.

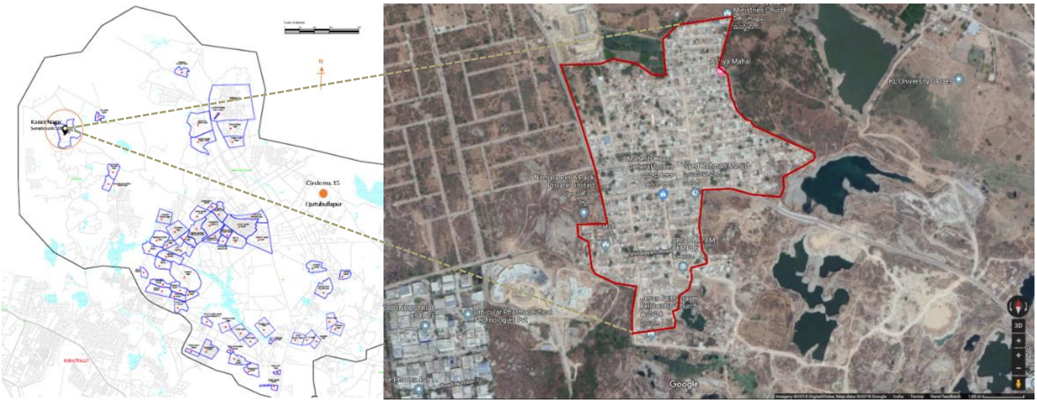


Figure 72: (Left) Map showing the location of Kaiser Nagar in Quthbullapur circle boundary; (Right) Satellite image of Kaiser Nagar

Slum Name: Kaiser Nagar
Slum Code: Circle 15_Slum B
Municipality Name: Quthbullapur
Zone Name: North Zone
City Name: Hyderabad, Telangana State, India
Population: 1951
Households: 437
Age of the Slum: >30 years
Structures in slum: The structures (or the buildings) in the slum area typically permanent in nature and are significantly used for residential purpose only.
Drinking water systems: This slum area is equipped with drinking water facilities and services such as household level individual taps, community level public taps, borewells, handpumps, water tankers, etc. The facilities and services are provided by HMWSSB.

Box 40: (Left) Brief profiling of Kaiser Nagar

Figure 73: (Right) Pictographs of Kaiser Nagar captured during field visits

29. Turkapally Bollaram (Circle 16_Slum A)

Turkapally Bollaram is one of the identified sample case studies geographically positioned in the North direction of the Hyderabad city region in the Alwal municipal circle boundary. The following figure 75 displays the location of this case study area in the Alwal circle boundary (to the left), and the satellite image (to the right) of the Turkapally Bollaram. This section further showcases the general particulars (refer box 41) and pictographical representation (figure 74) of the Turkapally Bollaram slum area.

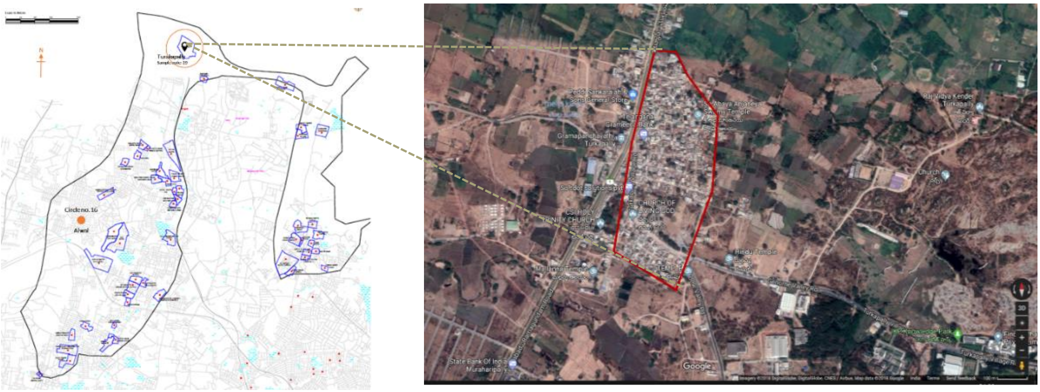


Figure 75: (Left) Map showing the location of Turkapally Bollaram in Alwal circle boundary; (Right) Satellite image of Turkapally Bollaram

Slum Name:	Turkapally Bollaram
Slum Code:	Circle 16_Slum A
Municipality Name:	Alwal
Zone Name:	North Zone
City Name:	Hyderabad, Telangana State, India
Population:	1246
Households:	334
Age of the Slum:	>30 years

Structures in slum: The structures (or the buildings) in the slum area typically permanent in nature and are significantly used for residential purpose only.

Drinking water systems: This slum area is equipped with drinking water facilities and services such as household level individual taps, community level public taps, borewells, handpumps, water tankers, etc. The facilities and services are provided by HMWSSB.

Box 41: (Left) Brief profiling of Turkapally Bollaram

Figure 74: (Right) Pictographs of Turkapally Bollaram captured during field visits

30. Bharat Nagar (Circle 16_Slum B)

Bharat Nagar is one of the identified sample case studies geographically positioned in the North direction of the Hyderabad city region in the Alwal municipal circle boundary. The following figure 76 displays the location of this case study area in the Alwal circle boundary (to the left), and the satellite image (to the right) of the Bharat Nagar. This section further showcases the general particulars (refer box 42) and pictographical representation (figure 77) of the Bharat Nagar slum area.

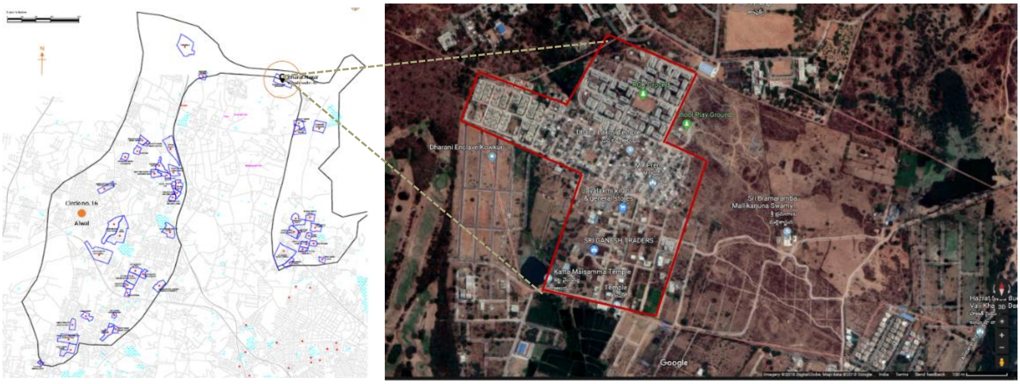


Figure 76: (Left) Map showing the location of Bharat Nagar in Alwal circle boundary; (Right) Satellite image of Bharat Nagar

Slum Name:	Bharat Nagar
Slum Code:	Circle 16_Slum B
Municipality Name:	Alwal
Zone Name:	North Zone
City Name:	Hyderabad, Telangana State, India
Population:	1209
Households:	305
Age of the Slum:	>30 years

Structures in slum: The structures (or the buildings) in the slum area typically permanent in nature and are significantly used for residential purpose only.

Drinking water systems: This slum area is equipped with drinking water facilities and services such as household level individual taps, community level public taps, borewells, handpumps, water tankers, etc. The facilities and services are provided by HMWSSB.

Box 42: (Left) Brief profiling of Bharat Nagar

Figure 77: (Right) Pictographs of Bharat Nagar captured during field visits

31. I N Nagar (Circle 17_Slum A)

I N Nagar is one of the identified sample case studies geographically positioned in the North-East direction of the Hyderabad city region in the Malkajgiri municipal circle boundary. The following figure 79 displays the location of this case study area in the Malkajgiri circle boundary (to the left), and the satellite image (to the right) of the I N Nagar. This section further showcases the general particulars (refer box 43) and pictographical representation (figure 78) of the I N Nagar slum area.

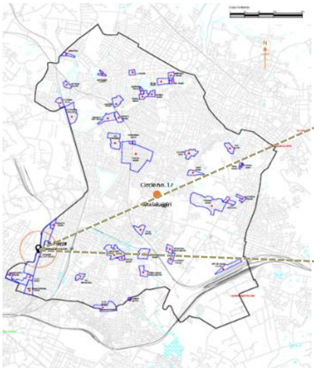


Figure 79: (Left) Map showing the location of I N Nagar in Malkajgiri circle boundary; (Right) Satellite image of I N Nagar

Slum Name: Indira Nehru (I N) Nagar
Slum Code: Circle 17_Slum A
Municipality Name: Malkajgiri
Zone Name: North Zone
City Name: Hyderabad, Telangana State, India
Population: 5366
Households: 1396
Age of the Slum: >30 years
Structures in slum: The structures (or the buildings) in the slum area typically permanent in nature and are significantly used for residential purpose only.
Drinking water systems: This slum area is equipped with drinking water facilities and services such as household level individual taps, community level public taps, borewells, handpumps, water tankers, etc. The facilities and services are provided by HMWSSB.

Box 43: (Left) Brief profiling of I N Nagar

Figure 78: (Right) Pictographs of I N Nagar captured during field visits

32. B J R Nagar (Circle 17_Slum B)

B J R Nagar is one of the identified sample case studies geographically positioned in the North-East direction of the Hyderabad city region in the Malkajgiri municipal circle boundary. The following figure 81 displays the location of this case study area in the Malkajgiri circle boundary (to the left), and the satellite image (to the right) of the B J R Nagar. This section further showcases the general particulars (refer box 44) and pictographical representation (figure 80) of the B J R Nagar slum area.

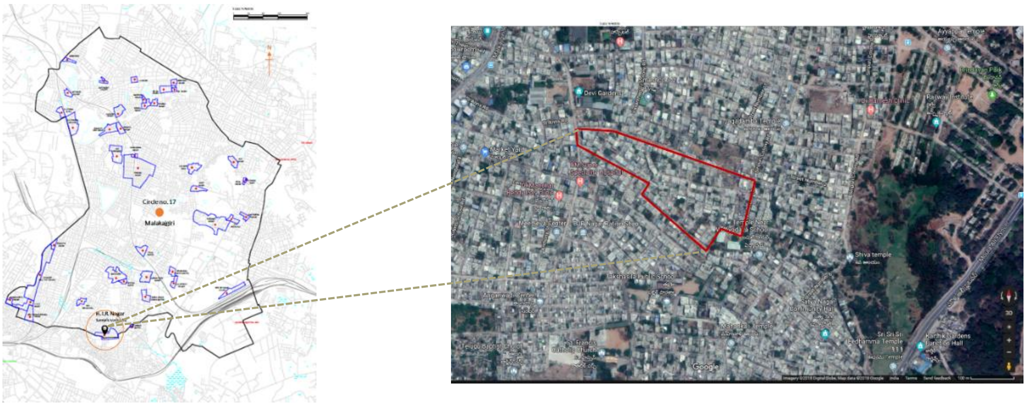


Figure 81: (Left) Map showing the location of B J R Nagar in Malkajgiri circle boundary; (Right) Satellite image of B J R Nagar

Slum Name: B J R Nagar
Slum Code: Circle 17_Slum B
Municipality Name: Malkajgiri
Zone Name: North Zone
City Name: Hyderabad, Telangana State, India
Population: 2809
Households: 677
Age of the Slum: >30 years
Structures in slum: The structures (or the buildings) in the slum area typically permanent in nature and are significantly used for residential purpose only.
Drinking water systems: This slum area is equipped with drinking water facilities and services such as household level individual taps, community level public taps, borewells, handpumps, water tankers, etc. The facilities and services are provided by HMWSSB.

Box 44: (Left) Brief profiling of B J R Nagar

Figure 80: (Right) Pictographs of B J R Nagar captured during field visits

33. Hamal Basthi Phase-I (Circle 18_Slum A)

Hamal Basthi Phase-I is one of the identified sample case studies geographically positioned in the East direction of the Hyderabad city region in the Secunderabad municipal circle boundary. The following figure 83 displays the location of this case study area in the Secunderabad circle boundary (to the right), and the satellite image (to the left) of the Hamal Basthi Phase-I. This section further showcases the general particulars (refer box 45) and pictographical representation (figure 82) of the Hamal Basthi Phase-I slum area.

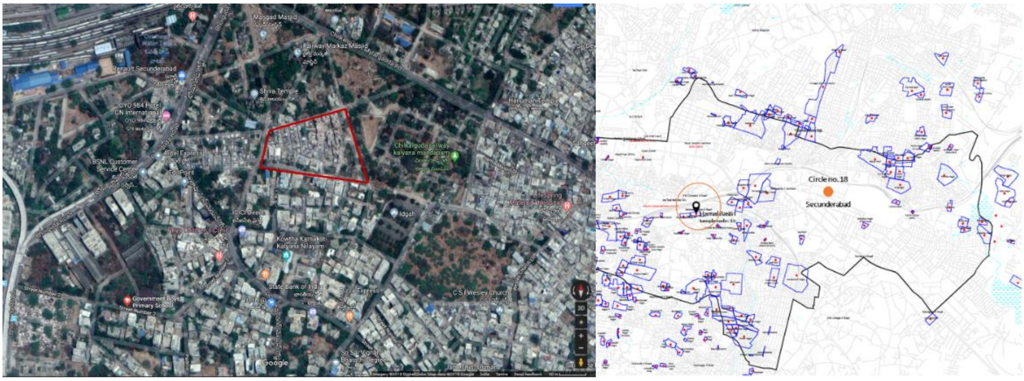


Figure 83: (Right) Map showing the location of Hamal Basthi Phase-I in Secunderabad circle boundary; (Left) Satellite image of Hamal Basthi Phase-I

Slum Name: Hamal Basthi Phase-I
Slum Code: Circle 18_Slum A
Municipality Name: Secunderabad
Zone Name: North Zone
City Name: Hyderabad, Telangana State, India
Population: 1624
Households: 400
Age of the Slum: >30 years
Structures in slum: The structures (or the buildings) in the slum area typically permanent in nature and are significantly used for residential purpose only.
Drinking water systems: This slum area is equipped with drinking water facilities and services such as household level individual taps, community level public taps, borewells, handpumps, water tankers, etc. The facilities and services are provided by HMWSSB.

Box 45: (Left) Brief profiling of Hamal Basthi Phase-I

Figure 82: (Right) Pictographs of Hamal Basthi Phase-I captured during field visits

34. Hamal Basthi Phase-II (Circle 18_Slum B)

Hamal Basthi Phase-II is one of the identified sample case studies geographically positioned in the East direction of the Hyderabad city region in the Secunderabad municipal circle boundary. The following figure 84 displays the location of this case study area in the Secunderabad circle boundary (to the right), and the satellite image (to the left) of the Hamal Basthi Phase-II. This section further showcases the general particulars (refer box 46) and pictographical representation (figure 85) of the Hamal Basthi Phase-II slum area.

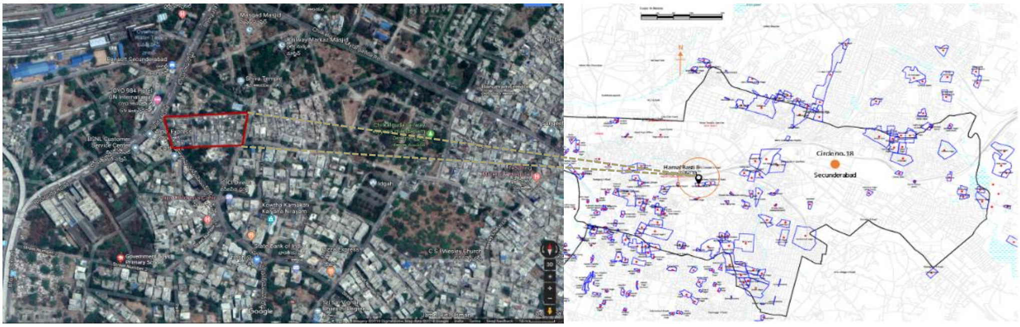


Figure 84: (Right) Map showing the location of Hamal Basthi Phase-I in Secunderabad circle boundary; (Left) Satellite image of Hamal Basthi Phase-II

Slum Name: Hamal Basthi Phase-II
Slum Code: Circle 18_Slum B
Municipality Name: Secunderabad
Zone Name: North Zone
City Name: Hyderabad, Telangana State, India
Population: 2386
Households: 566
Age of the Slum: >30 years
Structures in slum: The structures (or the buildings) in the slum area typically permanent in nature and are significantly used for residential purpose only.
Drinking water systems: This slum area is equipped with drinking water facilities and services such as household level individual taps, community level public taps, borewells, handpumps, water tankers, etc. The facilities and services are provided by HMWSSB.

Box 46: (Left) Brief profiling of Hamal Basthi Phase-II

Figure 85: (Right) Pictographs of Hamal Basthi Phase-II captured during field visits

Annexure 4 | Quality and Quantity of drinking water

a. Microbiological parameters

i. Thermotolerant coliforms

The following provides the assessment of the quality of drinking water from different sources of drinking water for the presence of thermotolerant coliforms. There should be no presence of thermotolerant coliforms in drinking water for acceptable levels.

Household/ public taps. 7 out of 17 drinking water samples, 41% samples from household/ public taps tested for thermotolerant coliforms are not meeting the requirements of both the national standards, and WHO guideline values. The drinking water samples tested from the slum no. 21, 26, 17, 31, 27, 10, 2 are not compliant to the standards, whereas the samples from the slum no. 23, 19, 13, 15, 33, 30, 11, 8, 5, 3 are compliant to the standards/ guidelines.

Borewells/ handpumps. 6 out of 17 drinking water samples, 35% samples from borewells/ handpumps tested for thermotolerant coliforms are not meeting the requirements of both the national standards, and WHO guideline values. The drinking water samples tested from the slum no. 26, 15, 31, 30, 8, 5 are not compliant with the standards, whereas the samples from the slum no. 21, 23, 19, 33, 2, 3, 10, 11, 13, 17, 27 are compliant to the standards/ guidelines.

Water tankers. 1 out of 17 drinking water samples, 6% samples from water tankers tested for thermotolerant coliforms are not meeting the requirements of both the national standards, and WHO guideline values. The drinking water samples tested from the slum no. 30 are not compliant with the standards, whereas the samples from the slum no. 31, 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 33 are compliant to the standards/ guidelines.

ii. Turbidity

The following section provides the assessment of drinking water quality in terms of turbidity levels. The acceptable turbidity levels in the drinking water ranges between 0 and 5 NTU (Nephelometric Turbidity Unit).

Household/ public taps. 0 out of 17 drinking water samples, i.e. 0% samples from households/ public taps tested for turbidity levels are not meeting the requirements of both the national standards, and WHO guideline values. The drinking water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines.

Borewells/ handpumps. Similarly, 0 out of 17 drinking water samples, i.e. 0% samples from borewells/ handpumps tested for turbidity levels are not meeting the requirements of both the national standards, and WHO guideline values. The drinking water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines.

Water tankers. Similarly, 0 out of 17 drinking water samples, i.e. 0% samples from water tankers tested for turbidity levels are not meeting the requirements of both the national standards, and WHO guideline values. The drinking water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines.

iii. pH (potential Hydrogen)

The following section provides the assessment of drinking water quality in terms of pH levels. The acceptable pH levels in the drinking water ranges between 6.5 and 8.5.

Household/ public taps. 0 out of 17 drinking water samples, i.e. 0% samples from households/ public taps tested for pH levels are not meeting the requirements of both the national standards, and WHO guideline values. The drinking water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines. The pH values of drinking water are within the permissible pH limits in these slum areas.

Borewells/ handpumps. Similarly, 0 out of 17 drinking water samples, i.e. 0% samples from borewells/ handpumps tested for pH levels are not meeting the requirements of both the national standards, and WHO guideline values. The drinking water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines.

Water tankers. Similarly, 0 out of 17 drinking water samples, i.e. 0% samples from water tankers tested for pH levels are not meeting the requirements of both the national standards, and WHO guideline values. The drinking water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines. The pH values of drinking water are within the permissible pH limits in these slum areas.

iv. Residual Chlorine

The following provides the assessment of drinking water quality supplied by HMWSSB in terms of residual chlorine levels. The residual chlorine levels are applicable only to the drinking water supplied through household level and community level tap connections. In order to protect the drinking water from viral infection, it is required to maintain minimum levels of residual chlorine ranging between 0.2 and 1.0 mg/l.

Household/ public taps. 16 out of 17 drinking water samples, i.e. 94% samples from households/ public taps tested for residual chlorine levels, are not meeting the requirements of both the national standards, and WHO guideline values. Further, 1 out of 17 drinking water samples, i.e. 6% samples from households/ public taps are meeting the requirements of both the national standards, and WHO guideline values. The drinking water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31 are not compliant to the standards, whereas the water sample from the slum no. 33 is compliant to the standards/ guidelines. The residual chlorine levels in the drinking water are within the permissible limits in this slum area.

v. Total Coliforms

The following provides the assessment of drinking water quality in terms of non-presence of Total Coliforms as standard acceptable levels for consumption purposes.

Household/ public taps. 11 out of 17 drinking water samples, i.e. 65% samples from households/ public taps tested for Total coliform levels are not meeting the requirements of both the national standards, and WHO guideline values. The drinking water samples from the slum area no. 21, 23, 26, 15, 17, 33, 31, 27, 10, 2, 8 are not compliant to the standards, whereas the water samples from the slum no. 19, 13, 11, 5, 3, 30 are compliant to the standards/ guidelines.

Borewells/ handpumps. 8 out of 17 drinking water samples, i.e. 47% samples from borewells/ handpumps tested for Total coliform levels are not meeting the requirements of both the national standards, and WHO guideline levels. The drinking water samples from the slum area no. 23, 26, 19, 15, 31, 30, 8, 5 are not compliant to the standards, whereas the water samples from the slum no. 21, 33, 2, 3, 10, 11, 13, 17, 27 are compliant to the standards/ guidelines.

Water tankers. 1 out of 17 drinking water samples, i.e. 6% samples from water tanker tested for Total coliform levels are not meeting the requirements of both the national standards, and WHO guideline values. The drinking water samples from the slum area no. 30 are non-compliant to the standards, whereas the water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 31, 33 are compliant to the standards/ guidelines.

vi. Escherichia Coli (E.coli)

The following provides the assessment of quality of drinking water pertaining to non-existence of E.coli elements as standard acceptable levels for consumption purposes.

Household/ public taps. 3 out of 17 drinking water samples, i.e. 18% samples from households/ public taps tested for E.coli levels are not meeting the requirements of both the national standards, and WHO guideline values. The drinking water samples from the slum area no. 26, 31, 2 are not compliant to the standards, whereas the water samples from the slum no. 21, 23, 19, 13, 15, 17, 33, 27, 11, 10, 8, 5, 3, 30 are compliant to the standards/ guidelines.

Borewells/ handpumps. 5 out 17 drinking water samples, i.e. 29% samples from borewells/ handpumps tested for E.coli levels are not meeting the requirements of both the national standards, and WHO guideline levels. The drinking water samples from the slum area no. 26, 31, 30, 8, 5 are not compliant to the standards, whereas the water samples from the slum no. 21, 23, 19, 15, 33, 2, 3, 10, 11, 13, 17, 27 are compliant to the standards/ guidelines.

Water tankers. 1 out of 17 drinking water samples, i.e. 50% samples from water tanker tested for E.coli levels are not meeting the requirements of both the national standards, and WHO guideline values. The drinking water samples from the slum area no. 30 are non-compliant to the standards, whereas the water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 31, 33 are compliant to the standards/ guidelines.

b. Chemical parameters

i. Phenolphthalein (P)

Considering the laboratory test results of the drinking water samples collected from different sources stated in the section 4.4.1, the following provides the in-depth analysis of the quality of drinking water in terms of Phenolphthalein levels. The permissible levels range between 0 and 0.2 mg/l.

Household/ public taps. 0 out of 17 drinking water samples, i.e. 0% samples from households/ public taps rested for Phenolphthalein levels are not meeting the requirements of both the national standards, and WHO guideline values. The drinking water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines. The Phenolphthalein (P) values of drinking water are within the permissible limits in these slum areas.

Borewells/ handpumps. Similarly, 0 out of 17 drinking water samples, i.e. 0% samples from borewells/ handpumps tested for Phenolphthalein (P) levels are not meeting the requirements of both the national standards, and WHO guideline values. The drinking slum area no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines. The Phenolphthalein (P) values of drinking water are within the permissible limits in these slum areas.

Water tankers. 0 out of 17 drinking water samples, i.e. 0% samples from water tankers tested for Phenolphthalein (P) levels are not meeting the requirements of both the national standards, and WHO guideline values. The drinking water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/

guidelines. The Phenolphthalein (P) values of drinking water are within the permissible limits in these slum areas.

ii. Total Alkalinity (T)

Considering the laboratory test results of the drinking water samples collected from different sources stated in the section 4.4.1, the following provides the in-depth analysis of the quality of drinking water in terms of Total Alkalinity levels. The permissible limits range between 0 and 600 mg/l.

Household/ public taps. 0 out of 17 drinking water samples, i.e. 0% samples from households/ public taps rested for Total Alkalinity levels are not meeting the requirements of both the national standards, and WHO guideline values. The drinking water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines. The Total Alkalinity values of drinking water are within the permissible limits in these slum areas.

Borewells/ handpumps. 0 out of 17 drinking water samples, i.e. 0% samples from borewells/ handpumps tested for Total Alkalinity levels are not meeting the requirements of both the national standards, and WHO guideline values. The drinking water samples from the slum area no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines. The Total Alkalinity values of drinking water are within the permissible limits in these slum areas.

Water tankers. Similarly, 0 out of 17 drinking water samples, i.e. 0% samples from water tankers tested for Total Alkalinity levels are not meeting the requirements of both the national standards, and WHO guideline values. The drinking water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines. The Total Alkalinity values of drinking water are within the permissible limits in these slum areas.

iii. Carbonates

Considering the laboratory test results of the drinking water samples collected from different sources stated in the section 4.4.1, the following provides the in-depth analysis of the quality of drinking water in terms of Carbonate levels. The permissible levels range between 0 and 600 mg/l.

Household/ public taps. 0 out of 17 drinking water samples, i.e., about 0% samples from households/ individual/ municipal/ public taps tested for Carbonate levels are not meeting the requirements of both the national standards, and WHO guideline values. The water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines. The Carbonate values of drinking water are within the permissible limits in these slum areas.

Borewells/ handpumps. 0 out of 17 drinking water samples, 0% samples from borewells/ handpumps tested for Carbonate levels are not meeting the requirements of both the national standards, and WHO guideline values. The water samples from the slum area no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines. The Carbonate values of drinking water are within the permissible limits in these slum areas.

Water tankers. 0 out of 17 drinking water samples, i.e., about 0% samples from water tankers tested for Carbonate levels are not meeting the requirements of both the national standards, and WHO guideline values. The water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines. The Carbonate values of drinking water are within the permissible limits in these slum areas.

iv. Hydroxides

Considering the laboratory test results of the drinking water samples collected from different sources, the following provides the in-depth analysis of the quality of drinking water in terms of acceptable hydroxide levels, i.e., ranging between 0 to 600 mg/l.

Household/ public taps. 0 out of 17 drinking water samples, i.e., about 0% samples from households/ individual/ municipal/ public taps tested for hydroxide levels are not meeting the requirements of both the national standards, and WHO guideline values. The water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines. The hydroxide values of drinking water are within the permissible limits in these slum areas.

Borewells/ handpumps. 0 out of 17 drinking water samples, i.e., about 0% samples from borewells/ handpumps tested for hydroxide levels are not meeting the requirements of both the national standards, and WHO guideline values. The water samples from the slum area no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines. The hydroxide values of drinking water are within the permissible limits in these slum areas.

Water tankers. 0 out of 17 drinking water samples, i.e., about 0% samples from water tankers tested for hydroxide levels are not meeting the requirements of both the national standards, and WHO guideline values. The water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines. The hydroxide values of drinking water are within the permissible limits in these slum areas.

v. Total Hardness

Considering the laboratory test results of the drinking water samples collected from different sources, the following provides the in-depth analysis of the quality of drinking water in terms of acceptable Total Hardness levels, i.e., ranging between 200 to 600 mg/l.

Household/ public taps 0 out of 17 drinking water samples, 0% samples from households/ individual/ municipal/ public taps tested for Total Hardness levels are not meeting the requirements of both the national standards, and WHO guideline values. The water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines. The Total Hardness values of drinking water are within the permissible limits in these slum areas.

Borewells/ handpumps. 2 out of 17 drinking water samples, 12% samples from borewells/ handpumps tested for Total Hardness levels are not meeting the requirements of both the national standards, and WHO guideline values. The water samples from the slum area no. 21, and 31 are not compliant to the standards, whereas the water samples from the slum area no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 23, 26, 27, 30, 33 are compliant to the standards/ guidelines. The Total Hardness values of drinking water are within the permissible limits in these slum areas.

Water tankers. 0 out of 17 drinking water samples, 0% samples from water tankers tested for Total Hardness levels are not meeting the requirements of both the national standards, and WHO guideline values. The water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines. The Total Hardness values of drinking water are within the permissible limits in these slum areas.

vi. Calcium

Considering the laboratory test results of the drinking water samples collected from different sources, the following provides the in-depth analysis of the quality of drinking water in terms of acceptable calcium levels, i.e., ranging between 75 to 200 mg/l.

Household/ public taps. 0 out of 17 drinking water samples, 0% samples from households/ individual/ municipal/ public taps tested for calcium levels are not meeting the requirements of both the national standards, and WHO guideline values. The water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines. The calcium values of drinking water are within the permissible limits in these slum areas.

Borewells/ handpumps. 0 out of 17 drinking water samples, i.e., about 0% samples from borewells/ handpumps tested for calcium levels are not meeting the requirements of both the national standards, and WHO guideline values. The water samples from the slum area no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines. The calcium values of drinking water are within the permissible limits in these slum areas.

Water tankers. 0 out of 17 drinking water samples, i.e., about 0% samples from water tankers tested for calcium levels are not meeting the requirements of both the national standards, and WHO guideline values. The water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines. The calcium values of drinking water are within the permissible limits in these slum areas.

vii. Magnesium

Considering the laboratory test results of the drinking water samples collected from different sources, the following provides the in-depth analysis of the quality of drinking water in terms of acceptable magnesium levels, i.e., ranging between 30 to 100 mg/l.

Household/ public taps. 0 out of 17 drinking water samples, i.e., about 0% samples from households/ individual/ municipal/ public taps tested for magnesium levels are not meeting the requirements of both the national standards, and WHO guideline values. The water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines. The magnesium values of drinking water are within the permissible limits in these slum areas.

Borewells/ handpumps. 0 out of 17 drinking water samples, i.e., about 0% samples from borewells/ handpumps tested for magnesium levels are not meeting the requirements of both the national standards, and WHO guideline values. The water samples from the slum area no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines. The magnesium values of drinking water are within the permissible limits in these slum areas.

Water tankers. 1 out of 17 drinking water samples, i.e., about 6% samples from water tankers tested for magnesium levels are not meeting the requirements of both the national standards, and WHO guideline values. The water samples from the slum area no. 31 are non-compliant to the standards, whereas the water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 33 are compliant to the standards/ guidelines. The magnesium values of drinking water are within the permissible limits in these slum areas.

viii. Ammonia

Considering the laboratory test results of the drinking water samples collected from different sources, the following provides the in-depth analysis of the quality of drinking water in terms of acceptable ammonia levels, i.e., ranging between 0 to 0.5 mg/l.

Household/ public taps. 0 out of 17 drinking water samples, i.e., about 0% samples from households/ individual/ municipal/ public taps tested for ammonia levels are not meeting the requirements of both the national standards, and WHO guideline values. The water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines. The ammonia values of drinking water are within the permissible limits in these slum areas.

Borewells/ handpumps. 0 out of 17 drinking water samples, i.e., about 0% samples from borewells/ handpumps tested for ammonia levels are not meeting the requirements of both the national standards, and WHO guideline values. The water samples from the slum area no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines. The ammonia values of drinking water are within the permissible limits in these slum areas.

Water tankers. 0 out of 17 drinking water samples, i.e., about 0% samples from water tankers tested for ammonia levels are not meeting the requirements of both the national standards, and WHO guideline values. The water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines. The ammonia values of drinking water are within the permissible limits in these slum areas.

ix. Nitrite

Considering the laboratory test results of the drinking water samples collected from different sources, the following provides the in-depth analysis of the quality of drinking water in terms of acceptable nitrite levels, i.e., ranging between 0 to 0.9 mg/l.

Household/ public taps. 0 out of 17 drinking water samples, i.e., about 0% samples from households/ individual/ municipal/ public taps tested for nitrite levels are not meeting the requirements of both the national standards, and WHO guideline values. The water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines. The nitrite values of drinking water are within the permissible limits in these slum areas.

Borewells/ handpumps. 1 out 17 drinking water samples, i.e., about 6% samples from borewells/ handpumps tested for nitrite levels are not meeting the requirements of both the national standards, and WHO guideline levels. The water samples from the slum area no. 21 are not compliant to the standards, whereas the water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines.

Water tankers. 0 out of 17 drinking water samples, i.e., about 0% samples from water tankers tested for nitrite levels are not meeting the requirements of both the national standards, and WHO guideline values. The water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines. The nitrite values of drinking water are within the permissible limits in these slum areas.

x. Nitrate

Considering the laboratory test results of the drinking water samples collected from different sources, the following provides the in-depth analysis of the quality of drinking water in terms of acceptable nitrate levels, i.e., ranging between 0 to 45 mg/l.

Household/ public taps. 1 out of 17 drinking water samples, i.e., about 6% samples from households/ individual/ municipal/ public taps tested for nitrate levels are not meeting the requirements of both the national standards, and WHO guideline values. The water samples from the slum area no. 21 are not compliant to the standards, whereas the water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines.

Borewells/ handpumps. 2 out 17 drinking water samples, i.e., about 12% samples from borewells/ handpumps tested for nitrate levels are not meeting the requirements of both the national standards, and WHO guideline levels. The water samples from the slum area no. 23, and 26 are not compliant to the standards, whereas the water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 27, 30, 31, 33 are compliant to the standards/ guidelines.

Water tankers. 0 out of 17 drinking water samples, i.e., about 0% samples from water tankers tested for nitrate levels are not meeting the requirements of both the national standards, and WHO guideline values. The water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines. The nitrate values of drinking water are within the permissible limits in these slum areas.

xi. Nitrogen

Considering the laboratory test results of the drinking water samples collected from different sources, the following provides the in-depth analysis of the quality of drinking water in terms of acceptable nitrogen levels, i.e., ranging between 0 to 10 mg/l.

Household/ public taps. 1 out of 17 drinking water samples, i.e., about 6% samples from households/ individual/ municipal/ public taps tested for nitrogen levels are not meeting the requirements of both the national standards, and WHO guideline values. The water samples from the slum area no. 21 are not compliant to the standards, whereas the water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines.

Borewells/ handpumps. 2 out 17 drinking water samples, i.e. about 12% samples from borewells/ handpumps tested for nitrogen levels are not meeting the requirements of both the national standards, and WHO guideline levels. The water samples from the slum area no. 23, and 26 are not compliant to the standards, whereas the water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 27, 30, 31, 33 are compliant to the standards/ guidelines.

Water tankers. 0 out of 17 drinking water samples, i.e., about 0% samples from water tankers tested for nitrogen levels are not meeting the requirements of both the national standards, and WHO guideline values. The water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines. The nitrogen values of drinking water are within the permissible limits in these slum areas.

xii. Chlorides

Considering the laboratory test results of the drinking water samples collected from different sources, the following provides the in-depth analysis of the quality of drinking water in terms of acceptable chlorides levels, i.e., ranging between 0 to 1000 mg/l.

Household/ public taps. 0 out of 17 drinking water samples, i.e., about 0% samples from households/ individual/ municipal/ public taps tested for chlorides levels are not meeting the requirements of both the national standards, and WHO guideline values. The water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines. The chlorides values of drinking water are within the permissible limits in these slum areas.

Borewells/ handpumps. 0 out of 17 drinking water samples, i.e., about 0% samples from borewells/ handpumps tested for chlorides levels are not meeting the requirements of both the national standards, and WHO guideline values. The water samples from the slum area no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines. The chlorides values of drinking water are within the permissible limits in these slum areas.

Water tankers. 0 out of 17 drinking water samples, i.e., about 0% samples from water tankers tested for chlorides levels are not meeting the requirements of both the national standards, and WHO guideline values. The water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines. The chlorides values of drinking water are within the permissible limits in these slum areas.

xiii. Fluorides

Considering the laboratory test results of the drinking water samples collected from different sources, the following provides the in-depth analysis of the quality of drinking water in terms of acceptable fluoride levels, i.e., ranging between 0 to 1.5 mg/l.

Household/ public taps. 0 out of 17 drinking water samples, i.e., about 0% samples from households/ individual/ municipal/ public taps tested for fluoride levels are not meeting the requirements of both the national standards, and WHO guideline values. The water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines. The fluoride values of drinking water are within the permissible limits in these slum areas.

Borewells/ handpumps. 4 out 17 drinking water samples, i.e., about 24% samples from borewells/ handpumps tested for fluoride levels are not meeting the requirements of both the national standards, and WHO guideline levels. The water samples from the slum area no. 23, 30, 2, and 8 are not compliant to the standards, whereas the water samples from the slum no. 3, 5, 10, 11, 13, 15, 17, 19, 21, 26, 27, 31, 33 are compliant to the standards/ guidelines.

Water tankers. 0 out of 17 drinking water samples, i.e., about 0% samples from water tankers tested for fluoride levels are not meeting the requirements of both the national standards, and WHO guideline values. The water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines. The fluoride values of drinking water are within the permissible limits in these slum areas.

xiv. Sulfates

Considering the laboratory test results of the drinking water samples collected from different sources, the following provides the in-depth analysis of the quality of drinking water in terms of acceptable sulfate levels, i.e., ranging between 0 to 400 mg/l.

Household/ public taps. 0 out of 17 drinking water samples, i.e., about 0% samples from households/ individual/ municipal/ public taps tested for sulfate levels are not meeting the requirements of both the national standards, and WHO guideline values. The water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines. The sulfate values of drinking water are within the permissible limits in these slum areas.

Borewells/ handpumps. 0 out 17 drinking water samples, 0% samples from borewells/ handpumps tested for sulfate levels are not meeting the requirements of both the national standards, and WHO guideline levels. The water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines. The sulfate values of drinking water are within the permissible limits in these slum areas.

Water tankers. 0 out of 17 drinking water samples, i.e., about 0% samples from water tankers tested for sulfate levels are not meeting the requirements of both the national standards, and WHO guideline values. The water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines. The sulfate values of drinking water are within the permissible limits in these slum areas.

xv. Iron

Considering the laboratory test results of the drinking water samples collected from different sources, the following provides the in-depth analysis of the quality of drinking water in terms of acceptable iron levels, i.e., ranging between 0 to 0.3 mg/l.

Household/ public taps. 0 out of 17 drinking water samples, i.e., about 0% samples from households/ individual/ municipal/ public taps tested for iron levels are not meeting the requirements of both the national standards, and WHO guideline values. The water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines. The iron values of drinking water are within the permissible limits in these slum areas.

Borewells/ handpumps. 0 out 17 drinking water samples, i.e., about 0% samples from borewells/ handpumps tested for iron levels are not meeting the requirements of both the national standards, and WHO guideline levels. The water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines. The iron values of drinking water are within the permissible limits in these slum areas.

Water tankers. 0 out of 17 drinking water samples, i.e., about 0% samples from water tankers tested for iron levels are not meeting the requirements of both the national standards, and WHO guideline values. The water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines. The iron values of drinking water are within the permissible limits in these slum areas.

xvi. Manganese

Considering the laboratory test results of the drinking water samples collected from different sources, the following provides the in-depth analysis of the quality of drinking water in terms of acceptable manganese levels, i.e., ranging between 0 to 0.3 mg/l.

Household/ public taps. 0 out of 17 drinking water samples, i.e., about 0% samples from households/ individual/ municipal/ public taps tested for manganese levels are not meeting the requirements of both the national standards, and WHO guideline values. The water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines. The manganese values of drinking water are within the permissible limits in these slum areas.

Borewells/ handpumps. 0 out 17 drinking water samples, i.e., about 0% samples from borewells/ handpumps tested for manganese levels are not meeting the requirements of both the national standards, and WHO guideline levels. The water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines. The manganese values of drinking water are within the permissible limits in these slum areas.

Water tankers. 0 out of 17 drinking water samples, i.e., about 0% samples from water tankers tested for manganese levels are not meeting the requirements of both the national standards, and WHO guideline values. The water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines. The manganese values of drinking water are within the permissible limits in these slum areas.

c. Physical parameters

In addition to microbiological and chemical parameters, certain physical characteristics of the water such as color, odor, electric conductivity, and total dissolved solids should also be included in assessment of water quality, as they are critical indicators of change in quality and are often cited by consumers as reasons for rejecting a source. The consumers of drinking water, at the outset, observe these physical parameters and determine the quality aspects. Considering the physical parameters recommended for assessment of quality of drinking water in RADWQ framework, the current research study which is primarily focusing on drinking water quality and quantity in the selected slum areas in the Hyderabad city region details on the laboratory test analysis for the observation of the above stated physical parameters in all the drinking water samples collected from various sources of drinking water.

i. Color

Considering the laboratory test results of the drinking water samples collected from different sources, the following provides the in-depth analysis of the quality of drinking water in terms of customer acceptable color levels, i.e., colorless.

Household/ public taps. 0 out of 17 drinking water samples, i.e., about 0% samples from households/ individual/ municipal/ public taps tested for color levels are not meeting the requirements of both the national standards, and WHO guideline values. The water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines. The color levels of drinking water are within the acceptable limits in these slum areas.

Borewells/ handpumps. 0 out 17 drinking water samples, i.e., about 0% samples from borewells/ handpumps tested for color levels are not meeting the requirements of both the national standards, and WHO guideline levels. The water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines. The color levels of drinking water are within the permissible limits in these slum areas.

Water tankers. 0 out of 17 drinking water samples, i.e., about 0% samples from water tankers tested for color levels are not meeting the requirements of both the national standards, and WHO guideline values. The water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines. The color levels of drinking water are within the permissible limits in these slum areas.

ii. Odor

Considering the laboratory test results of the drinking water samples collected from different sources, the following provides the in-depth analysis of the quality of drinking water in terms of customer acceptable odor levels, i.e., Odorless.

Household/ public taps. 1 out of 17 drinking water samples, i.e., about 6% samples from households/ individual/ municipal/ public taps tested for nitrogen levels are not meeting the requirements of both the national standards, and WHO guideline values. The water samples from the slum area no. 31 are not compliant to the standards, whereas the water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 33 are compliant to the standards/ guidelines.

Borewells/ handpumps. 1 out 17 drinking water samples, i.e., about 6% samples from borewells/ handpumps tested for odor levels are not meeting the requirements of both the national standards, and WHO guideline levels. The water samples from the slum area no. 5 are not compliant to the standards, whereas the water samples from the slum no. 2, 3, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines. The odor levels of drinking water are within the permissible limits in these slum areas.

Water tankers. 0 out of 17 drinking water samples, i.e., about 0% samples from water tankers tested for odor levels are not meeting the requirements of both the national standards, and WHO guideline values. The water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines. The odor levels of drinking water are within the permissible limits in these slum areas.

iii. Electrical Conductivity (EC)

Considering the laboratory test results of the drinking water samples collected from different sources, the following provides the in-depth analysis of the quality of drinking water in terms of customer acceptable odor levels, i.e., ranging between 0 to 2000 mg/l.

Household/ public taps. 0 out of 17 drinking water samples, 0% samples from households/ individual/ municipal/ public taps tested for EC levels are not meeting the requirements of both the national standards, and WHO guideline values. The water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines. The EC levels of drinking water are within the acceptable limits in these slum areas.

Borewells/ handpumps. 3 out 17 drinking water samples, i.e., about 23% samples from borewells/ handpumps tested for EC levels are not meeting the requirements of both the national standards, and WHO guideline levels. The water samples from the slum area no. 21, 30, 3 are not compliant to the standards, whereas the water samples from the slum no. 2, 5, 8, 10, 11, 13, 15, 17, 19, 23, 26, 27, 31, 33 are compliant to the standards/ guidelines.

Water tankers. 0 out of 17 drinking water samples, i.e., about 0% samples from water tankers tested for EC levels are not meeting the requirements of both the national standards, and WHO guideline values. The water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines. The EC levels of drinking water are within the permissible limits in these slum areas.

iv. Total Dissolved Solids (TDS)

Considering the laboratory test results of the drinking water samples collected from different sources, the following provides the in-depth analysis of the quality of drinking water in terms of customer acceptable TDS levels, i.e., ranging between 0 to 2000 mg/l.

Household/ public taps. 17 out of 17 drinking water samples, i.e., about 100% samples from households/ individual/ municipal/ public taps tested for TDS levels are meeting the requirements of both the national standards, and WHO guideline values. The water samples from the slum no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines. The TDS levels of drinking water are not within the acceptable limits in these slum areas.

Borewells/ handpumps. 17 out 17 drinking water samples, i.e., about 100% samples from borewells/ handpumps tested for TDS levels are not meeting the requirements of both the national standards, and WHO guideline levels. The water samples from slum no. 2, 8, 3, 5, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines.

Water tankers. 17 out of 17 drinking water samples, i.e., 100% samples from water tanker tested for TDS levels are meeting the requirements of both the national standards, and WHO guideline values. The water samples from the slum area no. 2, 3, 5, 8, 10, 11, 13, 15, 17, 19, 21, 23, 26, 27, 30, 31, 33 are compliant to the standards/ guidelines.

d. Duration of supply/ availability

Based on the literature review and the households' perception analysis stated in previous sections, it can be stated that the slums areas in the Hyderabad city region have varying durations (in number of hours) of the supply and availability of drinking water, which is limiting the availability of the quantity of drinking water. The literature review reveals that the slum households' population in Hyderabad city region fetch water for drinking and other domestic purposes depending on the availability for certain number of hours ranging from 0.25 hours to 3 hours during the days on which the drinking water is made available to the slum households/population. It can also be stated that the quantity of drinking water fetched/ collected and stored is also highly dependent on duration of supply/ availability of drinking water.

The analysis section primarily focuses on understanding the interplay between the slum areas, and the duration of supply/ availability of drinking water during the days of supply/ availability of the drinking water. Considering the perception analysis of quantity of drinking water in the slum areas of the Hyderabad city region, the duration (in number of hours) of supply/ availability of drinking water for the majority share of the slum households/ population is very low. Tis shall signify that the estimations of quantity of drinking water available for drinking and other domestic purposes to be lower than the expected requirements of the households/ population, i.e., 24 hours supply/ availability of drinking water from any source of drinking water on the days of supply/ availability of drinking water.

Considering the above-mentioned, the following provides the in-depth results of the household level primary analysis pertaining to the duration of the drinking water available for collection on the day of supply of drinking water in the slum areas of the Hyderabad city region. Based on the statistical analysis of the household level information captured through primary surveys and the field level observations in the shortlisted slum areas for the current research study, it can be stated that there are about 252 out of 2281 households having the supply/ availability of drinking water in their localities/ communities for the duration ranging between 2.25 Hours to 3 hours on the day of supply of drinking water, i.e., only about 11% of the total slum households/ population. The household analysis also reveals that there are about 889 out of 2281 households having access to drinking water for the duration ranging between 1.50 Hours to 2.00 Hours on the day of supply of drinking water, i.e., about 39% of the total slum households/ population. Further, the household analysis also reveals that there are about 597 out of 2281 households having access to drinking water collection/ fetching on the day of supply of drinking water for the duration ranging between 1 Hour to 1.25 Hours only, i.e., about 26% of the total slum population/ households. In addition, the analysis also reveals that there is significant share of households/ population having to access to drinking water collection on the days of provision of the same for duration less than 0.50 hours as well. It can be stated from the household information that there are about 543 out of 2281 households having access to drinking water collection/ fetching on the day of supply of drinking water for the duration ranging between 0.25 Hours to 0.50 Hours only, i.e., about 24% of the total slum households/ population with these characteristics. The graph illustrates the percentage distribution of households in slum areas with varying durations (in number of Hours) of availability/ supply of drinking water. The household analysis of duration of drinking water availability in slum areas/ development in Hyderabad city region discloses that ***In summary considering the weighted average of duration in number of hours on the day of drinking water availability to the households/ population in the slum areas of the city, it is about 1.39 (rounded off to 1.4) Hours.***

e. Seasonal Variations

Considering the analysis provided in previous sections (ref. section no.), the challenges/ issues pertaining to quality and quantity of drinking water, as stated in the earlier section, can be categorized into (a) color, (b) turbidity, (c) unnatural taste, (d) unnatural odor, (e) traces of coliforms, (f) traces of algae, and (g) low quantity. However, based on the literature review (ref. documents) it can be stated that the problems/ challenges/ issues pertaining to drinking water quality and quantity are not consistent and vary across different months in a year. In order to appreciate the consistency/ regularity/ occurrence of these prevailing problem challenges/ issues pertaining to drinking water quality and quantity, it is important to analyse and understand the perceptions of households on quality and quantity of drinking water in **different months in a year**. Further, the literature review (ref. documents) also suggests that the problems/ challenges/ issues pertaining to quality and quantity of drinking water in the Hyderabad city region (including slum areas in the city region) have an influence of prevailing **climatic seasonal conditions**. It was also argued that the quantity of drinking water availability in pre-monsoon seasons (summer season in Indian context) is low, when compared to other seasons. Similarly, the quality of drinking water in monsoon seasons (rainy seasons in Indian context) is low when compared to other seasons. Considering the above-mentioned, for the ease of capturing and analyzing/ understanding the regularities/ irregularities of problems/ issues/ challenges pertaining to quality and quantity of drinking water in the slum areas of Hyderabad city region, the households' perception details of quality and quantity of drinking water are captured across different seasons. According to IMD (Indian Meteorological Department), there are three (3) designated climatological seasons in any particular year, namely (a) winters, (b) summers or pre-monsoon, and (c) monsoon. However, in order to analyze the quality and quantity parameters of drinking water across different months, the following seasons to months mapping and relationship shall yield the required results. According to IMD, the winters in India are in the months of November, December, January, and February. The winters are followed by summers for the months of March, April, May, and June. Immediately after summers, the monsoon conditions take charge in the months of July, August, September, and October. <Insert connecting text>

Considering the above-stated, the following sections provides the in-depth understanding of the household level primary information pertaining to the households' perception of the problems/ challenges/ issues with reference to the quality and quantity of drinking water across different seasons/ month in a year. It is also important to note that considering the interpretation/ analysis stated in section 5.2.4 on number of years of stay in the slum area, it can be re-stated that the about 75% of the total slum population spatially spread across all the circles in the Hyderabad city region are residing in their localities for more than five (5) years. This signifies that these slum households/ population shall have better understanding of their localities/ slum areas and are the best sources of information. It can also be stated that the ability of these slum households/ population to recollect and state all the prevailing conditions on quality and quantity of drinking water over the past few years during the household interviews, is acceptable and considered for the current research study analysis.

Drinking water "Quantity". Based on the statistical analysis of the household level information on perceptions of households captured in the shortlisted slum areas for the current research, it can be stated that there are about 1905 out of 2281 households claim that the "quantity" of drinking from different sources in the summer seasons is of a major concern, i.e., in the months of March, April, May and June in a year. This is about 84% of the total slum households/ population stating that they have issues/ challenges pertaining to availability of adequate quantity of drinking water in summer. The perception analysis also reveals that there are about 1116 out of 2281 households with access to different sources of drinking water claim that the drinking water they fetch from different sources of water is not sufficient, especially during the Monsoon seasons, i.e., in the months of July, August, September, and October. This is about 49% of the total slum households/ population are not pleased with the quantity of drinking water they fetch from different sources of drinking water during these months. In addition to this, it can also be observed that the households/ population is slum areas are suffering from inadequate drinking water during winter seasons as well. The household analysis discloses that there are about 714 out of 2281 households with access to different sources of drinking water claim that they are encountering the adequate quantity issues even during winters, i.e., during November, December, January and February months of a year. This is about 31% of the total slum households/ population falling under this category of analysis. The figure 86 illustrates the percentage distribution of households in slum areas with issues pertaining to "quantity" of drinking water spread across different months/ seasons in a year.

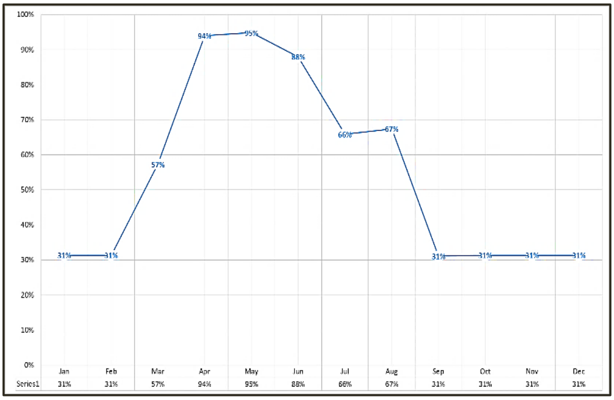


Figure 86: Seasonal variation of drinking water quantity

Drinking water "Color". Based on the statistical analysis of the household level information on perceptions of households captured in the shortlisted slum areas for the current research, it can be stated that there are about 176 out of 2281 households claiming that the color of drinking from different sources in the summer seasons is of a major concern, i.e., in the months of March, April, May and June in a year. This is about 8% of the total slum households/ population stating that they have issues/ challenges pertaining to safe quality in terms of color of the drinking water in summer. The perception analysis also reveals that there are about 704 out of 2281 households with access to different sources of drinking water claim that the drinking water they fetch from different sources of water is not of appropriate color, especially during the monsoon seasons, i.e., in the months of July, August, September, and October.

This is about 31% of the total slum households/ population are not pleased with the quality of drinking water in terms of the color of the drinking water they fetch from different sources of drinking water during these months. In addition to this, it can also be observed that the households/ population is slum areas are suffering from inappropriate color of the drinking water during winter seasons as well. The household analysis discloses that there are about 18 out of 2281 households with access to different sources of drinking water claiming that they are encountering the adequate quality issues even during winters, i.e., during November, December, January and February months of a year. This is about 1% of the total slum households/ population falling under this category of analysis. The figure 87 illustrates the percentage distribution of households in slum areas with issues pertaining to "color" of drinking water spread across different months/ seasons in a year.

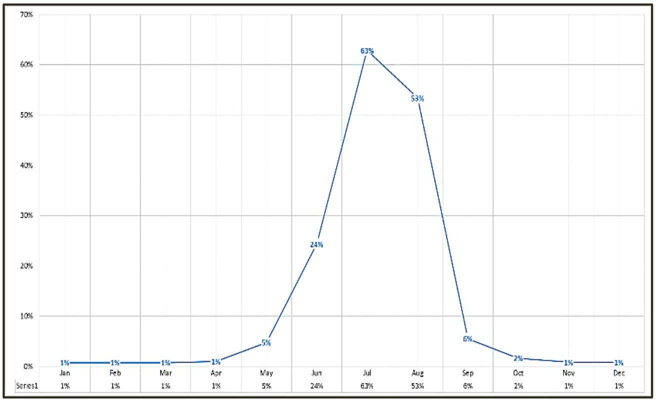


Figure 87: Seasonal variation of drinking water color

Drinking water "Odor". Based on the statistical analysis of the household level information on perceptions of households captured in the shortlisted slum areas for the current research, it can be stated that there are about 379 out of 2281 households claiming that the odor of drinking water from different sources in the summer seasons is of a major concern, i.e., in the months of March, April, May and June in a year. This is about 17% of the total slum households/ population stating that they have issues/ challenges pertaining to safe

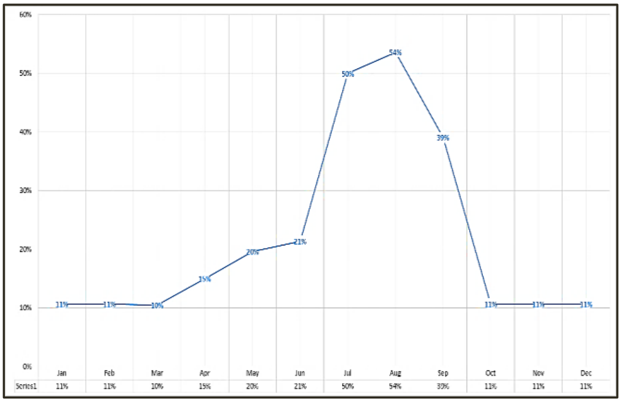


Figure 88: Seasonal variation drinking order

quality in terms of odor of the drinking water in summer. The perception analysis also reveals that there are about 874 out of 2281 households with access to different sources of drinking water claim that the drinking water they fetch from different sources of water is not of appropriate odor, especially during the monsoon seasons, i.e., in the months of July, August, September, and October. This is about 38% of the total slum households/ population are not pleased with the quality of drinking water in terms of the odor of the drinking water they fetch from different sources of drinking water during these months. In addition to this, it can also be observed that the households/ population is slum areas are suffering from inappropriate odor of the drinking water during winter seasons as well. The household analysis discloses that there are about 243 out of 2281 households with access to different sources of drinking water claiming that they are encountering the inadequate quality issues even during winters, i.e., during November, December, January and February months of a year. This is about 11% of the total slum households/ population falling under this category of analysis. The figure 88 illustrates the percentage distribution of households in slum areas with issues pertaining to "odor" of drinking water spread across different months/ seasons in a year.

Drinking water "Turbidity". Based on the statistical analysis of the household level information on perceptions of households captured in the shortlisted slum areas for the current research, it can be stated that there are about 201 out of 2281 households claiming that the turbidity in the drinking water from different sources in the summer seasons is of a major concern, i.e., in the months of March, April, May and June in a year. This is about 9% of the total slum households/ population stating that they have issues/ challenges pertaining to safe quality in terms of turbidity in the drinking water in summer. The perception analysis also reveals that there are about 998 out of 2281 households with access to different sources of drinking water claim that the drinking water they fetch from different sources of water is turbid, especially during the monsoon seasons, i.e., in the months of July, August, September, and October. This is about 44% of the total slum households/ population are not pleased with the quality of drinking water in terms of the color (turbidity) of the drinking water they fetch from different sources of drinking water during these months. In addition to this, it can also be observed that the households/ population is slum areas are not suffering from turbid drinking water during

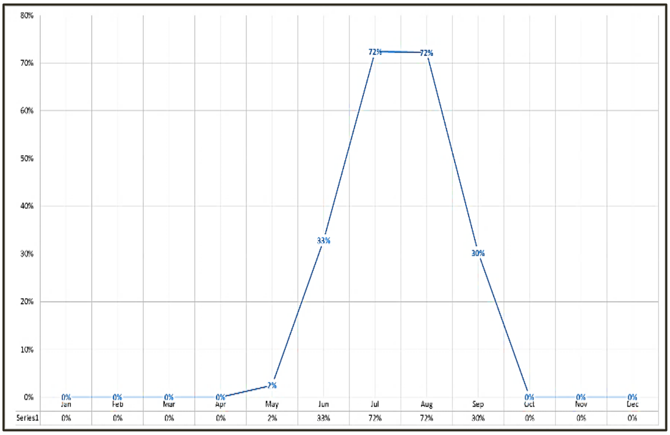


Figure 89: Seasonal variation drinking water turbidity

winter seasons, i.e., during November, December, January and February months of a year. The figure 89 illustrates the percentage distribution of households in slum areas with issues pertaining to "turbidity" in the drinking water spread across different months/ seasons in a year.

Drinking water "Taste". Based on the statistical analysis of the household level information on perceptions of households captured in the shortlisted slum areas for the current research, it can be stated that there are about 201 out of 2281 households claiming that the taste of the drinking water from different sources in the summer seasons is of a major concern, i.e., in the months of March, April, May and June in a year. This is about 9% of the total slum households/ population stating that they have issues/ challenges pertaining to safe quality in terms of taste of the drinking water in summer. The perception analysis also reveals that there are about 998 out of 2281 households with access to different sources of drinking water claim that the drinking water they fetch from different sources of water is abnormal taste, especially during the monsoon seasons, i.e., in the months of July, August, September, and October. This is about 44% of the total slum households/ population are not pleased with the quality of drinking water in terms of the taste of the drinking water they fetch from different sources of drinking water during these months. In addition to this, it can also be observed that the households/ population is slum areas are not suffering from inappropriate taste of drinking water during winter seasons, i.e., during November, December, January and February months of a year. The figure 90 illustrates the percentage distribution of households in slum areas with issues pertaining to "taste" of the drinking water spread across different months/ seasons in a year.

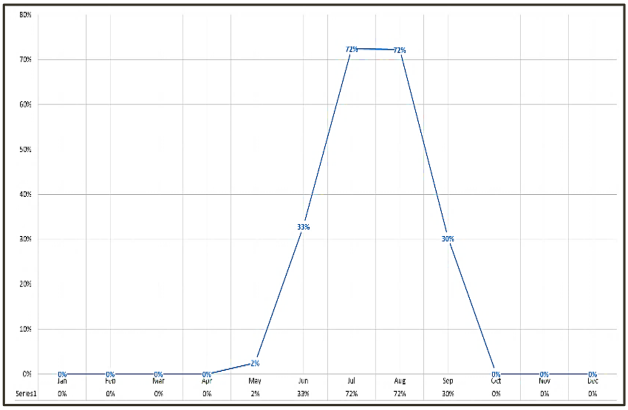


Figure 90: Seasonal variation drinking water taste

Drinking water "Algae". Based on the statistical analysis of the household level information on perceptions of households captured in the shortlisted slum areas for the current research, it can be stated that there are only about 7 out of 2281 households claiming that the algae traces in the drinking water from different sources in the summer seasons is of a major concern, i.e., in the months of March, April, May and June in a year. This is about less than 1% of the total slum households/ population stating that they have issues/ challenges pertaining to safe quality in terms of algae content in the drinking water in summer. The perception analysis also reveals that there are about 24 out of 2281 households with access to different sources of drinking water claim that the drinking water they fetch from different sources of water is comprising of foreign particles, especially during the monsoon seasons, i.e., in the months of July, August, September, and October.

This is about only about 1% of the total slum households/ population are not pleased with the quality of drinking water and found the algae content in the drinking water they fetch from different sources of drinking water during these months. In addition to this, it can also be observed that there is about 1 out 2281 households/ population with access to different sources of drinking water in slum areas are suffering from algae content in the drinking water during winter seasons, i.e., during November, December, January and February months of a year. This is only about less than 1% of the total slum households/ population. The figure 91 illustrates the percentage distribution of households in slum areas with issues pertaining to algae content in the drinking water spread across different months/ seasons in a year.

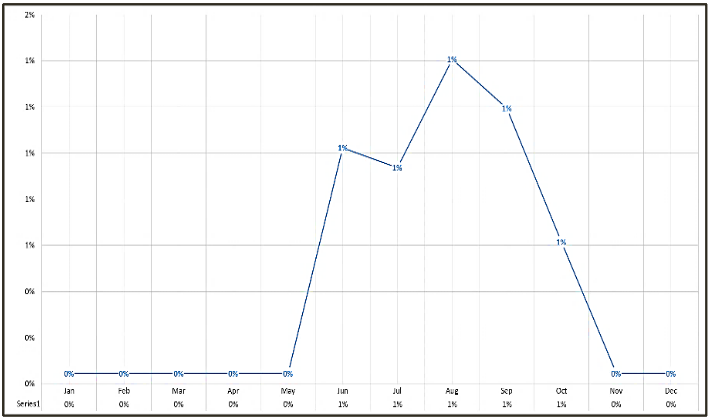


Figure 91: Seasonal variation drinking water algae

Drinking water "Coliforms". Based on the statistical analysis of the household level information on perceptions of households captured in the shortlisted slum areas for the current research, it can be stated that there are only about 222 out of 2281 households claiming that the coliforms traces in the drinking water from different sources in the summer seasons is of a major concern, i.e., in the months of March, April, May and June in a year. This is about less than 10% of the total slum households/ population stating that they have issues/

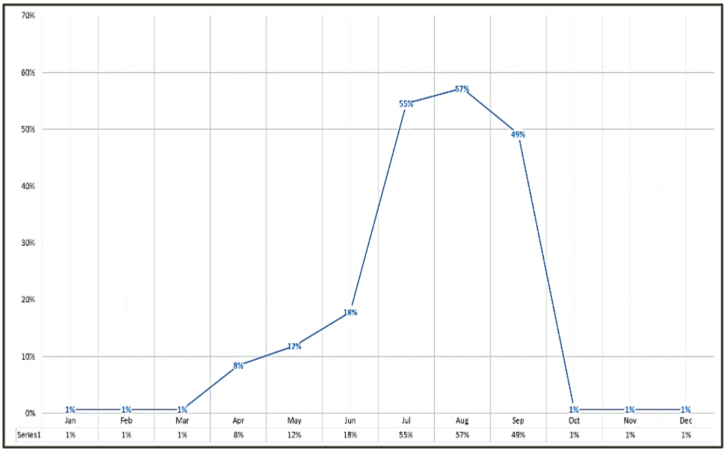


Figure 92: Seasonal variation drinking water coliforms

challenges pertaining to safe quality in terms of coliforms content in the drinking water in summer. The perception analysis also reveals that there are about 922 out of 2281 households with access to different sources of drinking water claim that the drinking water they fetch from different sources of water is comprising of foreign particles, especially during the monsoon seasons, i.e., in the months of July, August, September, and October. This is about only about 40% of the total slum households/ population are not pleased with the quality of drinking water and found the coliforms content in the drinking water they fetch from different sources of drinking water during these months. In addition to this, it can also be observed that there is about 15 out 2281 households/ population with access to different sources of drinking water in slum areas are suffering from coliforms content in the drinking water during winter seasons, i.e., during November, December, January and February months of a year. This is only about less than 1% of the total slum households/ population. The figure 92 illustrates the percentage distribution of households in slum areas with issues pertaining to coliforms content in the drinking water spread across different months/ seasons in a year.

Annexure 5 | Questionnaires

a. Perception analysis quality and quantity of drinking water, decision making procedures, sources of drinking water, challenges faced due to drinking water conditions, etc.

This semi-structured questionnaire in the table 85 was administered at household level in all the select slum areas to capture the required details to understand the perceptions of households on drinking water quality and quantity and decision making procedures. Further, to have an expert's judgement, details pertaining to drinking water quality is captured using this questionnaire.

Table 85: Household level questionnaire

A	General Information				
1	Region:	HMDA	5	Date of Visit:	<insert dd/mm/yy>
2	City:	Hyderabad	6	Investigator:	<insert name>
3	Municipality:	<insert name>	7	Respondent:	<insert name>
4	Ward No.:	<insert no.>	8	Area/ Location:	<insert slum name>
B	**Diagnostic Information**				
9	Type of structure				
	(a) Permanent	(b) Semi-Permanent	(c) Temporary		(d) Others <Specify>
10	Usage of structure (may select multiple options, if required)				
	(a) Residential	(b) Commercial	(c) Others <Specify>		(d) Others <Specify>
11	Ownership details of the house/ dwelling				
	(a) Own	(b) Rented	(c) Others <specify>		(d) Others <Specify>
12	Since how many years you are staying in this house/ dwelling				
	(a) 1-5	(b) 6-10	(c) 10-20		(d) > 30
13	Purpose of your stay in this dwelling in this city (may select multiple options, if required)				
	(a) employment	(b) education	(c) others <specify>		(d) others <specify>
14	Highest education qualification among the households in the dwelling/ house (may select multiple options, if required)				
	(a) None	(b) < 10th class	(c) 10th – 12th		(d) Degree

	(e) Others <Specify>				
15	Total number of households in the dwelling				
	(a) 2-3	(b) 4-5	(c) 6-8	(d) > 9	
16	How many of the households work for daily/monthly income				
	(a) 2-3	(b) 4-5	(c) 6-8	(d) all	
17	Occupation details of the households in the dwelling/ house (may select multiple options, if required)				
	(a) Daily laborer	(b) Private services	(c) Govt. services		
	If (a), on average, what is the daily wage rate (in Rs.) per person			<specify details>	
18	Average number of days spend in a week at workplace by each employee				
	(a) 1-2	(b) 3-4	(c) 5-6	(d) 7	
19	Average number of hours spent at the workplace by each employee in a day				
	(a) 4-5	(b) 6-8	(c) 9-12	(d) > 12	
20	Average monthly Income (in Rs.) of the households in the dwelling/ house				
	(a) 1000-2000	(b) 2001-3000	(c) 3001-4000	(d) 4001-5000	
	(e) 5001-6000	(f) 6001-7000	(g) 7000-8000	(h) > 8001	
21	Average monthly recurring expenditure on household for each of the categories. Please specify amount				
	(a) Housing rent		(g) Electricity		
	(b) Food & beverages		(h) Water		
	(c) Education		(i) Gas/ Fuel		
	(d) Clothing		(j) Entertainment		
	(e) Health/ Medical		(k) Loans		
	(f) Travel		(l) Others <specify>		
22	Sources of drinking water used by the households (may select multiple options, if required)				
	(a) individual tap	(b) public tap	(c) open wells	(d) tubewell/ handpump/ borewell	
	(e) water tankers	(f) bottled water			
23	Is the drinking water quality and quantity from the following sources acceptable for you? What is your perception of quality and quantity aspects? Please rank "1" – Unacceptable, "5" – Acceptable				
	(a) individual tap	1	2	3	4	5
	(b) public tap	1	2	3	4	5

	(c) open wells	1	2	3	4	5
	(d) tubewell/ handpump/ borewell	1	2	3	4	5
	(e) water tankers (government)	1	2	3	4	5
	(f) water tankers (private)	1	2	3	4	5
	(g) bottled water	1	2	3	4	5

24	Please state the type of quality issues that you face from the following sources of drinking water. (Tick the appropriate)						
	(a) individual tap	color	turbidity	taste	odor	Coliform	algae
	(b) public tap	color	turbidity	taste	odor	Coliform	algae
	(c) open wells	color	turbidity	taste	odor	Coliform	algae
	(d) tubewell/ handpump/ borewell	color	turbidity	taste	odor	Coliform	algae
	(e) water tankers	color	turbidity	taste	odor	Coliform	algae
	(f) bottled water	color	turbidity	taste	odor	Coliform	algae

25	Please specify the following details on availability and storage of drinking water in any particular week				
	Source	Days on which water is supplied	Timings & No. of hours supplied/ available	How many buckets (each containing 8-10 liters) of water is drawn	Collected water stored for no. of days
	(a) individual tap	<specify>	<specify>	<specify>	<specify>
	(b) public tap	<specify>	<specify>	<specify>	<specify>
	(c) open wells	<specify>	<specify>	<specify>	<specify>
	(d) tubewell/ handpump/ borewell	<specify>	<specify>	<specify>	<specify>
	(e) water tankers	<specify>	<specify>	<specify>	<specify>
	(f) bottled water	<specify>	<specify>	<specify>	<specify>

26	In case of non-availability of Individual taps, distance (in meters) to travel to fetch drinking water				
	public tap	(a) 0-50	(b) 51-100	(c) 101-150	(d) > 150
	open wells	(a) 0-50	(b) 51-100	(c) 101-150	(d) > 150
	water tankers	(a) 0-50	(b) 51-100	(c) 101-150	(d) > 150
	Others (specify)	(a) 0-50	(b) 51-100	(c) 101-150	(d) > 150
	Others (specify)	(a) 0-50	(b) 51-100	(c) 101-150	(d) > 150

27	How long (in minutes) does it take to fetch water and return home			
	(a) 15-30	(b) 31-60	(c) 60-120	(d) > 120

28	How frequently does you or your family members’ working schedules are affected with the timings of drinking water supply/ availability in a given week?

	(a) once	(b) twice	(c) thrice	(d) others <specify>

29	Average expenditure on drinking water sources			
	Source	**Initial investments**	**Monthly expenditure**	**Misc. expenses**
	individual municipal tap			
	Public municipal tap			
	open wells			
	tubewell/ handpump/ borewell			
	water tankers (in last 1 yr.)	-		
	bottled water (in last 1 yr.)	-		

30	Mention the approximate number of buckets (each bucket is approx. 8-10 liters) used for the select purpose of usage and the source of water		
	Purpose	**Source of water**	**Number of buckets used**
	Bathing		<specify no.>
	Washing clothes		<specify no.>
	Washing utensils		<specify no.>
	Drinking		<specify no.>
	Cooking		<specify no.>
	Toilets		<specify no.>
	Cleaning house		<specify no.>
	Others <specify>		<specify no.>
	Others <specify>		<specify no.>

31	When do any problems usually occur? Please tick the appropriate.												
	Issue/ Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
	Color												
	Turbidity												
	Taste												
	Odor												
	Coliforms												
	Algae												
	Quantity												
	Availability												
	<specify>												

32	Which of the following sources of water are causing illness due to quality issues. Please rank, "1" being causing high levels of illness, "5" being causing no illness.	
	Options	**Rank**
	individual tap	

	public tap	
	open wells	
	tubewell/ handpump/ borewell	
	water tankers	
	bottled water	
	others <specify>	

33	In last 6 months due to drinking water quality issues, specify the kind of diseases you or your family members suffered from, the frequency of illness caused and for the no. of days the patient suffered from the illness caused		
	Disease Name	**Frequency of illness**	**No. of days of illness**
	Cholera		
	Diarrhea		
	Malaria		
	Typhoid		
	Amoebiasis		
	Hepatitis A		
	Others <specify>		
	Others <specify>		

34 What are the most common months in which you or your family fall sick due to above mentioned diseases. Please tick the appropriate.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

35 How frequently does you or your family members’ working schedules are affected every time when ill?

(a) once	(b) twice	(c) thrice	(d) others <specify>

36 In last 6 months, for the illness caused due to drinking water quality issues, specify the amount spend on medical exigency each time

	Month, Amount	**Month, Amount**	**Month, Amount**
Doctor Fee	<specify>	<specify>	<specify>
Medicine Fee	<specify>	<specify>	<specify>

37 What are the treatment methods used at household level for drinking water and the incurred expenses

Treatment methods	**Initial investments**	**Monthly expenditure**	**Miscellaneous expenses**
use clothes to filter the water	<specify>	<specify>	<specify>
boiling water on cooking gas	<specify>	<specify>	<specify>
purifying equipment	<specify>	<specify>	<specify>

	others <specify>	<specify>	<specify>	<specify>
	others <specify>	<specify>	<specify>	<specify>

38	What are the proposed specific improvements required for satisfactory water services both in quality and quantity aspects. Please rank your willingness to accept against each option. State “1” for highest priority/ willingness and “5” for least priority/ willingness.	
	Options	**Priority**
	Individual water tap connections	
	Community water tap connections	
	Importance to quality of water	
	Importance to quantity of water	
	More number of hours of supply of water supply	
	Fixed timing of supply of water	
	24X7 water supply	
	Decreasing the water tariffs	
	Increasing the water tariffs	
	Privatization of water supply	
	Others <specify>	
	Others <specify>	

39	How much more (in %) are you willing to pay for the improved services pertaining to drinking water in the area from the existing expenditures	
	Option	**How much more (state in % from the existing prices)**
	individual tap	<specify>
	public tap	<specify>
	open wells	<specify>
	tubewell/ handpump/ borewell	<specify>
	water tankers	<specify>
	bottled water	<specify>
	others <specify>	<specify>

40	Whom do you inform in case of any problems pertaining to drinking water			
	(a) neighbors	(b) local groups/ representatives	(c) water board staff/ authority/ government	(d) others <specify>
41	What are the means of communication to file a complaint			
	(a) directly meeting the officials (HMWSSB)	(b) complaining to public/ local representatives	(c) mobile/ emails/ letters	(d) Customer Care Service (of HMWSSB)

	(e) others <specify>			
42	How many days does it take to resolve the complaint by HMWSSB			
	(a) < 24 hours	(b) 2-5 days	(c) 6-10 days	(d) > 10 days
43	How frequently the service provider of drinking water does the monitoring of drinking water facilities and services			
	(a) once in a week	(b) once in two weeks	(c) once in a month	(d) only when problem occurs
	(e) occasional	(f) others <specify>		
44	What are the local groups/ community level associations and their associated details			
	Name of the group/ association	**Organization structure**	**delegated roles & responsibilities**	
	<specify>	<specify>	<specify>	
45	What is the frequency for the community level meetings held to discuss water related issues			
	(a) once in a week	(b) once in two weeks	(c) once in a month	(d) only when problem occurs
46	What are the on-going community level programmes/ completed improvements related to drinking water for this community/ area			
	Name of the programme/ improvements	**Details**		
	<specify>	<specify>		
47	What were the concerns and requirements stated to the authorities pertaining to drinking water during any consultation meetings held at community/ area level			
	<specify>			
	<specify>			
	<specify>			
48	Are you satisfied with the current service provider (HMWSSB)			
	(a) complete satisfaction	(b) satisfied	(c) partial satisfaction	(d) not satisfied
49	If "partial satisfaction and not satisfied" at question 49, please state the reasons			
	<specify>			
	<specify>			

	<specify>		
50	What is your perception of ***quality of decision making process of HMWSSB*** in providing you safe and adequate drinking water facilities and services for each of the following parameters. Please rank between "1" (unacceptable) and "5" (highly acceptable)		
	Parameters	Rank	Comments/ Details
	(a) in-line with vision and objectives statements/ any policies of HMWSSB		
	(b) considering the existing local conditions (through field assessments, interviews/ surveys/ FGDs)		
	(c) considering technical and financial feasibility/ implications		
	(d) considering services needs assessment (based on surveys/ interviews/ FDGs)		
	(e) considering analysis of priority area analysis (based on field level analysis, surveys, interviews, FDGs)		
	(f) considering viable alternatives/ best practices/ innovative ideas/ local resources (by identifying, communicating and discussing with slum residents)		
	(g) considering impact analysis of previous projects/ schemes (through field assessments/ interviews/ FGDs)		
	(h) considering the feedback from users/ public on facilities & services (the level of importance and satisfaction)		

	(i) considering the behavioral changes in users/ public/ analysis if quality improvement/ decrement of life due to existing conditions/ completed projects (perception analysis/ interviews/ surveys/ FGDs)		
	(j) responsible for information sharing and communication		<specify the details that are shared/ information> such as <details on functions of water boards>, <details on vision, statements, objectives, polices, programmes, projects>, <ongoing & completed projects>, <water pricing policy and subsidy pricing>, <information on decision making procedures, frameworks and policies; how, when and where to participate>; <specify the details that you perceive are important to know and to be shared>
	(k) conducting community engagement campaigns		
	(l) citizen participation during which stage of project cycle		<during planning/ formulation> <after planning/ formulation> <during implementation phase> <post implementation phase>

b. Laboratory testing of drinking water quality

This checklist in the table 86 was used to record the drinking water quality parameters from different sources based on the observations during laboratory tests of the samples collected from the select case study areas.

Table 86: Drinking water laboratory testing checklist

A	General Information				
1	Region:	HMDA	7	Date of Visit:	<insert dd/mm/yy>
2	City:	Hyderabad	8	Investigator:	<insert name>
3	Municipality:	<insert name>	9	Sample No.:	<insert details>
4	Ward No.:	<insert no.>			
5	Area/ Location:	<insert slum name>			
6	Description of sampling point location		<insert details>		

B	Diagnostic Information			
9	**Parameters**	**Unit**	**Reading**	**Comments (if any)**
(a)	Appearance	-	<based on laboratory test>	<insert details>
(b)	Odor	-	<based on laboratory test>	<insert details>
(c)	Thermotolerant coliforms	No./100 ml	<based on laboratory test>	<insert details>
(d)	Faecal streptococci	No./100 ml	<based on laboratory test>	<insert details>
(e)	pH	pH units	<based on laboratory test>	<insert details>
(f)	Conductivity	uS/cm	<based on laboratory test>	<insert details>
(g)	Turbidity	NTU	<based on laboratory test>	<insert details>
(h)	Free/ Residual chlorine	mg/l	<based on laboratory test>	<insert details>
(i)	Total chlorine	mg/l	<based on laboratory test>	<insert details>
(j)	Nitrate	mg/l	<based on laboratory test>	<insert details>
(k)	Arsenic	mg/l	<based on laboratory test>	<insert details>
(m)	Fluoride	mg/l	<based on laboratory test>	<insert details>
(o)	<others>	<specify>	<specify>	<specify>
(P)	<others>	<specify>	<specify>	<specify>

c. Decision making procedures followed by Government agencies to provide drinking water facilities and services

This semi-structured questionnaire in the table 87 was administered at institutional (HMWSSB) level, which is responsible for providing drinking water services and facilities, for capturing the primary information pertaining to quality of decision making processes.

Table 87: Institutional level questionnaire

A	General Information				
1	Region:	HMDA	5	Date of Visit:	<insert dd/mm/yy>
2	City:	Hyderabad	6	Investigator:	<insert name>
3	Organization:	<insert name>	7	Respondent:	<insert name>
4	Role of Organization:	<insert details>			

B	Diagnostic Information	
1	What are the direct & indirect functions of HMWSSB	
	Direct functions	**Indirect functions**
	<specify details>	<specify details>
2	What are the vision/ commitment statement, objectives, strategic plans of HMWSSB	
	<specify vision statement, goals>	
	<specify objectives (medium and long term)>	
	<specify priorities and plans/projects (both short, medium and long term)>	

3	What were the programmes/ projects/ schemes taken up by HMWSSB in past 10 years to improve the infrastructure conditions (esp. drinking water facilities and services) in the slum areas			
	< programmes/ projects/ schemes >	<objectives of programmes/ projects/ schemes/ timelines/ target population/ areas>	<specify outcomes/ impacts>	<funding agency> <project cost>
4	What were the reasons identified for not able to achieve the expected targets (if any)? <Specify details>.			
5	What are the upcoming/ proposed short- and long-term plans/policies/schemes to improve the infrastructure conditions (esp. drinking water facilities and services) in the slum areas			
	< programmes/ projects/ schemes >	<objectives of programmes/ projects/ schemes/ timelines/ target population/ areas>	<specify outcomes/ impacts>	<funding agency> <project cost>
6	What are the integral components of any decisions made on policies/ projects/ schemes for slum areas **<Tick the appropriate>**			

	<e.g.: decision on providing safe and adequate drinking water facilities/ services to slum areas; decision on which slum area and how much safe and adequate drinking water facilities/ services to provide; decision on improvements on drinking water facilities and services in slum areas>		
	Tick	Inputs from:	Details/ Notes
		(i) **National & State policies** <Are National and State level Policies considered during decision making process?> <Anything specific to slum areas>	
		(ii) **Vision statements/ Strategy plans** <Are vision considered during decision making process?> <Anything specific to slum areas>	
		(iii) **Laws, regulations & procedures** <Do they support the decisions made?> <Are they anything specific to slum areas> <Any hurdles foreseen/ encountered?>	
		(iv) **analysis of existing local conditions** <Do you consider empirical analysis of the existing local conditions of services and facilities **in slum areas** through surveys/ interviews/ FGDs at community level during decision making process>	
		(v) **technical feasibility** <Do you consider technical feasibility study before taking up the project?> <What are the aspects considered in technical feasibility study?>	
		(vi) **financial planning & management** <Is the financial planning & management according to Strategic Planning?>	
		(vii) **analysis of financial implications** <Do you consider cost-benefit analysis of the schemes/ projects> <Do you consider any risk analysis of the schemes/ projects> <Do you consider value for money analysis of the schemes/ projects>	

		< dedicated finance and accounting staff with specific skill sets with dedicated roles and responsibilities>	
		(viii) **analysis of viable alternatives** <Do you consider any viable alternatives/ options in projects/ solutions to problems, technology usage, material usage, etc.,>	
		(ix) **internal research and analysis** <Is there an internal research and analysis team in HMWSSB who performs analysis of different problems/ challenges and solutions that can be considered>	
		(xi) **analysis of best practices/ innovative ideas** <Do you consider the analysis of neighboring state agencies who implemented some best practices/ innovative ideas> <Do you analyse the potential funding arrangements> <Do you analysis of usage of local resources - finance, human, equipment>	
		(xiii) **lessons from earlier policies/ projects** <Do you consider the details on impact analysis of previous projects/ schemes?>	
		(xiv) **feedback from users/ public on facilities & services** <Do you consider the details on levels of importance & satisfaction based on surveys/ interviews/ FGDs>	
		(xv) **services needs assessments/ priority areas analysis** <Do you analyse and consider the services needs assessments and priority areas based on surveys/ interviews/ FGDS>	
		(xvi) **analysis of behavioral changes in users/ analysis of quality improvement of life**	

		<Do you consider the impact assessment of previous projects/ schemes> <Do you consider the satisfaction levels of the users on the previous projects/ schemes>	
		(xvii) **resource (natural & manpower) analysis and management** <Do you consider the resource availability analysis (both natural & manpower) during the decisions taken>	
		(xviii) **analysis of standards & benchmarking** <Do you consider the analysis of standards & benchmarking during the decisions taken>	
		(xix) **public information & engagement campaigns** <Do you share the information and conduct public campaigns>	
		(xx) **annual plans & performance information/ reports** <Do you prepare annual plans> <Do you conduct monitoring & evaluation of implemented projects/ programmes> <How frequently is the analysis carried out> <Do you develop any performance indicators and targets to measure the progress of projects/ programmes> <Do you have any long-term indicators at community level and analyse them at regular intervals> <Do you have medium term indicators at corporate level and analyze them at regular intervals> <Do you have short term indicators at staff level/ team/ individual level, specifically staff targets, staff performance, staff appraisals>	
		(xxi) **implementation plan**	

		<any project management techniques used> <how realistic are the implementation plans>	
		(xxii) **project implementation team/ structure** <any designated team for project implementation, monitoring and quality control>	
		(xxiii) **flexible plans/ policies/ strategies** <Are the plans/ policies/ strategies updated based on changing circumstances?> <Are those circumstances (changing or not) captured at regular intervals>	
		(xxiv) **training & capacity building of internal staff** <is there a mechanism for analyzing the skills and competencies of staff> <Training needs assessments are carried out regularly?>	
		(xxv) **SWOT analysis**	
		(xxvi) **ICT** <any information from monitoring/ management information system> <analysis of type of complaints/ grievances>	
		(xxvii) **stakeholder pressures**	
		(xxviii) **procurement policy & procedures** <Procurement process is secure, transparent and complies with regulations and local protocols>	
		<others> <specify>	
		<others> <specify>	
15	What are the revenue sources for HMWSSB?		

	(a) Own income	<specify different types of income>			
	(b) State govt. funding	(c) Central govt. funding	(d) External funding	(e) public-private partnership (PPP)	(f) others <specify>
16	As per official records at the HMWSSB, what is total number of users having facilities (individual tap connections/ public tap connections)				
	<specify slum wise details>				
17	As per official records at the HMWSSB, what is the total number of users having facilities have access to services (supply of drinking water)				
	<specify slum wise details>				
18	Specify the details on differential pricing for various sets of population in Hyderabad region for drinking water facilities & services (for initial investment incentives and recurring expenditures)				
	<specify details>				
19	What are the revenue collection mechanisms for drinking water service users of various sets of population in Hyderabad region				
	<specify details – different revenue collection mechanisms for different types of revenue>				
20	As per official records at the HMWSSB, what is the total number of users against which the service charges are collected				
	<specify slum wise details>				
21	Specify the mechanism/ system in place for monitoring/ policing the unaccounted services				
	<specify details – different policing mechanisms for monitoring facilities & services>				
22	What are the expenditure patterns in percentages for the HMWSSB? <documentary evidence: annual financial statements>				

	(a) Capital projects (Central funding)	(b) Capital projects (State funding)	(c) Recurring expenses	(d) Loans & advances	(e) others <specify>
23	Specify the mechanism/ system in place for supply of standard quality of drinking water to slum areas				
	<specify details – detailed flow of activities>				
24	Specify the mechanism/ system in place for supply of standard quality of drinking water to slum areas				
	<specify details>				
25	What are the innovative projects taken-up that reduced the financial burdens/ had significant cost saving				
	<specify details>				
23	Who are the internal stakeholders participating in decision making (both for planning & budgeting)				
	(a) management staff	(b) operational staff	(c) designated team	(d) others <specify>	
26	Roles & responsibilities of employees in decision making process <defined anywhere? – document-based evidences> <specify details>				
	Designation	**No. of employees**	**Contribution to decisions**		

27	What are the HR policies/ strategies in place for engaging and appreciating/ rewarding (for employee involvement, communication and participation) the **voice of staff (internal stakeholders)** in decision making process
	<specify details>

28	Who are the external stakeholders participating in decision making (both for planning and budgeting)			
	(a) local people (from slum areas)	(b) local representatives (from slum areas)	(c) public representatives/ politicians/ political management	(d) media
	(e) NGOs/ Private agencies (national & international)/ women-based NGOs	(f) civil societies/ organizations	(g) parastatal agencies/ civic organizations <specify names>	(h) subject matter experts (national & international)

29	What are the regulations and procedures in legislative and regulatory frameworks, procedures/ mechanisms in place for **engaging the voice of citizen participation** in decision making processes
	<specify details>

30	Typically, who are the different sections of people from slum areas participate to discuss issues pertaining to drinking water				
	(a) men	(b) women	(c) young/ children	(d) elderly	(e) disabled

31	What kind of aspects are given importance by different sections of people from slum areas who participate in discussions pertaining to improvements in drinking water facilities and services						
	Men	Quality	Quantity	Accessibility	Hygiene	Cost	Timings
	Women	Quality	Quantity	Accessibility	Hygiene	Cost	Timings
	Young/ children	Quality	Quantity	Accessibility	Hygiene	Cost	Timings
	Elderly	Quality	Quantity	Accessibility	Hygiene	Cost	Timings
	Disabled	Quality	Quantity	Accessibility	Hygiene	Cost	Timings

32	How does these external stakeholders participate in decision making (both for planning and budgeting)			
	(a) by mobilization of stakeholders to participate (awareness creation about rights and civic responsibilities)	(b) only partial involvement during discussions	(c) voluntary participation with a sense of belonging and attachment	
33	Which form of participation are external stakeholders most likely to use to gather reactions/ feedbacks and influence the decision making process (both for planning and budgeting)			
	(a) debates on local issues and experiences	(b) public hearing/ forums	(c) surveys/ interviews/ FGDs on regular basis <specify>	(d) votes on issues
	(e) petitions	(f) protests	(g) media pressure	(h) employee pressure
	(i) political pressure	(j) electronic communications (ICT)	(k) votes/ opinions on alternatives/ choices (incl. financials)	
34	How are the received feedbacks treated and incorporated in decision making (both for planning and budgeting)			
	(a) not considered	(b) considered (recorded, scrutinized, analyzed and prioritized) but not communicated back to stakeholders	(c) communicate back to relevant stakeholders about the reliable information and outcomes in a timely manner	(d) well documented and make it accessible to public through different means <specify>
35	During which stage of policies/ project life cycle, the external stakeholders’ consultations are taken into account			
	(a) planning/ formulation/ decision making	(b) after planning/ formulation/ decision making	(c) during implementation phase	(d) post implementation phase
36	What are the main issues that are triggered during stakeholder consultations pertaining to drinking water facilities and services			
	<specify details>			

37	What are the main issues for the non-participation of relevant stakeholders (esp. citizens from slum areas) in decision making process			
	<specify details>			
38	What kind of initiatives are taken up to improve the citizen participation in decision making processes			
	<specify details>			
39	Detailed workflow of any programme/ project/ police formulation (decision making process) in the department/ institution			
	Details tasks Actors involved <specify actors>	<specify tasks/ activities>	<specify tasks/ activities>	<specify tasks/ activities>

Documents to be collected:

Vision documents, business plans, action plans, project plans, existing policies, procedure documents, operating rules and guidance, internal audit and review reports and external audit, inspection and review documents; available resources (manpower, financial), financial statements, performance indicators and analysis report, organizational structure, HR policies and strategies, training and capacity building policy, procurement policy & procedures, etc.,

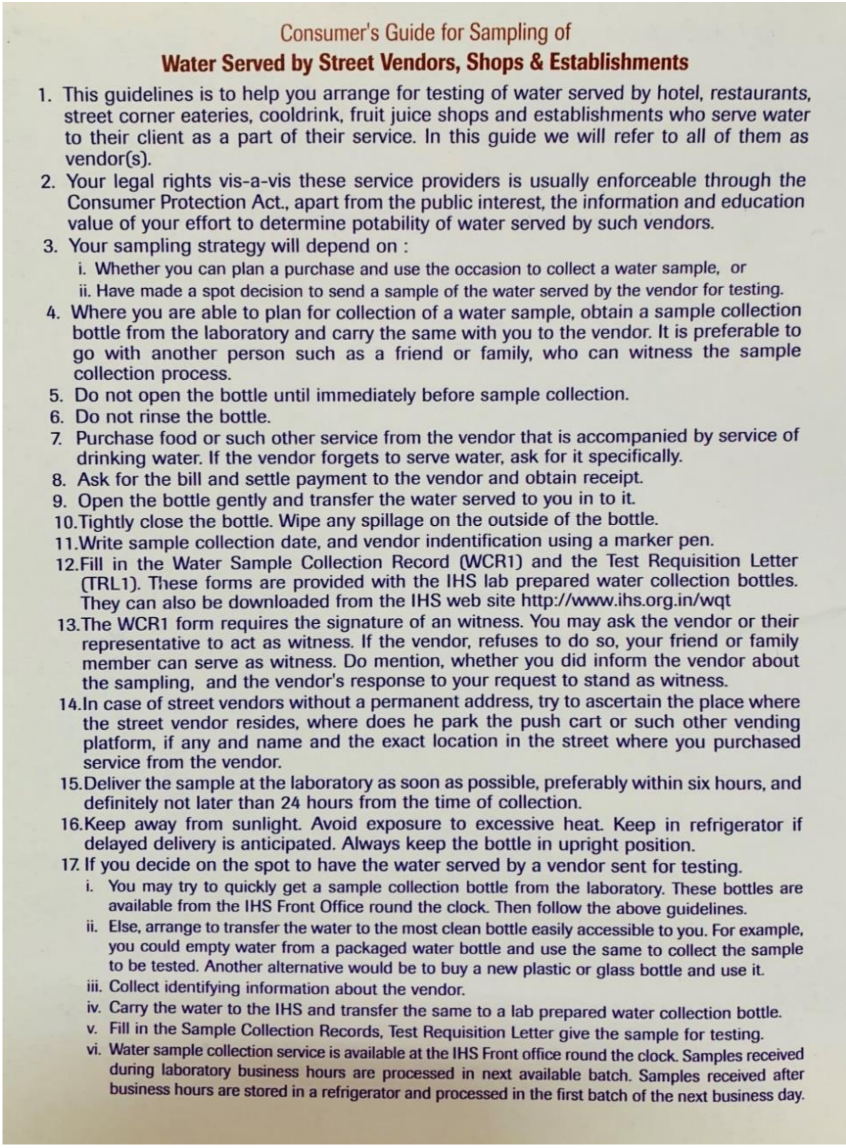
List of documents required:

1. Vision statement and objectives of HMWSSB (latest copy)
2. Strategy document/ annual plan of HMWSSB (latest copy)
3. Annual financial statements
4. Report on analysis of existing water infrastructure conditions in slum areas
5. MIS report on slum wise details:
    a. total number of users having facilities (individual tap connections/ public tap connections) and
    b. total number of users having access to services (supply of drinking water)
    c. total number of users against which the implementation/ service charges are collected
6. Government orders/ policy on differential water pricing
7. Annual financial statements (copy)
8. Existing policies & procedures

Annexure 6 | Water sample collection and testing procedures

a. Water sample collection procedures

The following figures 93-97 provide the details on drinking water sample collection procedures.



Consumer's Guide for Sampling of

Water Served by Street Vendors, Shops & Establishments

1. This guidelines is to help you arrange for testing of water served by hotel, restaurants, street corner eateries, cooldrink, fruit juice shops and establishments who serve water to their client as a part of their service. In this guide we will refer to all of them as vendor(s).
2. Your legal rights vis-a-vis these service providers is usually enforceable through the Consumer Protection Act., apart from the public interest, the information and education value of your effort to determine potability of water served by such vendors.
3. Your sampling strategy will depend on :
   i. Whether you can plan a purchase and use the occasion to collect a water sample, or
   ii. Have made a spot decision to send a sample of the water served by the vendor for testing.
4. Where you are able to plan for collection of a water sample, obtain a sample collection bottle from the laboratory and carry the same with you to the vendor. It is preferable to go with another person such as a friend or family, who can witness the sample collection process.
5. Do not open the bottle until immediately before sample collection.
6. Do not rinse the bottle.
7. Purchase food or such other service from the vendor that is accompanied by service of drinking water. If the vendor forgets to serve water, ask for it specifically.
8. Ask for the bill and settle payment to the vendor and obtain receipt.
9. Open the bottle gently and transfer the water served to you in to it.
10. Tightly close the bottle. Wipe any spillage on the outside of the bottle.
11. Write sample collection date, and vendor indentification using a marker pen.
12. Fill in the Water Sample Collection Record (WCR1) and the Test Requisition Letter (TRL1). These forms are provided with the IHS lab prepared water collection bottles. They can also be downloaded from the IHS web site http://www.ihs.org.in/wqt
13. The WCR1 form requires the signature of an witness. You may ask the vendor or their representative to act as witness. If the vendor, refuses to do so, your friend or family member can serve as witness. Do mention, whether you did inform the vendor about the sampling, and the vendor's response to your request to stand as witness.
14. In case of street vendors without a permanent address, try to ascertain the place where the street vendor resides, where does he park the push cart or such other vending platform, if any and name and the exact location in the street where you purchased service from the vendor.
15. Deliver the sample at the laboratory as soon as possible, preferably within six hours, and definitely not later than 24 hours from the time of collection.
16. Keep away from sunlight. Avoid exposure to excessive heat. Keep in refrigerator if delayed delivery is anticipated. Always keep the bottle in upright position.
17. If you decide on the spot to have the water served by a vendor sent for testing.
   i. You may try to quickly get a sample collection bottle from the laboratory. These bottles are available from the IHS Front Office round the clock. Then follow the above guidelines.
   ii. Else, arrange to transfer the water to the most clean bottle easily accessible to you. For example, you could empty water from a packaged water bottle and use the same to collect the sample to be tested. Another alternative would be to buy a new plastic or glass bottle and use it.
   iii. Collect identifying information about the vendor.
   iv. Carry the water to the IHS and transfer the same to a lab prepared water collection bottle.
   v. Fill in the Sample Collection Records, Test Requisition Letter give the sample for testing.
   vi. Water sample collection service is available at the IHS Front office round the clock. Samples received during laboratory business hours are processed in next available batch. Samples received after business hours are stored in a refrigerator and processed in the first batch of the next business day.

Figure 93: Drinking water sample collection procedures (Pg. 1)

Water Quality Testing Services

SvCd	Service	Quantity of sample required	Bottle or Packet Preparations	Page No.
B125	Water Collection Bottle - 125 ml.		NA	2
B01L	Water Collection Bottle - 1000 ml.		NA	2
BPT	Basic Potability Test	500 ml	Lab-B01L	3
CPT	Complete Potability Test	1000 ml	Lab-B01L	4
BCT	Bacteriological Analysis	100 ml	Lab-B125	5
BIT	Bottled Water Integrity Test	Pack	NA	6
FLD	Fluoride Analysis of Water	100 ml	Client	6
GQT	Ground Water Quality Test	500 ml	Client	7
GBT	Ground Water Bacteriological Contamination Test	100 ml	Lab-B125	8
GPT	Ground Water Potability Test.	1000 ml	Lab-B01L	9
CAT	Chlorine Availability Test	100g /ml	Client	10
AQT	Alum Quality Test	100g	Client	10
LAT	Liquid Chlorine Acceptability Test	100 ml	Client	11
SCS	Sample Collection Service	AA	AA	12
FCS	Fast Sample Collection Service	AA	AA	12
ECS	Emergency Sample Collection Service	AA	AA	12
SNS	Sanitary Survey of Source	AA	AA	12

Notes:

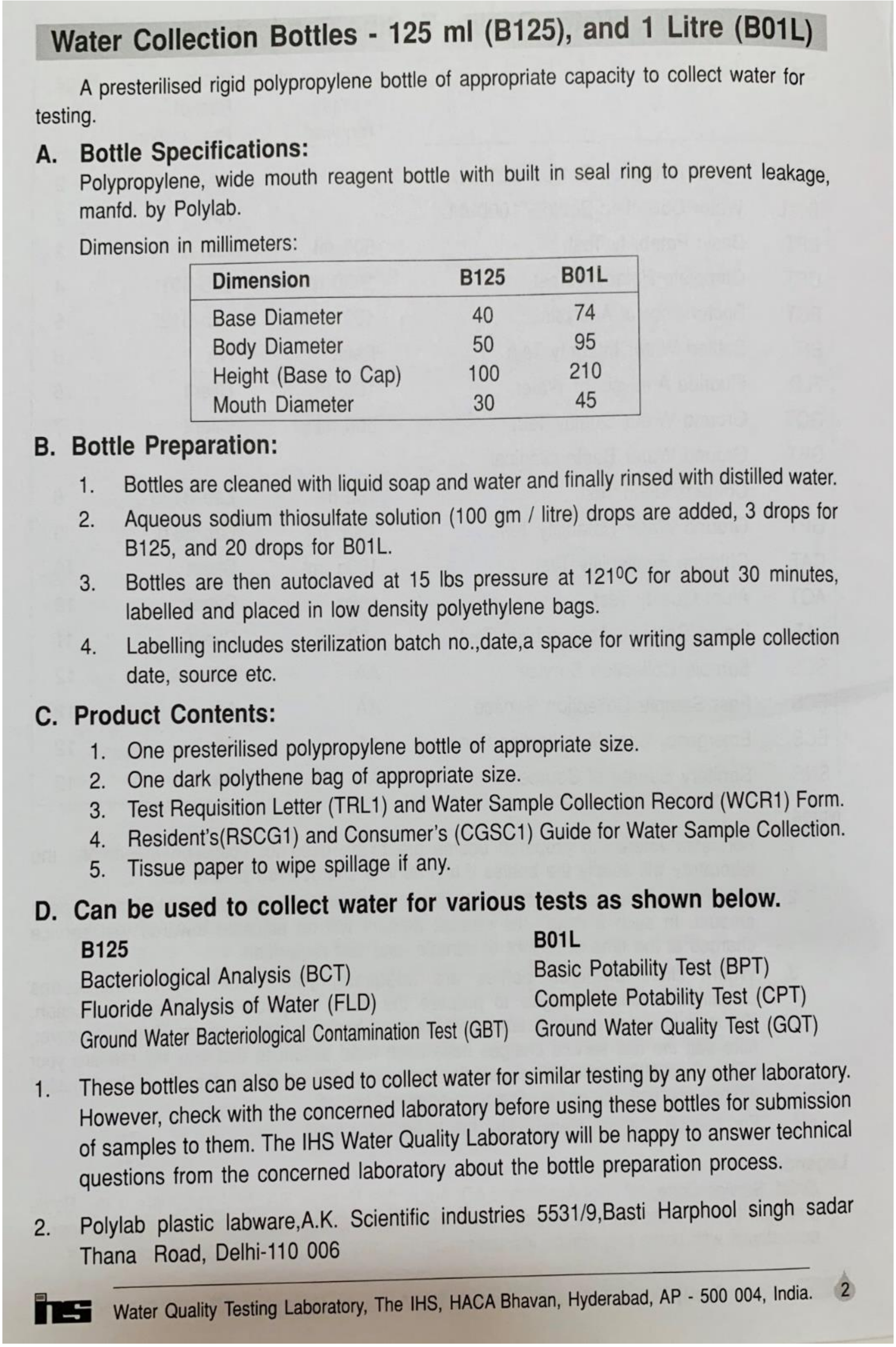
1. For tests where lab prepared bottles are to be used for collection of sample, the laboratory will supply the bottles if test service charges are paid in full.
2. Alternatively, you can collect the laboratory prepared bottles on payment of the deposit amount. In such a case the deposit amount will be adjusted towards test service charges at the time of reciept of sample, and test requisition.
3. Where client prepared bottles are adequate, you should follow instructions contained in this catalogue to prepare the bottle or packet for sample collection. You may, however, purchase laboratory prepared bottles for this purpose. Please, however, note that the test service charges have been fixed assuming that you will prepare your bottle / packet for collection of sample. Hence only 50% of bottle deposit will be adjusted in case you use any of the laboratory prepared bottles.
4. For service charges please refer the latest price list.

Legend:

SvCd: Service Code; NA: Not Applicable; AD: Adjustable Deposit; AA: As Appropriate. Lab : Bottle prepared by the Laboratory or its equivalent to be used; Client: Bottle Prepared by the client in accordance with bottle preparation instructions in the catalogue. CB: Estimate on case basis.

Water Quality Testing Laboratory, The IHS, HACA Bhavan, Hyderabad, AP - 500 004, India. 1

Figure 94: Drinking water sample collection procedures (Pg. 2)



Water Collection Bottles - 125 ml (B125), and 1 Litre (B01L)

A presterilised rigid polypropylene bottle of appropriate capacity to collect water for testing.

A. Bottle Specifications:

Polypropylene, wide mouth reagent bottle with built in seal ring to prevent leakage, manfd. by Polylab.

Dimension in millimeters:

Dimension	B125	B01L
Base Diameter	40	74
Body Diameter	50	95
Height (Base to Cap)	100	210
Mouth Diameter	30	45

B. Bottle Preparation:

1. Bottles are cleaned with liquid soap and water and finally rinsed with distilled water.
2. Aqueous sodium thiosulfate solution (100 gm / litre) drops are added, 3 drops for B125, and 20 drops for B01L.
3. Bottles are then autoclaved at 15 lbs pressure at 121^{0}C for about 30 minutes, labelled and placed in low density polyethylene bags.
4. Labelling includes sterilization batch no.,date,a space for writing sample collection date, source etc.

C. Product Contents:

1. One presterilised polypropylene bottle of appropriate size.
2. One dark polythene bag of appropriate size.
3. Test Requisition Letter (TRL1) and Water Sample Collection Record (WCR1) Form.
4. Resident's(RSCG1) and Consumer's (CGSC1) Guide for Water Sample Collection.
5. Tissue paper to wipe spillage if any.

D. Can be used to collect water for various tests as shown below.

B125
Bacteriological Analysis (BCT)
Fluoride Analysis of Water (FLD)
Ground Water Bacteriological Contamination Test (GBT)

B01L
Basic Potability Test (BPT)
Complete Potability Test (CPT)
Ground Water Quality Test (GQT)

1. These bottles can also be used to collect water for similar testing by any other laboratory. However, check with the concerned laboratory before using these bottles for submission of samples to them. The IHS Water Quality Laboratory will be happy to answer technical questions from the concerned laboratory about the bottle preparation process.
2. Polylab plastic labware,A.K. Scientific industries 5531/9,Basti Harphool singh sadar Thana Road, Delhi-110 006

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Figure 95: Drinking water sample collection procedures (Pg. 3)

Clients Guide for Preparation of Water Sample Collection Bottles

1. Identify a suitable glass or polypropylene bottle.
   i. Bottle volume should at least be 20% more than the volume of sample.
   ii. Prefer a bottle with wider mouth.
   iii. The bottle's cap should be closed tightly.
   iv. Used bottles are acceptable, but would require soaking and thorough cleaning.
2. Clean the bottle and its cap with soap water.Liquid soap is preferable.If using bar soap make sure that no soap piece is left behind in the bottle.
3. Rinse both bottle and cap in plain water adequately to remove traces of soap.If feasible, use distilled water for the final rinse.
4. Dry the bottle and its cap. Avoid exposure to dust while drying.
5. Place the cap securely, after drying.
6. Fix an ordinary self adhesive label to note sample collection date, time and source. A floppy disk label or a school note book label will do.
7. Use the bottle for collection of sample within four days of preparation.
8. Note that such a bottle can be used to collect water sample for testing of physical and chemical parameters. To check for presence of micro organisms and send a sample for bacteriological analysis use an appropriate lab prepared (presterilised) bottle.

Legal Provisions about water quality :

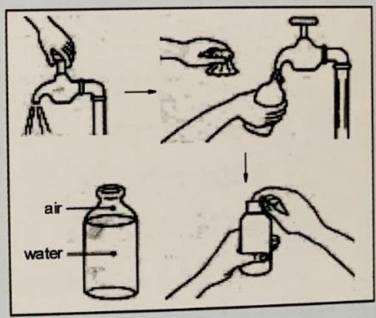
The Andhra Pradesh Public Health (APPHA) Act, 1939, fixes responsibility on the local authority for water supply. Thus the municipal authorities and Gram Panchayats are legally required to provide for sufficient supply of drinking water for consumption by inhabitants of the area within their jurisdiction.Under section 20 the District Collector has powers to cause enquires about sanitary condition of water supply system and adequacy of supply. Under section-21 the Director - Public Health has powers to direct a local authority to improve water supply. Under section 24 the Health Officer can give instructions to any person having control of drinking water source, to take appropriate action to maintain its hygiene.

IHS Water Quality Testing Laboratory, The IHS, HACA Bhavan, Hyderabad, AP - 500 004, India. 13

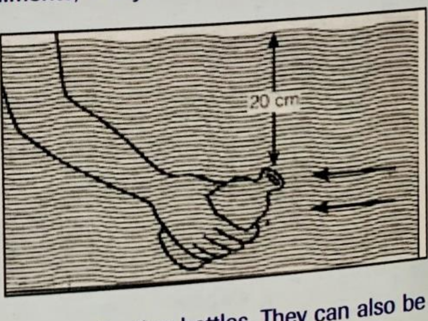
Figure 96: Drinking water sample collection procedures (Pg. 4)

Resident's Guide for Water Sample Collection.

1. Select and secure the sample collection bottle and a dark coloured carry bag:
   i. Depending on the test required, you may use either "client prepared" bottle or "lab prepared" bottle. Client prepared bottle means that the bottle can be prepared by you at home or in your establishment. Note that the bottle has to be prepared sufficiently before you use it to collect a sample, so that there is time for the bottle to dry. Lab prepared bottle means a presterilised bottle provided by the laboratory.
   ii. The Water Quality Testing Service catalogue shows where "client prepared" bottle is adequate for collection of sample. The laboratory may, however, prepare and supply a bottle for an additional service charge. Note that bottles are prepared with specific tests in mind. Hence check with laboratory, before you use a lab prepared bottle.
   iii. Note that, for certain tests separate bottle would not be required. For example, to test packaged water, simply deliver the packaged water as it is to the laboratory.
   iv. Here sample collection bottle means the lab prepared bottle or client prepared bottle as appropriate.



2. Do not open bottle untill, ready to use.
3. Do not rinse the bottle.
4. Plan to collect water into the bottle in such a way that the sample is representative of the water to be tested.
5. Open the bottle gently and fill water without any splashes.
6. Tightly close the bottle. Wipe any spillage on the outside of the bottle.
7. Write sample collection date, and brief identification of the source on the bottle label, using a permanent marker pen.
8. In case of collections from a storage tank, collect the sample from below the surface by gently dipping mouth of the bottle under the water gradually filling the bottle, so that you do not stir up the sediments, if any.



9. Place the bottle inside the dark coloured polythene bag and put adequate ice cubes inside the bag. The quantity of ice cubes should be enough to cover bottom $2/3^{rd}$ of the bottle. Excess ice above bottle's neck may cause mixing up of the sample with water from the ice. Make sure that ice cubes remain below the neck.
10. Fill in the Water Sample Collection Record (WCR1) and the Test Requisition Letter (TRL1). These forms are provided with the IHS lab prepared water collection bottles. They can also be downloaded from the IHS web site at http://www.ihs.org.in/wqt/index.htm.
11. Deliver the sample at the laboratory as soon as possible, preferably within six hours, and definitely not later than 24 hours from the time of collection.
12. Keep away from sunlight. Avoid exposure to excessive heat. Keep in refrigerator if delayed delivery is anticipated. Always keep the bottle in upright position.

Figure 97: Drinking water sample collection procedures (Pg. 5)

b. Water sample testing procedures

The following figures 98-99 provide the details for laboratory testing procedures for Complete Potability Test (CPT) and Ground Water Potability Test (GPT).

Complete Potability Test (CPT)

This test checks for more water quality parameters compared to the basic potability test and in addition, provides clues for possible sources of contamination, if any. Thus the test not only helps you know if the water consumed by your family and friends is potable but will also help investigate the possible source of contamination if any.

A. Sample Required:

At least one litre of water is collected in Water Collection Bottle - 1000 ml (B01L) or equivalent, delivered at laboratory preferably within 6 hrs, but not later than 24 hrs from time of collection. Keep away from sunlight. Avoid exposure to extensive heat. Keep in refrigerator, if delayed delivery is anticipated.

B. Test Duration:

If sample is found satisfactory, then report will be available after 48 hours. If sample is found to have bacteria then further test will be made to look for indication of fecal contamination, isolate specific organisms. This test will take another 48 hours. So report will be available after 96 hours.

C. Report Details:

1. Most probable number of organisms (MPN) present per 100 ml of water. This is an indicator of bacterial contamination.
2. Tests to investigate possible source of bacterial contamination. These tests will be done only if the MPN value is found unsatisfactory.
   i. Confirmatory test for E.Coli which indicates fecal contamination.
   ii. Isolation of specific bacteria such as Salmonella, Fecal Streptococci.
3. Physical indicators of contamination: PH, Color, Turbidity, and Electrical Conductivity.
4. Chemical Indicators of Contamination:(a) Ammonia,(b) Nitrites,and (c) Nitrates
5. Mineral Content Estimation. These test will assess whether the level of naturally dissolved minerals are within permissible limits.
   i. Fluoride content. This indicates risk of fluorosis.
   ii. Calcium, Magnesium, Sulfates, and Chlorides.
6. Indicators of Industrial Pollution: Alkalinity Test.
7. Quality of Treatment Assessment.
8. Interpretation, based on test results and sample collection record.

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Figure 98: Water sample testing procedures (Pg. 1)

Ground Water Potability Test (GPT)

This test checks for more quality parameters compared to the Ground water quality test and in addition, provides clues for possible sources of contamination if any. Thus this test not only helps you know whether the ground water consumed by you, your family and colleagues is potable but will also help investigate possible source of contamination if any.

A. Sample Required :-

At least one litre of water collected in water collection Bottle-1000ml (B01L) or equivalent,delivered at laboratory preferably within 6 hrs,but not later than 24 hrs from time of collection. Keep away from sunlight. Avoid exposure to excessive heat. Keep in refrigerator, if delayed delivery is anticipated.

B. Test Duration :

If sample found satisfactory,then report will be available after 48 hrs.If sample is found to have bacteria then further test will be made to look for indication of fecal contamination, isolate specific organism. This test will take another 48 hours. So report will be available after 96 hours.

C. Report Details:

1. Most probable number of organisms (MPN) present per 100 ml of water. This is an indicator of bacterial contamination.
2. Tests to investigate possible source of bacterial contamination. These tests will be done only if the MPN value is found unsatisfactory.
   i. Confirmatory test for E.Coli which indicates fecal contamination.
   ii. Isolation of specific bacteria such as Salmonella, Fecal Streptococci.
3. Physical indicators of contamination: P^{H}, Color, Turbidity, and Electrical Conductivity.
4. Chemical Indicators of Contamination:(a)Ammonia,(b)Nitrites, and(c) Nitrates
5. Mineral Content Estimation. These test will assess whether the level of naturally dissolved minerals are within permissible limits.
   i. Fluoride content, this indicates risk of fluorosis.
   ii. Calcium,Magnesium,Sulfate,Iron and Chlorides.Magnesium and Sulphates can be dangerous to mucus lining causing gastro intestinal irritation.
6. Indicators of Industrial Pollution: Total Dissolved Solids (TDS) and Alkalinity ensure in decreasing the potability; continuous exposure can lead to Gastrointestinal irritation.
7. Quality of treatment assessment.
8. Interpretation,based on test results and sample collection record.

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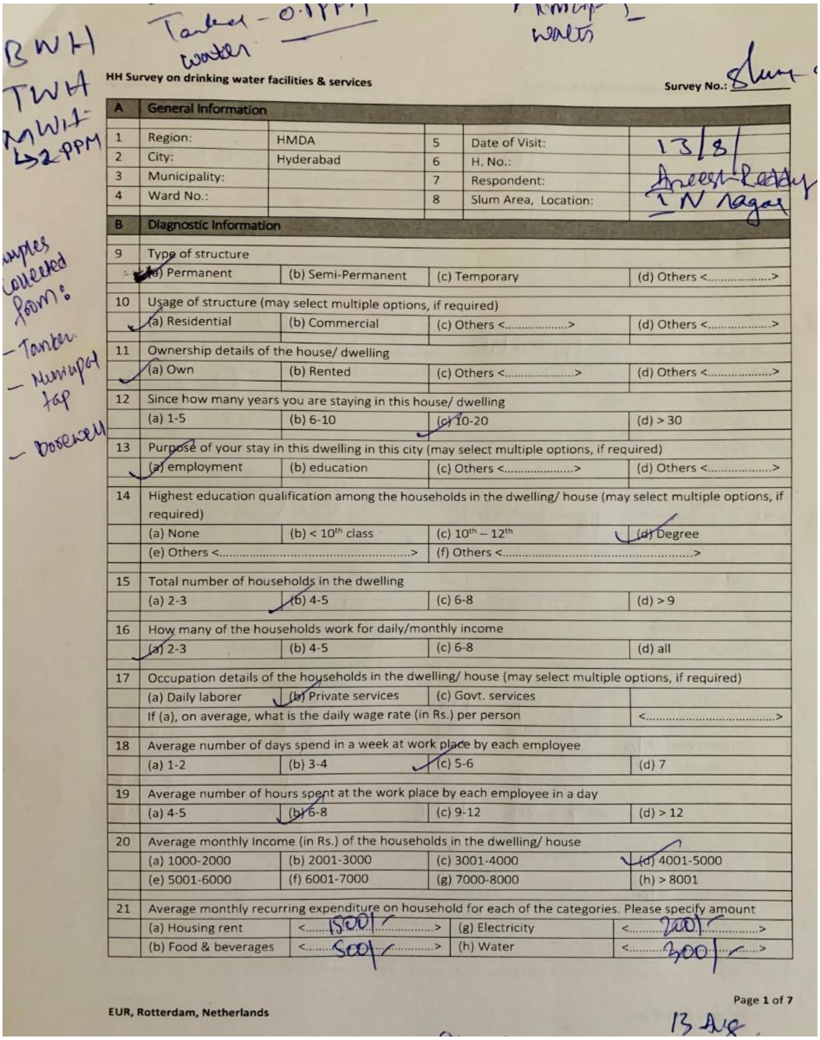
Figure 99: Water sample testing procedures (Pg. 2)

Annexure 7 | Sample filled in questionnaires

a. Perception analysis quality and quantity of drinking water, decision making procedures, sources of drinking water, challenges faced due to drinking water conditions, etc.

The following figures 100-106 provide the details captured during household level interviews in the slum areas to understand the perceptions of drinking water quality and quantity, and decision making procedures, sources of drinking water, challenges faced due to poor drinking water conditions, etc.



HH Survey on drinking water facilities & services

Survey No.: Slum

A	General Information						
1	Region:	HMDA		5	Date of Visit:	13/8/	
2	City:	Hyderabad		6	H. No.:		
3	Municipality:			7	Respondent:	Aneesh Reddy	
4	Ward No.:			8	Slum Area, Location:	TN Nagar	
B	Diagnostic Information						
9	Type of structure						
	(a) Permanent	(b) Semi-Permanent	(c) Temporary	(d) Others <...................>			
10	Usage of structure (may select multiple options, if required)						
	(a) Residential	(b) Commercial	(c) Others <..................>	(d) Others <..................>			
11	Ownership details of the house/ dwelling						
	(a) Own	(b) Rented	(c) Others <...................>	(d) Others <..................>			
12	Since how many years you are staying in this house/ dwelling						
	(a) 1-5	(b) 6-10	(c) 10-20	(d) > 30			
13	Purpose of your stay in this dwelling in this city (may select multiple options, if required)						
	(a) employment	(b) education	(c) Others <...................>	(d) Others <..................>			
14	Highest education qualification among the households in the dwelling/ house (may select multiple options, if required)						
	(a) None	(b) < 10th class	(c) 10th – 12th	(d) Degree			
	(e) Others <..........................>		(f) Others <..........................>				
15	Total number of households in the dwelling						
	(a) 2-3	(b) 4-5	(c) 6-8	(d) > 9			
16	How many of the households work for daily/monthly income						
	(a) 2-3	(b) 4-5	(c) 6-8	(d) all			
17	Occupation details of the households in the dwelling/ house (may select multiple options, if required)						
	(a) Daily laborer	(b) Private services	(c) Govt. services				
	If (a), on average, what is the daily wage rate (in Rs.) per person			<..............................>			
18	Average number of days spend in a week at work place by each employee						
	(a) 1-2	(b) 3-4	(c) 5-6	(d) 7			
19	Average number of hours spent at the work place by each employee in a day						
	(a) 4-5	(b) 6-8	(c) 9-12	(d) > 12			
20	Average monthly Income (in Rs.) of the households in the dwelling/ house						
	(a) 1000-2000	(b) 2001-3000	(c) 3001-4000	(d) 4001-5000			
	(e) 5001-6000	(f) 6001-7000	(g) 7000-8000	(h) > 8001			
21	Average monthly recurring expenditure on household for each of the categories. Please specify amount						
	(a) Housing rent	<.....1500/-.....>	(g) Electricity	<.....200/-.....>			
	(b) Food & beverages	<.....500/-.....>	(h) Water	<.....300/-.....>			

EUR, Rotterdam, Netherlands

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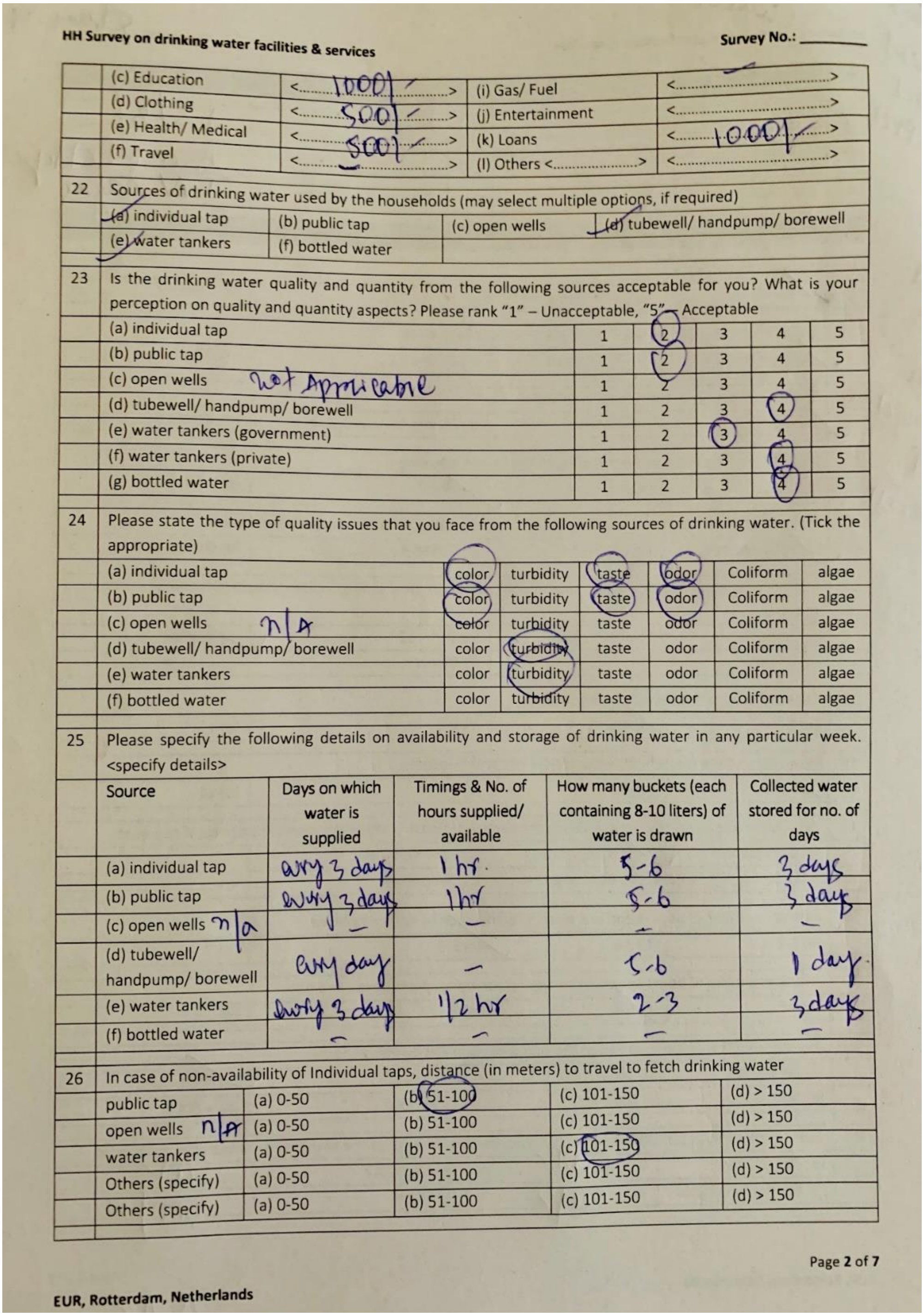
Figure 100: Filled-in household questionnaire (Pg. 1)



HH Survey on drinking water facilities & services

Survey No.: ________

	(c) Education	<.....1000/.....>	(i) Gas/ Fuel	<.............>
	(d) Clothing	<.....500/.....>	(j) Entertainment	<.............>
	(e) Health/ Medical	<.....500/.....>	(k) Loans	<.....1000/.....>
	(f) Travel	<.............>	(l) Others <..........>	<.............>

22	Sources of drinking water used by the households (may select multiple options, if required)			
	(a) individual tap	(b) public tap	(c) open wells	(d) tubewell/ handpump/ borewell
	(e) water tankers	(f) bottled water		

23	Is the drinking water quality and quantity from the following sources acceptable for you? What is your perception on quality and quantity aspects? Please rank "1" – Unacceptable, "5" – Acceptable					
	(a) individual tap	1	2	3	4	5
	(b) public tap	1	2	3	4	5
	(c) open wells not Applicable	1	2	3	4	5
	(d) tubewell/ handpump/ borewell	1	2	3	4	5
	(e) water tankers (government)	1	2	3	4	5
	(f) water tankers (private)	1	2	3	4	5
	(g) bottled water	1	2	3	4	5

24	Please state the type of quality issues that you face from the following sources of drinking water. (Tick the appropriate)						
	(a) individual tap	color	turbidity	taste	odor	Coliform	algae
	(b) public tap	color	turbidity	taste	odor	Coliform	algae
	(c) open wells n/A	color	turbidity	taste	odor	Coliform	algae
	(d) tubewell/ handpump/ borewell	color	turbidity	taste	odor	Coliform	algae
	(e) water tankers	color	turbidity	taste	odor	Coliform	algae
	(f) bottled water	color	turbidity	taste	odor	Coliform	algae

25	Please specify the following details on availability and storage of drinking water in any particular week. <specify details>				
	Source	Days on which water is supplied	Timings & No. of hours supplied/ available	How many buckets (each containing 8-10 liters) of water is drawn	Collected water stored for no. of days
	(a) individual tap	every 3 days	1 hr.	5-6	3 days
	(b) public tap	every 3 days	1 hr	5-6	3 days
	(c) open wells n/a	–	–	–	–
	(d) tubewell/ handpump/ borewell	every day	–	5-6	1 day.
	(e) water tankers	every 3 days	1/2 hr	2-3	3 days
	(f) bottled water	–	–	–	–

26	In case of non-availability of Individual taps, distance (in meters) to travel to fetch drinking water				
	public tap	(a) 0-50	(b) 51-100	(c) 101-150	(d) > 150
	open wells n/A	(a) 0-50	(b) 51-100	(c) 101-150	(d) > 150
	water tankers	(a) 0-50	(b) 51-100	(c) 101-150	(d) > 150
	Others (specify)	(a) 0-50	(b) 51-100	(c) 101-150	(d) > 150
	Others (specify)	(a) 0-50	(b) 51-100	(c) 101-150	(d) > 150

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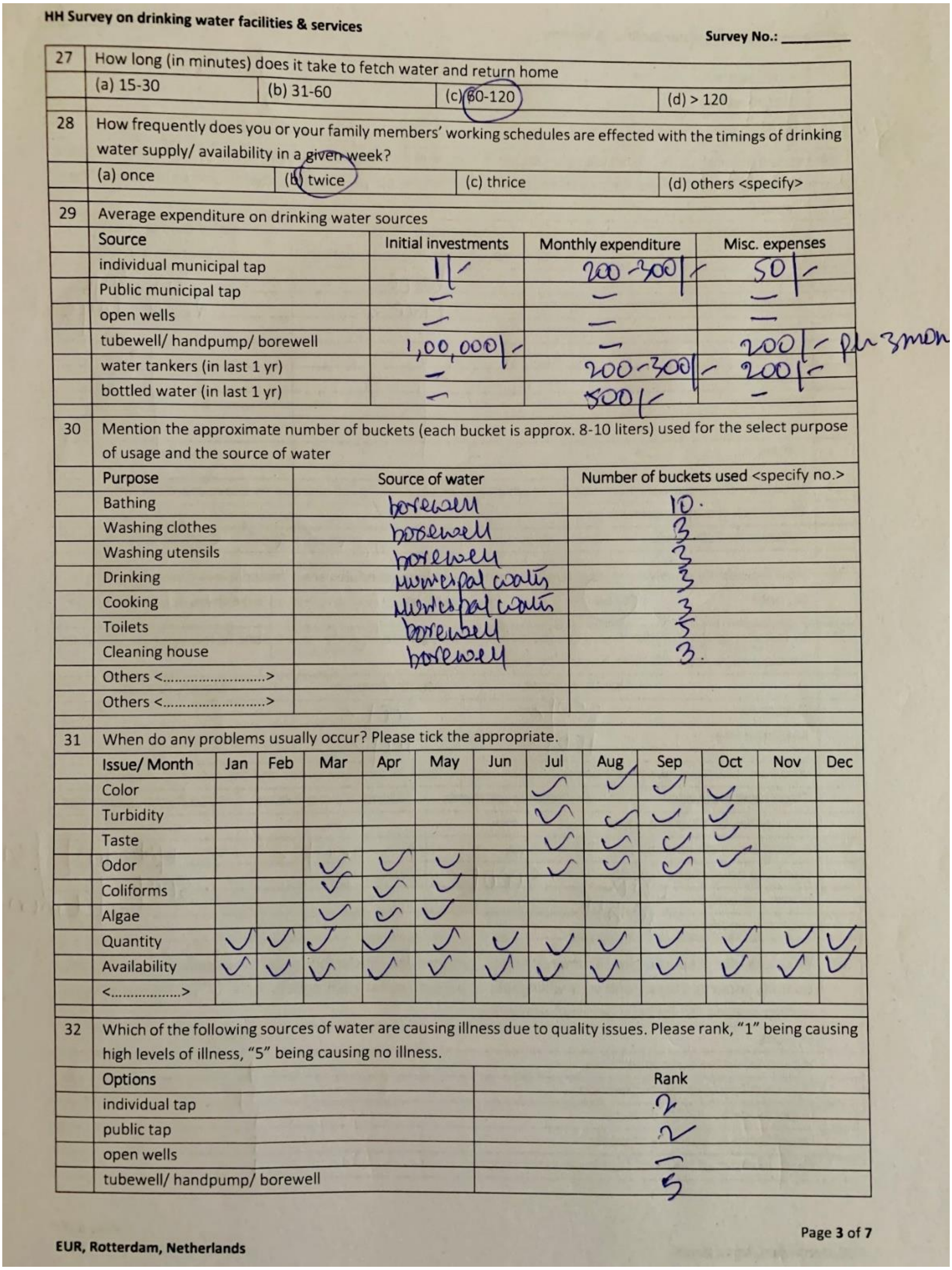
Figure 101: Filled-in household questionnaire (Pg. 2)



HH Survey on drinking water facilities & services **Survey No.:** ________

27	How long (in minutes) does it take to fetch water and return home			
	(a) 15-30	(b) 31-60	(c) 60-120	(d) > 120
28	How frequently does you or your family members' working schedules are effected with the timings of drinking water supply/ availability in a given week?			
	(a) once	(b) twice	(c) thrice	(d) others <specify>

29	Average expenditure on drinking water sources			
	Source	**Initial investments**	**Monthly expenditure**	**Misc. expenses**
	individual municipal tap	1/-	200-300/-	50/-
	Public municipal tap	–	–	–
	open wells	–	–	–
	tubewell/ handpump/ borewell	1,00,000/-	–	200/- per 3 mon
	water tankers (in last 1 yr)	–	200-300/-	200/-
	bottled water (in last 1 yr)	–	500/-	–

30	Mention the approximate number of buckets (each bucket is approx. 8-10 liters) used for the select purpose of usage and the source of water		
	Purpose	**Source of water**	**Number of buckets used <specify no.>**
	Bathing	borewell	10.
	Washing clothes	borewell	3
	Washing utensils	borewell	3
	Drinking	municipal water	3
	Cooking	municipal water	3
	Toilets	borewell	5
	Cleaning house	borewell	3.
	Others <.........................>		
	Others <.........................>		

31	When do any problems usually occur? Please tick the appropriate.												
	Issue/ Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
	Color							✓	✓	✓	✓		
	Turbidity							✓	✓	✓	✓		
	Taste							✓	✓	✓	✓		
	Odor			✓	✓	✓		✓	✓	✓	✓		
	Coliforms			✓	✓	✓							
	Algae			✓	✓	✓							
	Quantity	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Availability	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	<.................>												

32	Which of the following sources of water are causing illness due to quality issues. Please rank, "1" being causing high levels of illness, "5" being causing no illness.	
	Options	**Rank**
	individual tap	2
	public tap	2
	open wells	–
	tubewell/ handpump/ borewell	5

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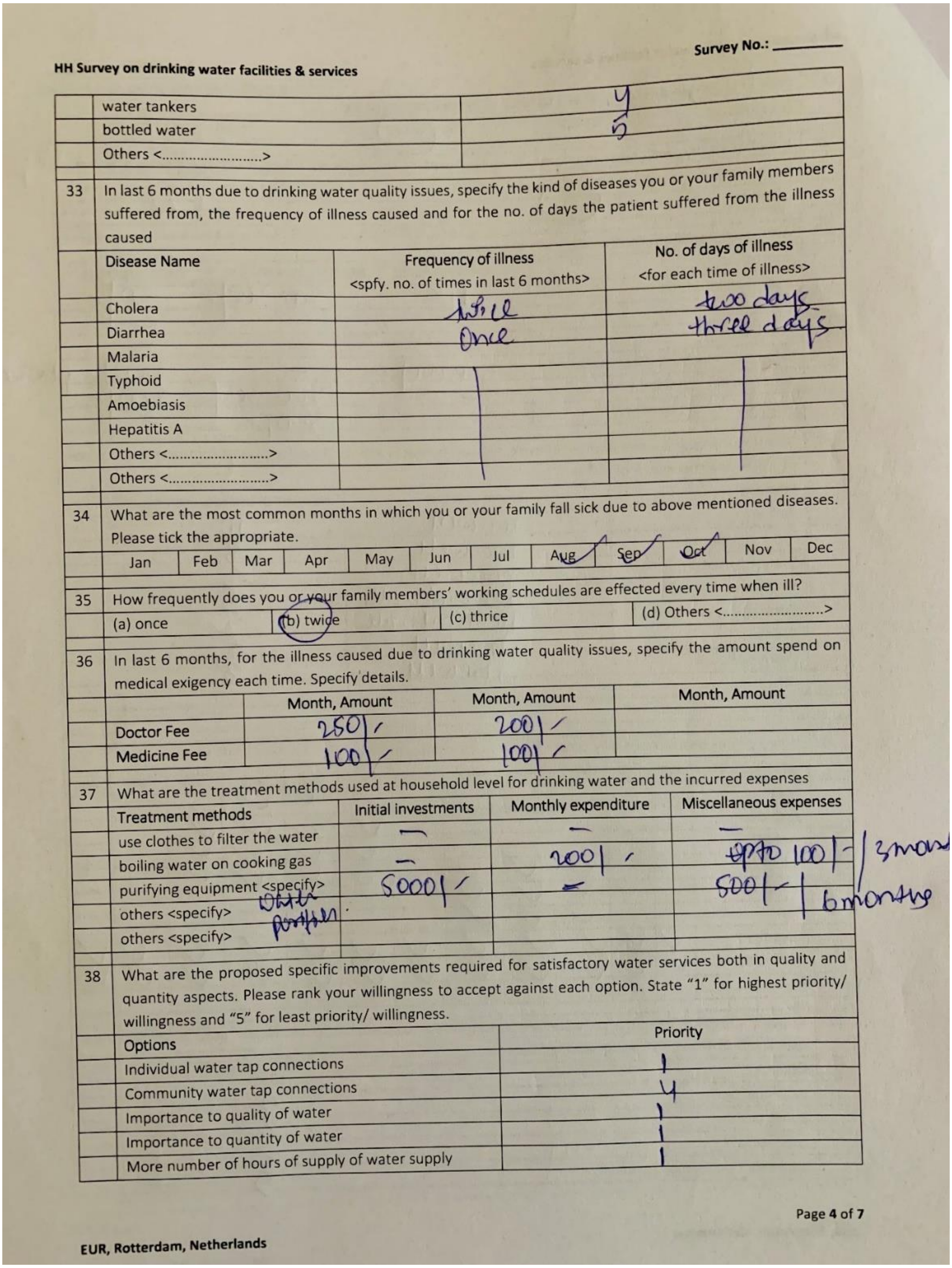
Figure 102: Filled-up household questionnaire (Pg. 3)



Survey No.: ________

HH Survey on drinking water facilities & services

	water tankers	4
	bottled water	5
	Others <........................>	

33 In last 6 months due to drinking water quality issues, specify the kind of diseases you or your family members suffered from, the frequency of illness caused and for the no. of days the patient suffered from the illness caused

Disease Name	Frequency of illness <spfy. no. of times in last 6 months>	No. of days of illness <for each time of illness>
Cholera	twice	two days
Diarrhea	Once	three days
Malaria		
Typhoid		
Amoebiasis		
Hepatitis A		
Others <........................>		
Others <........................>		

34 What are the most common months in which you or your family fall sick due to above mentioned diseases. Please tick the appropriate.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
							✓	✓	✓		

35 How frequently does you or your family members' working schedules are effected every time when ill?

(a) once (b) twice (c) thrice (d) Others <........................>

36 In last 6 months, for the illness caused due to drinking water quality issues, specify the amount spend on medical exigency each time. Specify details.

	Month, Amount	Month, Amount	Month, Amount
Doctor Fee	250/-	200/-	
Medicine Fee	100/-	100/-	

37 What are the treatment methods used at household level for drinking water and the incurred expenses

Treatment methods	Initial investments	Monthly expenditure	Miscellaneous expenses
use clothes to filter the water	—	—	—
boiling water on cooking gas	—	200/-	upto 100/- / 3 months
purifying equipment <specify> Water purifier	5000/-	—	500/- / 6 months
others <specify>			
others <specify>			

38 What are the proposed specific improvements required for satisfactory water services both in quality and quantity aspects. Please rank your willingness to accept against each option. State "1" for highest priority/ willingness and "5" for least priority/ willingness.

Options	Priority
Individual water tap connections	1
Community water tap connections	4
Importance to quality of water	1
Importance to quantity of water	1
More number of hours of supply of water supply	1

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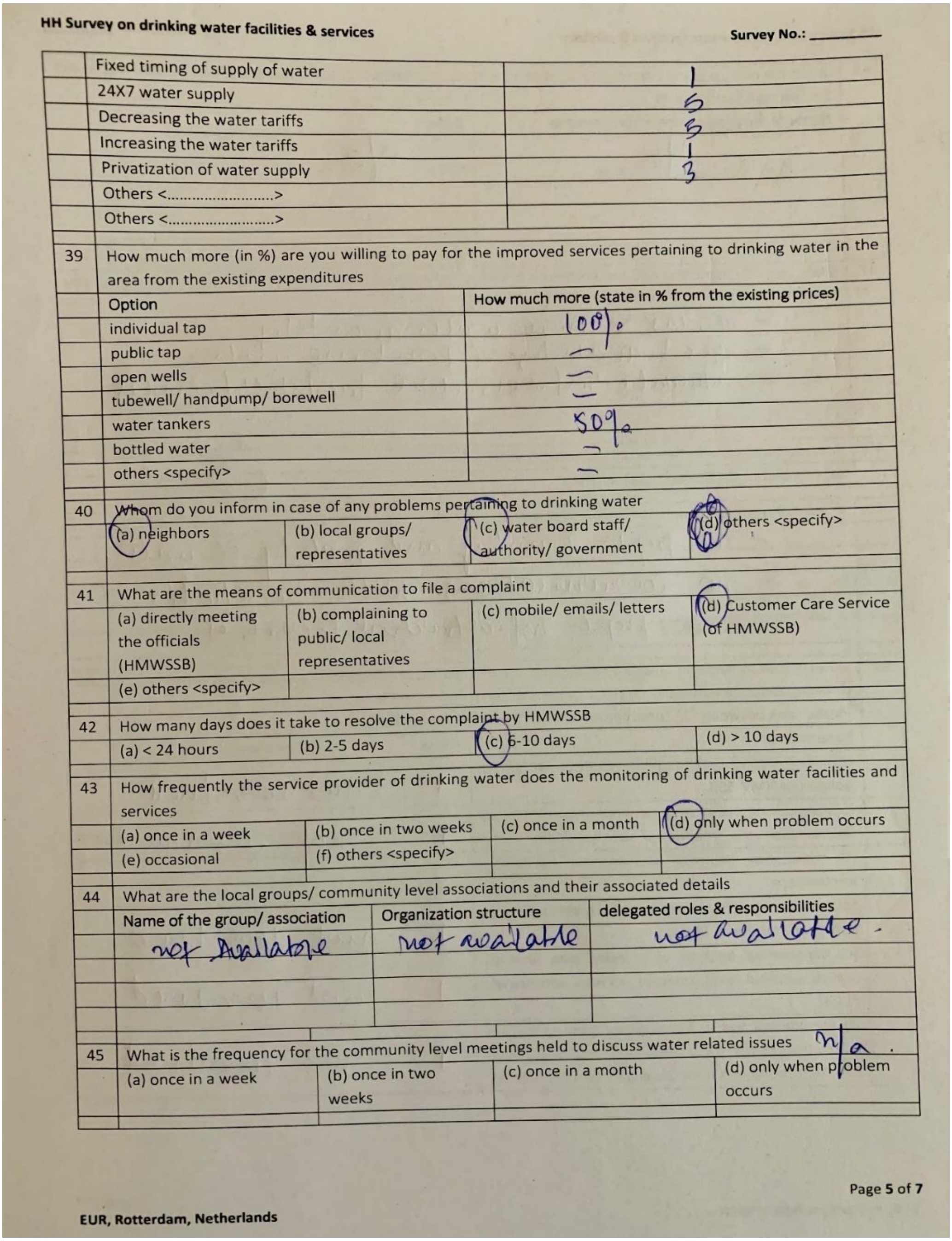
Figure 103: Filled-up household questionnaire (Pg. 4)



HH Survey on drinking water facilities & services **Survey No.:** ________

	Fixed timing of supply of water	1
	24X7 water supply	5
	Decreasing the water tariffs	3
	Increasing the water tariffs	1
	Privatization of water supply	3
	Others <........................>	
	Others <........................>	

39	How much more (in %) are you willing to pay for the improved services pertaining to drinking water in the area from the existing expenditures	
	Option	**How much more (state in % from the existing prices)**
	individual tap	100%
	public tap	–
	open wells	–
	tubewell/ handpump/ borewell	–
	water tankers	50%
	bottled water	–
	others <specify>	–

40	Whom do you inform in case of any problems pertaining to drinking water			
	(a) neighbors	(b) local groups/ representatives	(c) water board staff/ authority/ government	(d) others <specify>
41	What are the means of communication to file a complaint			
	(a) directly meeting the officials (HMWSSB)	(b) complaining to public/ local representatives	(c) mobile/ emails/ letters	(d) Customer Care Service (of HMWSSB)
	(e) others <specify>			
42	How many days does it take to resolve the complaint by HMWSSB			
	(a) < 24 hours	(b) 2-5 days	(c) 6-10 days	(d) > 10 days
43	How frequently the service provider of drinking water does the monitoring of drinking water facilities and services			
	(a) once in a week	(b) once in two weeks	(c) once in a month	(d) only when problem occurs
	(e) occasional	(f) others <specify>		

44	What are the local groups/ community level associations and their associated details		
	Name of the group/ association	**Organization structure**	**delegated roles & responsibilities**
	not available	not available	not available.

45	What is the frequency for the community level meetings held to discuss water related issues n/a.			
	(a) once in a week	(b) once in two weeks	(c) once in a month	(d) only when problem occurs

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Figure 104: Filled-in household questionnaire (Pg. 5)

HH Survey on drinking water facilities & services Survey No.: ________

46	What are the on-going community level programmes/ completed improvements related to drinking water for this community/ area

Name of the programme/ improvements	Details
n/a	n/a.

47	What were the concerns and requirements stated to the authorities pertaining to drinking water during any consultation meetings held at community/ area level
	- regular & more water quantity - good quality of drinking water - adequate infrastructure facilities/ services
48	Are you satisfied with the current service provider (HMWSSB)
	(a) complete satisfaction | (b) satisfied | (c) partial satisfaction | (d) not satisfied
49	If "partial satisfaction and not satisfied" at question 49, please state the reasons
	- no proper quantity and quality of water - no communications with households - no proper infrastructure facilities.
50	What is your perception on ***quality of decision-making process of HMWSSB*** in providing you safe and adequate drinking water facilities and services for each of the following parameters. Please rank between "1" (unacceptable) and "5" (highly acceptable)

Parameters	Rank	Comments/ Details
(a) in-line with vision and objectives statements/ any policies of HMWSSB	1	not considred
(b) considering the existing local conditions (through field assessments, interviews/ surveys/ FGDs)	1	not considred
(c) considering technical and financial feasibility/ implications	3.	
(d) considering services needs assessment (based on surveys/ interviews/ FDGs)	1	not considred.
(e) considering analysis of priority area analysis (based on field level analysis, surveys, interviews, FDGs)	1	not considred
(f) considering viable alternatives/ best practices/ innovative ideas/ local resources (by identifying, communicating and discussing with slum residents)	1	not considred

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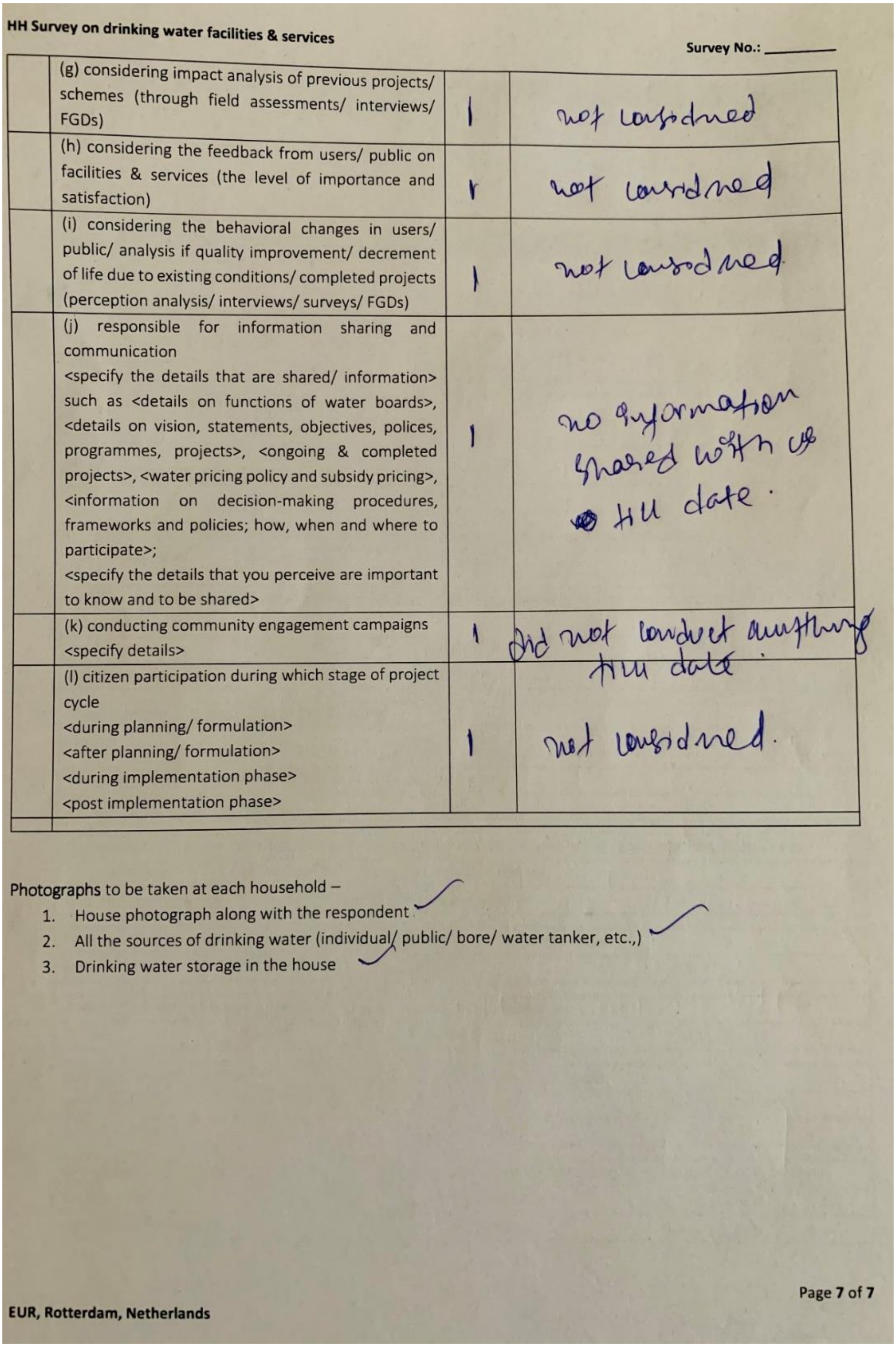
Figure 105: Filled-in household questionnaire (Pg. 6)



HH Survey on drinking water facilities & services

Survey No.: ________

	(g) considering impact analysis of previous projects/ schemes (through field assessments/ interviews/ FGDs)	1	not considered
	(h) considering the feedback from users/ public on facilities & services (the level of importance and satisfaction)	1	not considered
	(i) considering the behavioral changes in users/ public/ analysis if quality improvement/ decrement of life due to existing conditions/ completed projects (perception analysis/ interviews/ surveys/ FGDs)	1	not considered
	(j) responsible for information sharing and communication <specify the details that are shared/ information> such as <details on functions of water boards>, <details on vision, statements, objectives, polices, programmes, projects>, <ongoing & completed projects>, <water pricing policy and subsidy pricing>, <information on decision-making procedures, frameworks and policies; how, when and where to participate>; <specify the details that you perceive are important to know and to be shared>	1	no information shared with us till date.
	(k) conducting community engagement campaigns <specify details>	1	did not conduct anything till date.
	(l) citizen participation during which stage of project cycle <during planning/ formulation> <after planning/ formulation> <during implementation phase> <post implementation phase>	1	not considered.

Photographs to be taken at each household –

1. House photograph along with the respondent
2. All the sources of drinking water (individual/ public/ bore/ water tanker, etc.,)
3. Drinking water storage in the house

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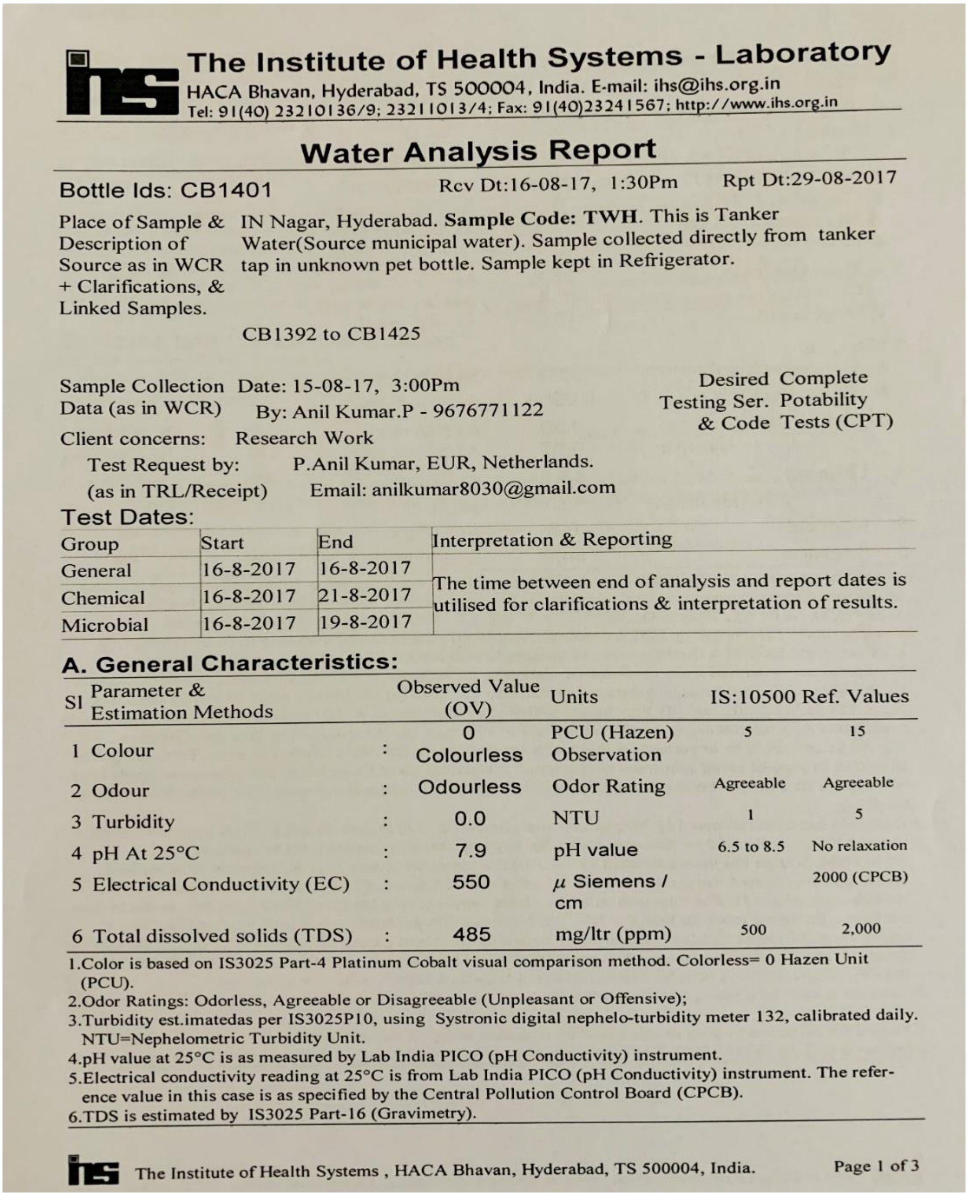
Figure 106: Filled-in household questionnaire (Pg. 7)

b. Drinking water quality

The following figures 107-115 provide the sample water quality reports prepared after laboratory testing of drinking water samples collected and submitted to The Institute of Health Systems, Hyderabad.



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Tel: 91(40) 23210136/9; 23211013/4; Fax: 91(40)23241567; http://www.ihs.org.in

Water Analysis Report

Bottle Ids: CB1401 Rcv Dt:16-08-17, 1:30Pm Rpt Dt:29-08-2017

Place of Sample & Description of Source as in WCR + Clarifications, & Linked Samples.: IN Nagar, Hyderabad. **Sample Code: TWH**. This is Tanker Water(Source municipal water). Sample collected directly from tanker tap in unknown pet bottle. Sample kept in Refrigerator.

CB1392 to CB1425

Sample Collection Data (as in WCR): Date: 15-08-17, 3:00Pm By: Anil Kumar.P - 9676771122

Desired Testing Ser. & Code: Complete Potability Tests (CPT)

Client concerns: Research Work

Test Request by: (as in TRL/Receipt) P.Anil Kumar, EUR, Netherlands. Email: anilkumar8030@gmail.com

Test Dates:

Group	Start	End	Interpretation & Reporting
General	16-8-2017	16-8-2017	The time between end of analysis and report dates is utilised for clarifications & interpretation of results.
Chemical	16-8-2017	21-8-2017	
Microbial	16-8-2017	19-8-2017	

A. General Characteristics:

Sl	Parameter & Estimation Methods		Observed Value (OV)	Units	IS:10500 Ref. Values	
1	Colour	:	0 Colourless	PCU (Hazen) Observation	5	15
2	Odour	:	Odourless	Odor Rating	Agreeable	Agreeable
3	Turbidity	:	0.0	NTU	1	5
4	pH At 25°C	:	7.9	pH value	6.5 to 8.5	No relaxation
5	Electrical Conductivity (EC)	:	550	μ Siemens / cm		2000 (CPCB)
6	Total dissolved solids (TDS)	:	485	mg/ltr (ppm)	500	2,000

1.Color is based on IS3025 Part-4 Platinum Cobalt visual comparison method. Colorless= 0 Hazen Unit (PCU).
2.Odor Ratings: Odorless, Agreeable or Disagreeable (Unpleasant or Offensive);
3.Turbidity est.imatedas per IS3025P10, using Systronic digital nephelo-turbidity meter 132, calibrated daily. NTU=Nephelometric Turbidity Unit.
4.pH value at 25°C is as measured by Lab India PICO (pH Conductivity) instrument.
5.Electrical conductivity reading at 25°C is from Lab India PICO (pH Conductivity) instrument. The reference value in this case is as specified by the Central Pollution Control Board (CPCB).
6.TDS is estimated by IS3025 Part-16 (Gravimetry).

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Figure 107: Drinking water from Tanker - Laboratory report (Pg. 1)

Water Analysis Report

Bottle Id:CB1401

B. Chemical Characteristics:

Sl	Parameter & Estimation Methods		Observed Value (OV)	Units	IS:10500 Ref. Values	
1	Alkalinity (Alk)					
a	Phenolpthalene Alk (P)	:	0	As $CaCO_3$ mg/l	200	600
b	Total Alkalinity (T)	:	122.4	As $CaCO_3$ mg/l		
c	Carbonate (CO_3)	:	0	As $CaCO_3$ mg/L		
d	Bicarbonate (HCO_3)	:	122.4	As $CaCO_3$ mg/L		
e	Hydroxides (OH)	:	0	As $CaCO_3$ mg/L		
2 a	Total Hardness	:	186.8	As $CaCO_3$ mg/l	200	600
b	Calcium	:	40.4	As Ca^{++} mg/L	75	200
c	Magnesium	:	103	As Mg^{++} mg/L	30	100
3	Nitrogen				Sum of (OV/GV) for NO_2 and NO_3 ≤ 1	
a	Ammonia (NH_3)	:	0.00	$NH_{3/4}$-N mg/L	0.5	No relaxation
b	Nitrite (NO_2)	:	0.0000	As NO_2-N mg/L	WHO: 0.9 mg/l as N	
c	Nitrate (NO_3)	:	0.30	As NO_3 mg/L	45	No relaxation
	As Nitorgen	:	0.07	As NO_3-N mg/L	10	No relaxation
4	Chloride	:	59.3	As Cl^- mg/L	250	1,000
	Chloride meq/l	:	1.67	meq/L		
5	Flouride	:	0.5	As F^- mg/L	1	1.5
6	Sulphates	:	64.9	As SO_4 mg/L	200	400

1.Alkalinity titration as in IS3025Pt23 or AWWA Simplified Procedures, using 50 ml water sample & colour indicators. Results expressed as equivalent to CaCO3 mg/L. If P=0, TAlk=HCO_3. IfP<½T, 2P=CO_3 & T-2P=HCO_3. If P=½T, TAlk=CO_3. IfP>½T,2P-T=OH, 2T-2P=CO_3 No HCO_3. If P=T, TAlk=OH.

2.Total hardness (TH) is est. by EDTA titration, using 50 ml sample & EBT indicator as in IS3025Pt21. Calcium is est. by EDTA titration using 50 ml sample with NaOH, P&R indicator as in IS3025Pt40. Mgnesium est. is derived from TH & Ca est. Followng IS3025Pt46. The US Environment Protection Agency (USEPA) classifies hardness of waters as (a) Soft: 0 to 75 mg/L, (b) Moderately hard: 76 to 150 mg/L, (c) Hard: 151 to 300 mg/L, and (d) Very hard: >300 mg/L. According to WHO Guidelines (2011): Consumers, in some cases, may tolerate water hardness in excess of 500 mg/l. Drinking-water can be a contributor to Ca & Mg intake and could be important for those who are marginally deficient of these minerals. There are insufficient data to suggest either minimum or maximum concentrations of Ca or Mg at this time, as adequate intake will depend on a range of other factors. Therefore, no guideline values are proposed (by WHO) for hardness, Ca & Mg.

3.Ammonia has been estimated by Nesslerization method as in IS3025 part-34 using 50 ml undistilled sample. Nitrite has been estimated as Nitrogen mg/ltr, by naphthylethylenediamine (NEDA) method as in IS3025Pt34. Nitrate has been estimated by ultraviolet spectrophotometry as in APHA simplified methods. WHO has not proposed any guideline value for ammonia as it is not of immediate health relevance (WHO guideline 4th ed p313). The reference value for nitrite shown here is based on WHO guideline, as the IS does not have a guideline value for this. For NO_3, IS10500 specifies guideline value as 45 mg/l of NO_3. This is equivalent to 10 mg as N. (d) WHO guideline regarding combined nitrate plus nitrite: The sum of the ratios of the observed value (OV) to its guideline value (GV) should not exceed 1. Conversions: NH_3=1.21589 X NH_3-N; NH_4=1.28786 X NH_4-N; NO_2= 3.28443 X NO_2-N; 0.2259 X NO_3 = NO_3-N.

4.Chloride is estd. by titrating 50 ml sample with 0.0141N $AgNO_3$ soln. & K_2CrO_4 indicator as in IS3025part 32.

5.Fluoride is estimated by drop titration & color matching using ORLABs Fluoride kit.

6.Sulfate is estd .by IS3025 Pt-24 Turbidity nethod based on nephelometry & calibration with known standards.

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Figure 108: Drinking water from Tanker - Laboratory report (Pg. 2)

Water Analysis Report

Bottle Id:CB1401

C. Bacteriological Analysis:

Sl Parameter & Estimation Methods		Observed Value (OV)	Units	IS:10500 Ref. Values	
1 Total Coliforms	:	0	MPN/100ml,(95%CI)		
2 Thermotolerant Coliforms	:	Absent	Absent / Present	Absent	Absent
3 E.coli	:	Absent	Absent / Present	Absent	Absent

1.Most probable number (MPN) & 95% Confidence Interval (CI), is estimated by results of 24h incubation of 5 MacConkey broth culture tubes for each of 3 (10, 1 & 0.1 ml) dilutions, using IS1622-1981 App-B, Table-3/4.
2.Positive culture of total coliforms, from the tube with maximum dilution, is incubated in briliant green lactose broth (BGLB) for 24 hours and examined for gas formation to identify thermo-tolerant coliforms.
3.Positive culture of total coliforms, from the tube with maximum dilution, are incubated in tryptone water for 24 hours, and examined, after adding Kovac's reagent for pink ring to identify presence of Ecoli.

D. Notes and Recommendations:

1. Results may be interpreted in accordance with the client's research project.

28/8/17

Sri G.Surendra, Director

INSTITUTE OF HEALTH SYSTEMS ★ HACA BHAVAN, HYD. ★

References:

IS10500. Indian Standard Drinking Water Specification. Second Revision. New Delhi: Bureau of Indian Standard (BIS); 2012 May; https://law.resource.org/pub/in/bis/S06/is.10500.2012.pdf

WHO. Guidelines for drinking-water quality. Fourth Edition. Geneva: WHO, 2011. http://www.who.int/water_sanitation_health/publications/2011/dwq_guidelines/en/

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Figure 109: Drinking water from Tanker - Laboratory report (Pg. 3)

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Water Analysis Report

Bottle Ids: CB1419 Rcv Dt:16-08-17, 1:30Pm Rpt Dt:29-08-2017

Place of Sample & Description of Source as in WCR + Clarifications, & Linked Samples.	IN Nagar, Hyderabad. **Sample Code: BWH**. Borewell details unknown. Borewell fitted with handpump. Borewell surrounding are unsanitory conditions. Sample collected directly from handpump in unknown pet bottle. Sample kept in Refrigerator. CB1392 to CB1425
Sample Collection Data (as in WCR)	Date: 15-08-17, 8:00Pm By: Anil Kumar.P - 9676771122
Desired Testing Ser. & Code	Groundwater Potability Tests (GPT)
Client concerns:	Research Work
Test Request by: (as in TRL/Receipt)	P.Anil Kumar, EUR, Netherlands. Email: anilkumar8030@gmail.com

Test Dates:

Group	Start	End	Interpretation & Reporting
General	16-8-2017	16-8-2017	The time between end of analysis and report dates is utilised for clarifications & interpretation of results.
Chemical	16-8-2017	21-8-2017	
Microbial	16-8-2017	19-8-2017	

A. General Characteristics:

Sl	Parameter & Estimation Methods		Observed Value (OV)	Units	IS:10500 Ref. Values	
1	Colour	:	0 Colourless	PCU (Hazen) Observation	5	15
2	Odour	:	Odourless	Odor Rating	Agreeable	Agreeable
3	Turbidity	:	0.0	NTU	1	5
4	pH At 25°C	:	7.2	pH value	6.5 to 8.5	No relaxation
5	Electrical Conductivity (EC)	:	1150	μ Siemens / cm		2000 (CPCB)
6	Total dissolved solids (TDS)	:	829	mg/ltr (ppm)	500	2,000

1.Color is based on IS3025 Part-4 Platinum Cobalt visual comparison method. Colorless= 0 Hazen Unit (PCU).
2.Odor Ratings: Odorless, Agreeable or Disagreeable (Unpleasant or Offensive);
3.Turbidity est.imatedas per IS3025P10, using Systronic digital nephelo-turbidity meter 132, calibrated daily. NTU=Nephelometric Turbidity Unit.
4.pH value at 25°C is as measured by Lab India PICO (pH Conductivity) instrument.
5.Electrical conductivity reading at 25°C is from Lab India PICO (pH Conductivity) instrument. The reference value in this case is as specified by the Central Pollution Control Board (CPCB).
6.TDS is estimated by IS3025 Part-16 (Gravimetry).

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Figure 110: Drinking water from Borewells/ Handpumps - Laboratory report (Pg.1)

Water Analysis Report

Bottle Id:CB1419

B. Chemical Characteristics:

Sl	Parameter & Estimation Methods		Observed Value (OV)	Units	IS:10500 Ref. Values	
1	Alkalinity (Alk)					
a	Phenolpthalene Alk (P)	:	0	As $CaCO_3$ mg/l	200	600
b	Total Alkalinity (T)	:	372.7	As $CaCO_3$ mg/l		
c	Carbonate (CO_3)	:	0	As $CaCO_3$ mg/L		
d	Bicarbonate (HCO_3)	:	372.7	As $CaCO_3$ mg/L		
e	Hydroxides (OH)	:	0	As $CaCO_3$ mg/L		
2 a	Total Hardness	:	398.9	As $CaCO_3$ mg/l	200	600
b	Calcium	:	123.2	As Ca^{++} mg/L	75	200
c	Magnesium	:	22.1	As Mg^{++} mg/L	30	100
3	Nitrogen				Sum of (OV/GV) for NO_2 and NO_3 $\leq$ 1	
a	Ammonia (NH_3)	:	0.00	$NH_{3/4}$-N mg/L	0.5	No relaxation
b	Nitrite (NO_2)	:	0.0000	As NO_2-N mg/L	WHO: 0.9 mg/l as N	
c	Nitrate (NO_3)	:	36.60	As NO_3 mg/L	45	No relaxation
	As Nitorgen	:	8.27	As NO_3-N mg/L	10	No relaxation
4	Chloride	:	135.3	As Cl^- mg/L	250	1,000
	Chloride meq/l	:	3.81	meq/L		
5	Flouride	:	0.5	As F^- mg/L	1	1.5
6	Sulphates	:	135.2	As SO_4 mg/L	200	400
7	Total Iron	:	0.2	As Fe mg/L	0.3	1
8	Manganese	:	0.1	As Mn mg/L	0.1	0.3

1.Alkalinity titration as in IS3025Pt23 or AWWA Simplified Procedures, using 50 ml water sample & colour indicators. Results expressed as equivalent to CaCO3 mg/L. If P=0, TAlk=HCO_3. IfP<½T, 2P=CO_3 & T-2P=HCO_3. If P=½T, TAlk=CO_3. IfP>½T,2P-T=OH, 2T-2P=CO_3 No HCO_3. If P=T, TAlk=OH.

2.Total hardness (TH) is est. by EDTA titration, using 50 ml sample & EBT indicator as in IS3025Pt21. Calcium is est. by EDTA titration using 50 ml sample with NaOH, P&R indicator as in IS3025Pt40. Mgnesium est. is derived from TH & Ca est. Followng IS3025Pt46. The US Environment Protection Agency (USEPA) classifies hardness of waters as (a) Soft: 0 to 75 mg/L, (b) Moderately hard: 76 to 150 mg/L, (c) Hard: 151 to 300 mg/L, and (d) Very hard: >300 mg/L. According to WHO Guidelines (2011): Consumers, in some cases, may tolerate water hardness in excess of 500 mg/l. Drinking-water can be a contributor to Ca & Mg intake and could be important for those who are marginally deficient of these minerals. There are insufficient data to suggest either minimum or maximum concentrations of Ca or Mg at this time, as adequate intake will depend on a range of other factors. Therefore, no guideline values are proposed (by WHO) for hardness, Ca & Mg.

3.Ammonia has been estimated by Nesslerization method as in IS3025 part-34 using 50 ml undistilled sample. Nitrite has been estimated as Nitrogen mg/ltr, by naphthylethylenediamine (NEDA) method as in IS3025Pt34. Nitrate has been estimated by ultraviolet spectrophotometry as in APHA simplified methods. WHO has not proposed any guideline value for ammonia as it is not of immediate health relevance (WHO guideline 4th ed p313). The reference value for nitrite shown here is based on WHO guideline, as the IS does not have a guideline value for this. For NO_3, IS10500 specifies guideline value as 45 mg/l of NO_3. This is equivalent to 10 mg as N. (d) WHO guideline regarding combined nitrate plus nitrite: The sum of the ratios of the observed value (OV) to its guideline value (GV) should not exceed 1. Conversions: NH_3=1.21589 X NH_3-N; NH_4=1.28786 X NH_4-N; NO_2= 3.28443 X NO_2-N; 0.2259 X NO_3 = NO_3-N.

4.Chloride is estd. by titrating 50 ml sample with 0.0141N $AgNO_3$ soln. & K_2CrO_4 indicator as in IS3025part 32.

5.Fluoride is estimated by drop titration & color matching using ORLABs Fluoride kit.

6.Sulfate is estd .by IS3025 Pt-24 Turbidity nethod based on nephelometry & calibration with known standards.

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Figure 111: Drinking water from Borewells/ Handpumps - Laboratory report (Pg. 2)

Water Analysis Report

Bottle Id:CB1419

7.Total Iron is estimated by ORLABS OR-Fe-01 color chart comparator kit..
8.Manganese is estimated by ORLABS OR-Mn-01 color chart comparator kit.

C. Bacteriological Analysis:

Sl Parameter & Estimation Methods		Observed Value (OV)	Units	IS:10500 Ref. Values	
1 Total Coliforms	:	11(2,25)	MPN/100ml,(95%CI)		
2 Thermotolerant Coliforms	:	Present	Absent / Present	Absent	Absent
3 E.coli	:	Absent	Absent / Present	Absent	Absent

1.Most probable number (MPN) & 95% Confidence Interval (CI), is estimated by results of 24h incubation of 5 MacConkey broth culture tubes for each of 3 (10, 1 & 0.1 ml) dilutions, using IS1622-1981 App-B, Table-3/4.
2.Positive culture of total coliforms, from the tube with maximum dilution, is incubated in briliant green lactose broth (BGLB) for 24 hours and examined for gas formation to identify thermo-tolerant coliforms.
3.Positive culture of total coliforms, from the tube with maximum dilution, are incubated in tryptone water for 24 hours, and examined, after adding Kovac's reagent for pink ring to identify presence of Ecoli.

D. Notes and Recommendations:

1. Results may be interpreted in accordance with the client's research project.

Sri G.Surendra, Director

References:

IS10500. Indian Standard Drinking Water Specification. Second Revision. New Delhi: Bureau of Indian Standard (BIS); 2012 May; https://law.resource.org/pub/in/bis/S06/is.10500.2012.pdf

WHO. Guidelines for drinking-water quality. Fourth Edition. Geneva: WHO, 2011. http://www.who.int/water_sanitation_health/publications/2011/dwq_guidelines/en/

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Figure 112: Drinking water from Borewells/ Handpumps - Laboratory report (Pg. 3)

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HACA Bhavan, Hyderabad, TS 500004, India. E-mail: ihs@ihs.org.in
Tel: 91(40) 23210136/9; 23211013/4; Fax: 91(40)23241567; http://www.ihs.org.in

Water Analysis Report

Bottle Ids: CB1400 Rcv Dt:16-08-17, 1:30Pm Rpt Dt:29-08-2017

Place of Sample & Description of Source as in WCR + Clarifications, & Linked Samples.: IN Nagar, Hyderabad. **Sample Code: MWH**. Sample collected directly from municipal tap in unknown pet bottle. Sample kept in Refrigerator.

CB1392 to CB1425

Sample Collection Data (as in WCR): Date: 15-08-17, 4:00Pm By: Anil Kumar.P - 9676771122

Desired Testing Ser. & Code: Complete Potability Tests (CPT)

Client concerns: Research Work

Test Request by: P.Anil Kumar, EUR, Netherlands.
(as in TRL/Receipt) Email: anilkumar8030@gmail.com

Test Dates:

Group	Start	End	Interpretation & Reporting
General	16-8-2017	16-8-2017	The time between end of analysis and report dates is utilised for clarifications & interpretation of results.
Chemical	16-8-2017	21-8-2017	
Microbial	16-8-2017	19-8-2017	

A. General Characteristics:

Sl	Parameter & Estimation Methods		Observed Value (OV)	Units	IS:10500 Ref. Values	
1	Colour	:	0 Colourless	PCU (Hazen) Observation	5	15
2	Odour	:	Chlorine smell	Odor Rating	Agreeable	Agreeable
3	Turbidity	:	0.0	NTU	1	5
4	pH At 25°C	:	7.7	pH value	6.5 to 8.5	No relaxation
5	Electrical Conductivity (EC)	:	550	μ Siemens / cm		2000 (CPCB)
6	Total dissolved solids (TDS)	:	313	mg/ltr (ppm)	500	2,000

1.Color is based on IS3025 Part-4 Platinum Cobalt visual comparison method. Colorless= 0 Hazen Unit (PCU).
2.Odor Ratings: Odorless, Agreeable or Disagreeable (Unpleasant or Offensive);
3.Turbidity est.imatedas per IS3025P10, using Systronic digital nephelo-turbidity meter 132, calibrated daily. NTU=Nephelometric Turbidity Unit.
4.pH value at 25°C is as measured by Lab India PICO (pH Conductivity) instrument.
5.Electrical conductivity reading at 25°C is from Lab India PICO (pH Conductivity) instrument. The reference value in this case is as specified by the Central Pollution Control Board (CPCB).
6.TDS is estimated by IS3025 Part-16 (Gravimetry).

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Figure 113: Drinking water from Individual taps - Laboratory report (Pg. 1)

Water Analysis Report

Bottle Id:CB1400

B. Chemical Characteristics:

Sl	Parameter & Estimation Methods		Observed Value (OV)	Units	IS:10500 Ref. Values	
1	Alkalinity (Alk)					
a	Phenolpthalene Alk (P)	:	0	As $CaCO_3$ mg/l	200	600
b	Total Alkalinity (T)	:	175.7	As $CaCO_3$ mg/l		
c	Carbonate (CO_3)	:	0	As $CaCO_3$ mg/L		
d	Bicarbonate (HCO_3)	:	175.7	As $CaCO_3$ mg/L		
e	Hydroxides (OH)	:	0	As $CaCO_3$ mg/L		
2 a	Total Hardness	:	191.9	As $CaCO_3$ mg/l	200	600
b	Calcium	:	46.9	As Ca^{++} mg/L	75	200
c	Magnesium	:	18.4	As Mg^{++} mg/L	30	100
3	Nitrogen				Sum of (OV/GV) for NO_2 and NO_3 ≤ 1	
a	Ammonia (NH_3)	:	0.00	$NH_{3/4}$-N mg/L	0.5	No relaxation
b	Nitrite (NO_2)	:	0.0000	As NO_2-N mg/L	WHO: 0.9 mg/l as N	
c	Nitrate (NO_3)	:	0.90	As NO_3 mg/L	45	No relaxation
	As Nitorgen	:	0.20	As NO_3-N mg/L	10	No relaxation
4	Chloride	:	57	As Cl^- mg/L	250	1,000
	Chloride meq/l	:	1.61	meq/L		
5	Flouride	:	0.5	As F^- mg/L	1	1.5
6	Sulphates	:	55	As SO_4 mg/L	200	400

1.Alkalinity titration as in IS3025Pt23 or AWWA Simplified Procedures, using 50 ml water sample & colour indicators. Results expressed as equivalent to CaCO3 mg/L. If P=0, TAlk=HCO_3. IfP<½T, 2P=CO_3 & T-2P=HCO_3. If P=½T, TAlk=CO_3. IfP>½T,2P-T=OH, 2T-2P=CO_3 No HCO_3. If P=T, TAlk=OH.

2.Total hardness (TH) is est. by EDTA titration, using 50 ml sample & EBT indicator as in IS3025Pt21. Calcium is est. by EDTA titration using 50 ml sample with NaOH, P&R indicator as in IS3025Pt40. Mgnesium est. is derived from TH & Ca est. Followng IS3025Pt46. The US Environment Protection Agency (USEPA) classifies hardness of waters as (a) Soft: 0 to 75 mg/L, (b) Moderately hard: 76 to 150 mg/L, (c) Hard: 151 to 300 mg/L, and (d) Very hard: >300 mg/L. According to WHO Guidelines (2011): Consumers, in some cases, may tolerate water hardness in excess of 500 mg/l. Drinking-water can be a contributor to Ca & Mg intake and could be important for those who are marginally deficient of these minerals. There are insufficient data to suggest either minimum or maximum concentrations of Ca or Mg at this time, as adequate intake will depend on a range of other factors. Therefore, no guideline values are proposed (by WHO) for hardness, Ca & Mg.

3.Ammonia has been estimated by Nesslerization method as in IS3025 part-34 using 50 ml undistilled sample. Nitrite has been estimated as Nitrogen mg/ltr, by naphthylethylenediamine (NEDA) method as in IS3025Pt34. Nitrate has been estimated by ultraviolet spectrophotometry as in APHA simplified methods. WHO has not proposed any guideline value for ammonia as it is not of immediate health relevance (WHO guideline 4th ed p313). The reference value for nitrite shown here is based on WHO guideline, as the IS does not have a guideline value for this. For NO_3, IS10500 specifies guideline value as 45 mg/l of NO_3. This is equivalent to 10 mg as N. (d) WHO guideline regarding combined nitrate plus nitrite: The sum of the ratios of the observed value (OV) to its guideline value (GV) should not exceed 1. Conversions: NH_3=1.21589 X NH_3-N; NH_4=1.28786 X NH_4-N; NO_2= 3.28443 X NO_2-N; 0.2259 X NO_3 = NO_3-N.

4.Chloride is estd. by titrating 50 ml sample with 0.0141N $AgNO_3$ soln. & K_2CrO_4 indicator as in IS3025part 32.

5.Fluoride is estimated by drop titration & color matching using ORLABs Fluoride kit.

6.Sulfate is estd .by IS3025 Pt-24 Turbidity nethod based on nephelometry & calibration with known standards.

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Figure 114: Drinking water from Individual taps - Laboratory report (Pg. 2)

Water Analysis Report

Bottle Id:CB1400

C. Bacteriological Analysis:

Sl	Parameter & Estimation Methods		Observed Value (OV)	Units	IS:10500 Ref. Values	
1	Total Coliforms	:	23(7,70)	MPN/100ml,(95%CI)		
2	Thermotolerant Coliforms	:	Present	Absent / Present	Absent	Absent
3	E.coli	:	Present	Absent / Present	Absent	Absent

1.Most probable number (MPN) & 95% Confidence Interval (CI), is estimated by results of 24h incubation of 5 MacConkey broth culture tubes for each of 3 (10, 1 & 0.1 ml) dilutions, using IS1622-1981 App-B, Table-3/4.
2.Positive culture of total coliforms, from the tube with maximum dilution, is incubated in briliant green lactose broth (BGLB) for 24 hours and examined for gas formation to identify thermo-tolerant coliforms.
3.Positive culture of total coliforms, from the tube with maximum dilution, are incubated in tryptone water for 24 hours, and examined, after adding Kovac's reagent for pink ring to identify presence of Ecoli.

D. Notes and Recommendations:

1. Results may be interpreted in accordance with the client's research project.

28/4/19

Sri G.Surendra, Director

INSTITUTE OF HEALTH SYSTEMS HACA BHAVAN, HYD.

References:

IS10500. Indian Standard Drinking Water Specification. Second Revision. New Delhi: Bureau of Indian Standard (BIS); 2012 May; https://law.resource.org/pub/in/bis/S06/is.10500.2012.pdf.

WHO. Guidelines for drinking-water quality. Fourth Edition. Geneva: WHO, 2011. http://www.who.int/water_sanitation_health/publications/2011/dwq_guidelines/en/

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Figure 115: Drinking water from Individual taps - Laboratory report (Pg. 3)

c. Decision making procedures followed by Government agencies to provide drinking water facilities and services

The questionnaire which was administered at institutional (HMWSSB) level, which is responsible for providing drinking water services and facilities, collected the primary information pertaining to quality of decision making processes. The following table 88 provide the Stakeholders' responses collected during focus group discussions

Table 88: Stakeholders' responses during focused group discussions

#	Stakeholder	Responses
1	Director, Projects, HMWSSB	At Central level, CPHEO guidelines are followed. At State level, mandate of state government to provide safe ad adequate drinking water based on the guidelines given by Public Health Engineering, and Public Works Department. Initial infrastructure and services to the slum areas are provided by HMWSSB - the provision of infrastructure facilities and services in these notified Informal settlements/ slum areas; In order to classify the slum areas as notified slum areas, there shall be provision of minimum infrastructure facilities and services. Decision making process in providing infrastructure and services to the slum areas – 1. Agitations, Media, Communication of needs by general public, media, Corporators – Based on these, DPRs are prepared 2. DPRs are prepared as per CPHEO manuals 3. Technical clearances and financial clearances are taken 4. Technical clearances include water supply demand, technical demand, feasibility is analyzed – piped water, mobile water, borewells 5. Finding sources of funding - Funding agency (include analyzing capital recovery, O&M cost recovery) 6. Administrative sanctions 7. Technical sanctions 8. Call for tenders for construction activities/ Selection of contractor 9. Execution of works by the contractor 10. Quality checks of construction works of the contractor by water board 11. Water supply services by HMWSSB

		12. Awareness programmes at slum areas – water quality monitoring system – slums are given high priority
2	Director, Personnel & Administration Department	Conduct training programmes to employees – 1000 people - *Induction training to new recruits on regular basis* - *ASCI/ ESCI/ MCHRDA* - *In-house – basic training activities of the board; job specific technical trainings* - *MCR/ Outhouse – non-technical training (management, stress)* Individuals submit self-assessment reports – reporting officers will do the evaluation – this is as part of CR on annual basis Guidelines – Business power board proceedings Act no. 1959 Service regulations of water board Cadre strength + Organization structure Vision statement Government rules No role of P&A in decision making Annual estimates are given for basic trainings and related activities Sanctioned positions are not sufficient for existing operations – no chances are taken place after 1991-92 In case of any new establishment – new positions are sanctioned, and as per norms regular positions
3	Director, Finance & Accounts	Own income sources include User charges, new connection charges, Upgradation charges – XXX crores – meet the Other sources of income include interest, sale of scrap, deposit contributions, supervision charges, profit margins, etc. State level funds Two types of project funding – Grants and Loans Grants for minor schemes, welfare schemes, summer action plans Loans for major schemes; some of the examples of major schemes include source augmentation Majorly, it is more of loans, and less of grants HUDCO loans World Bank grants Expenditures – power/ pumping, staff salaries/ remuneration, operation & maintenance

		No project financing No role of F&A in decision making process Only accounting is done No major role of F&A Annual Financial Statements – Revenue Budget, Expenditure Budget, Deficit Recovery is below 20-30
4	Director, Projects/ Planning	Board of 11 members CM -> Ministers -> CS -> Directors (Finance HMWSSB, GHMC Commissioner, Sec MAUD, PS Irritation, PS Finance, MD HMWSSB, Director Health, Director Technical HMWSSB) *Decision making process:* 1. Requirements - Proposals from government/ NGOs/ Communities/ Local politicians 2. HoD (MD, HMWSSB) receives proposals 3. Depending on the size and type of the project the MD decides on who to take it up 4. In case of improvements to the existing infrastructure facilities and services, it goes to Director Technical/ Operational 5. In case of new/ large scale projects, it goes to Director Projects At Circle office, CGM (OM/ Projects) Concerned area, GM (OM/ Projects) 6. Project Divisions (PD) each Circle (headed by GM), and Sub-divisional project office (Dy. GM/ Managers) – Prepare survey report and estimations (include existing network, requirements, capital cost estimates, revenue estimates, budget tapping, technical drawings, etc. 7. Depending on the cost estimates, it either goes to MD or Board of Directors for approvals 8. More than 10 crores goes to Board of Directors for approvals 9. Below 10 crores, approvals given by MD 10. Proposals – Power of sanction for MD – 5 Crores 11. Tenders – 2 Crores, Tender committee approvals are required Ex: water supply distribution network project for the peripheral circles of GHMC –

		Third party quality assurance and quality control services for the works of constructions of RCC service reservoirs and providing inlet, outlet, and distribution network in different circles
5	Director, Transmission	1. There will be a SC/ST plan to take up projects for this set of population 2. HUDCO projects 3. No recent projects for slums 4. Infrastructure is still there for the slum areas; issues pertaining to services 5. Vision is to give delay 6. Lack of distribution network storage facilities 7. Customer feedback (MCC) (only for Operation & Maintenance) 8. No analysis for initiating projects 9. Senior engineer committee will do the best practice study 10. DCB – Demand Collection Balance
6	Director, Operations & Maintenance/ Technical	1. Responsible for laying out the water lines 2. Based on government schemes 3. Complaints received through MCC, dial, Meet MD 4. Problems such as tail-end points, pollutions, damaged pipes, leakages, replacements, change of alignments due to road cutting, construction of flyovers 5. Distribution network is done by this division – circle -> division -> subdivision -> sections (from slums through phone/ MCC/ Section/ Social media/ Emails) -> areas 6. Complaints received sent to Manager (Area level) 7. Manager (Area wise) [work inspectors/ line men for inspection does field verifications] -> Dy. GM -> GM [Monitoring authority] 8. Field level observations include geotagging of works, feedback from consumers, cross checking from consumers **Decision making process:** 1. Public representatives/ local communities give the representation given to water board 2. Served by engineers 3. Inspect the area

		4. Prepare the technical feasibility report (covering the water allocation assessment ward wise, population, HH, feasibility – gravity, pumps, reservoirs) 5. Financial estimates 6. Technical (wing) verifies 7. MD/ Directors/ Board of Directors approvals (depending on the value of the financial estimates)
7	P&A Wing	Primary duty – to supply potable water to residents of Hyderabad city including planning, designing, construction, maintenance To also manage/ maintain sewerage system Total of 6000 staff covering engineering, technical and non-technical P&A, F&A, Engineering, Sub-ordinate services, non-gazette, field staff; QAT wing, EDP (IT related) (Electronic Data Processing)
8		1. Complaints received from corporates (GHMC/ LC) 2. Local demographical analysis – Family details are captured (HH, Percapita/ per day = lpcd) 3. Estimates for drinking water pipelines 4. Funds required (budget from MLA, Local Corporators, Government, Department) 5. Requirements (150 lpcd X HH X Total population) a. 20 lpcd – drinking b. 35 lpcd – bathing c. 40 lpcd – washing d. 20 lpcd – cooking e. 30 lpcd – washroom 6. Project wing prepares DPRs, and send it to HoD 7. Raw source -> WPT -> BR -> Feeder -> Reservoirs -> Sub-Feeder -> HH
9	Director, Distribution division/ STP	1. Raw sources (Nagarjuna Sagar, Krishna, Godavari, Singur, Osman Sagar, Himayat Sagar, Manjeera) 2. WTP with different capacities (Location: Patancheru, Asif Nagar, Rangareddy Guddem, Godavari) 3. Krishna and Godavari has balancing reservoirs, before the water is sent to transmission lines 4. For other sources of drinking water, it is directly sent to consumers/ residents 5. From transmission lines, the water is sent to reservoirs 6. From reservoirs, the water is sent to sub-feeders, and HH 7. There are QAT for distribution systems (3 of them) - 1 centralized QAT at Asif Nagar

		8. At slum level a. Daily water quality testing is done b. Different sample points in slum and non-slum areas c. Onsite chlorination tests d. Chlorination tests are done by field officers with chlorinometer e. GM (QAT) -> GM (Divisional level, O&M) -> Subdivisions (3 managers) -> Sections (3) (each offices will take care of 7K consumers) f. Typical problems include leakages, aged pipes, and pit taps
10	Quality Assurance Testing Unit, Asif Nagar	There are 7 laboratories Testing is done every day in treatment plants, reservoirs, distribution network Testing is done monthly for source/ raw water There are standard operating procedures (SOPs)

Annexure 8 | Workflow

a. Existing decision making procedures

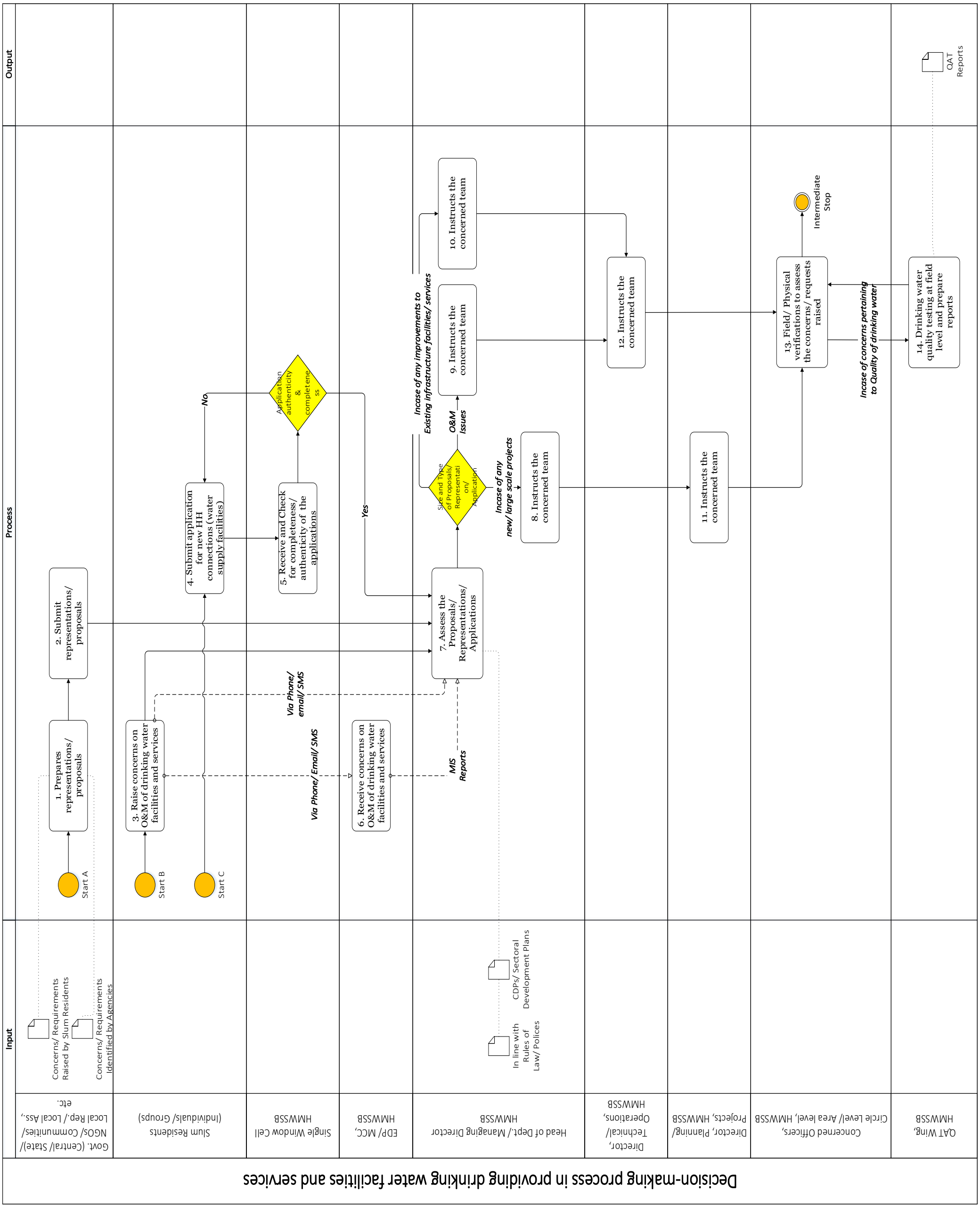

Figure 116: Existing decision making procedures (Part 1)

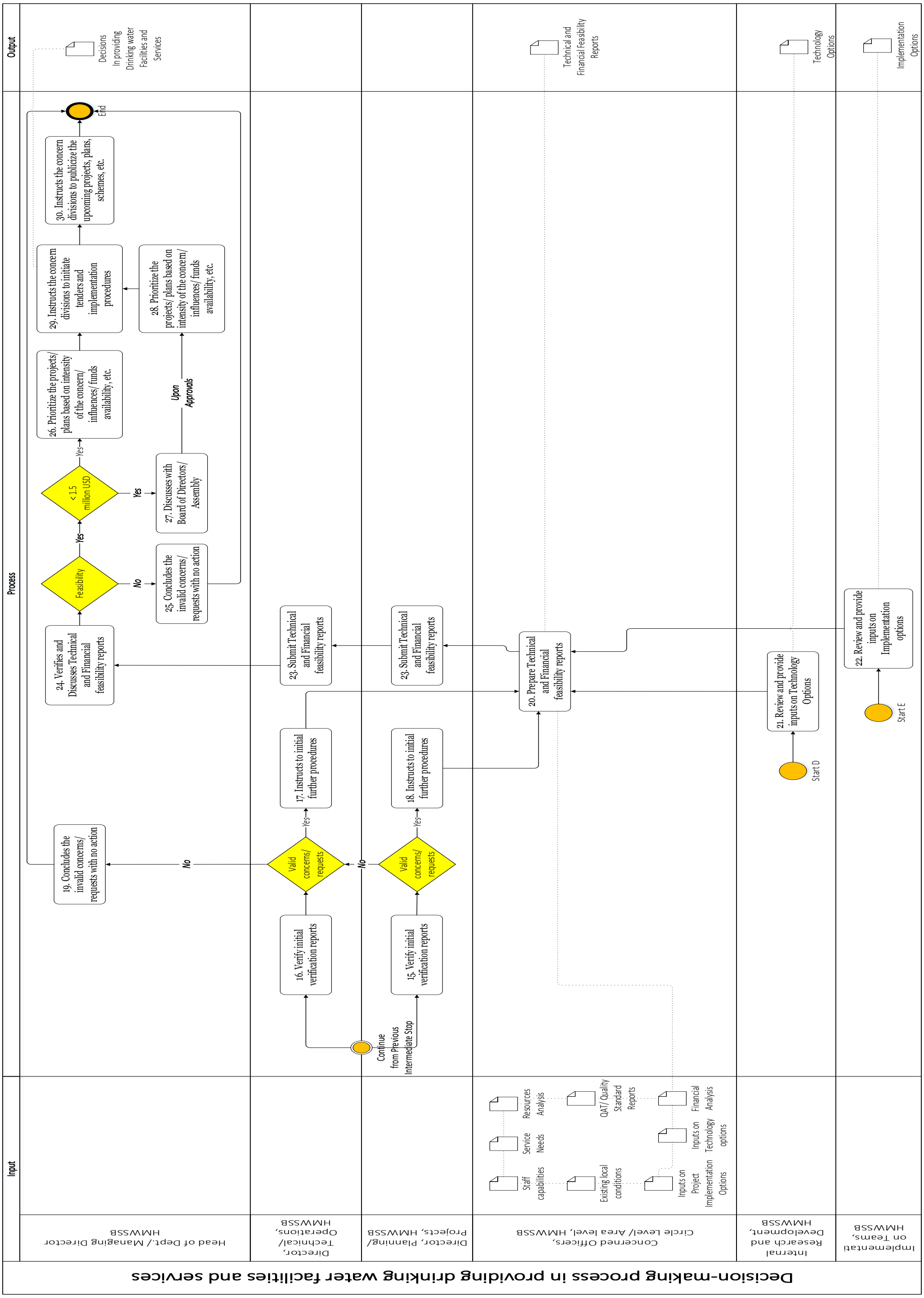

Figure 117: Existing decision making procedures (Part 2)

b. Proposed decision making procedures

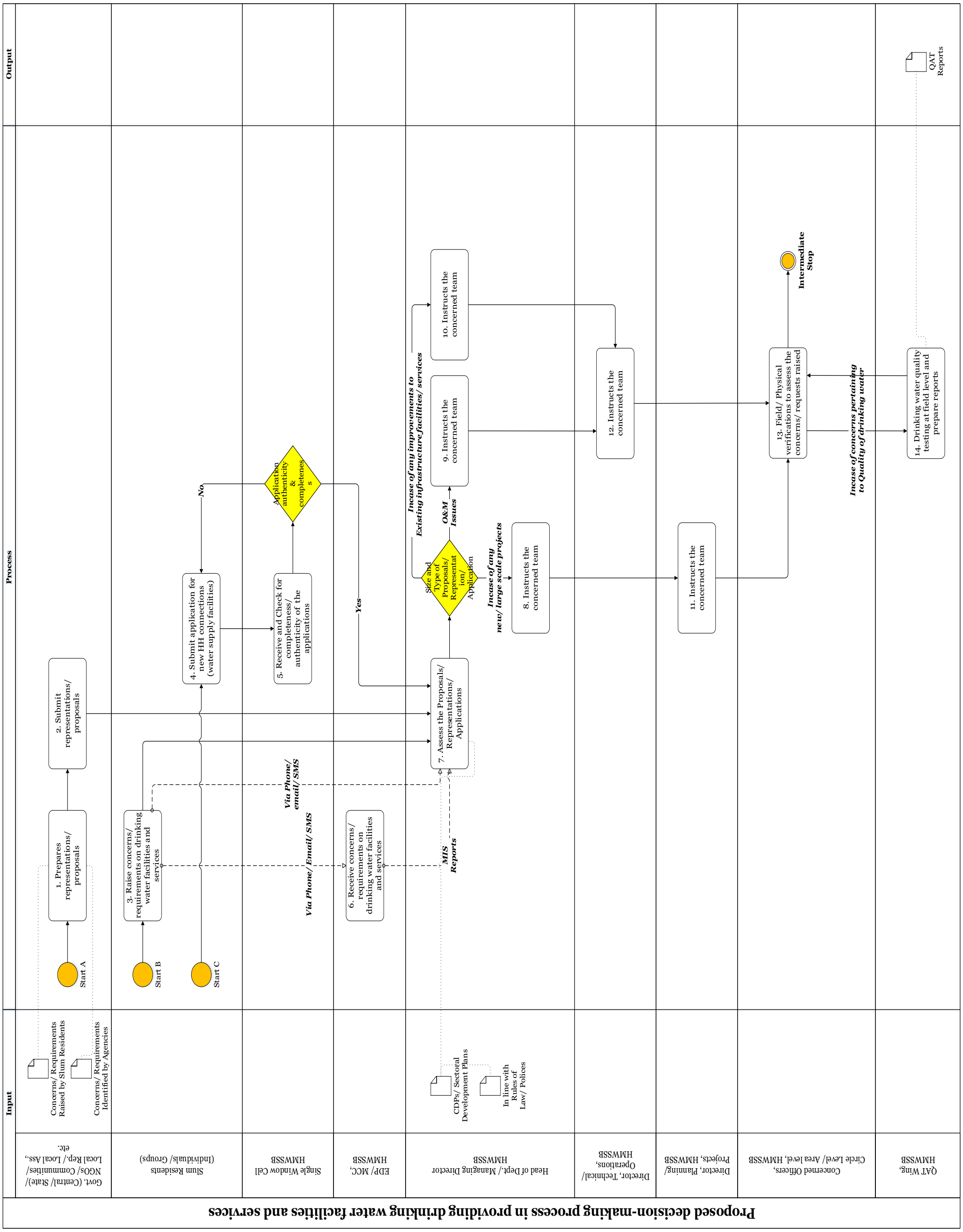

Figure 118: Proposed decision making procedures (Part 1)

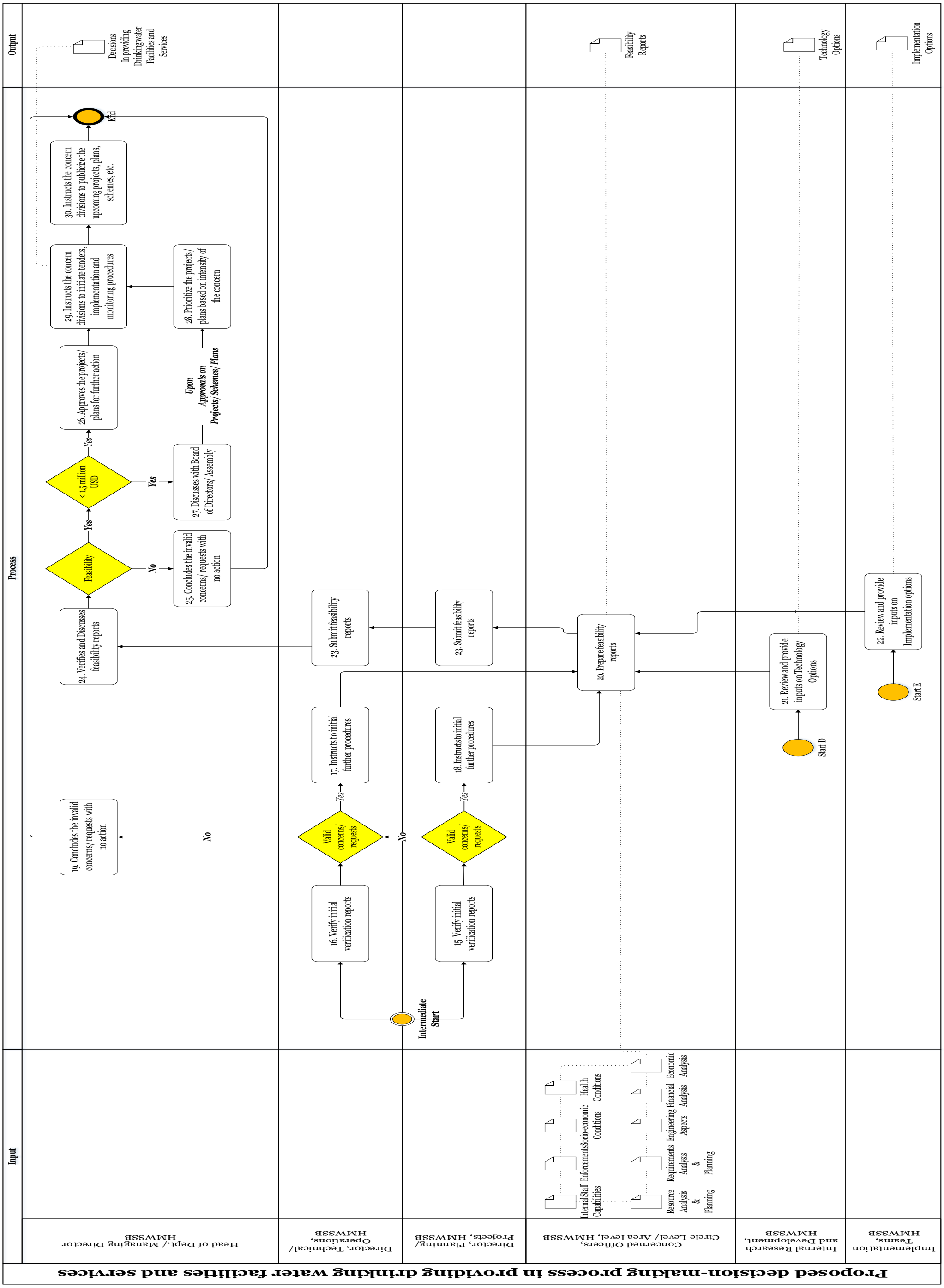

Figure 119: Proposed decision making procedures (Part 2)

Propositions

1. In India, government agencies, during their decision making procedures, are showing disparities, in considering factors such as socio-health, institutional, technical, economic and priority aspects, to provide drinking water facilities and services, amongst the urban poor communities (this PhD thesis).

2. In India, the decision making procedures followed by government agencies have a negative influence on the availability of drinking water in the urban poor communities (this PhD thesis).

3. People participation, opinions, requirements and conditions often considered during the decision making procedures to provide drinking water facilities and services, in Indian urban poor communities (this PhD thesis).

4. In India, drinking water authorities should bear responsibility for control of economic losses as poor quality and quantity of drinking water have negative impacts on poor communities, such as economic losses, i.e. productivity losses, medical expenditures, additional waters (this PhD thesis).

5. In India, drinking water is treated as "social good" rather than as "economic good", i.e., water facilities and services provided to the urban poor communities is at lower/ free service charges which in turn affecting the government agency's financial health (this PhD thesis).

6. Spatial planning generally demands high input of detailed data, whereas many other approaches/ applications can effectively be realised with good insight and creative thinking.

7. Government agencies require changes to reforms, structures, rules, regulations, laws, change and risk management, communication strategies, data harmonisation and exchange mechanisms, etc. for effective and efficient infrastructure management.

8. Bad governance reduces the organisational performance and overall financial health in service delivery.

9. Local communities and private stakeholders are promoting approaches to take advantage of the inabilities of state government agencies in providing better infrastructure facilities and services.

10. Accounting for physical infrastructure facilities and services although fraught with challenges but essential for sustainable development and management.

11. Urban poor communities are treated as "Vote bank" for the government agencies, i.e. the facilities and services provided are on temporary basis to triumph in the periodic elections.

About the Author

Personal Details.

Name	Anil Kumar Palakodeti
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Nationality	Indian
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Education.

Ph.D (Urban Governance and Management) — 2016-2020
Erasmus University Rotterdam, The Netherlands

M.Sc (International Planning and Development) — 2009-2010
Cardiff University, United Kingdom

B.Tech (Urban and Regional Planning) — 2005-2009
JNT University, India

Professional Experience.

A unique combination of expertise in academic and non-academic setting as a PhD researcher at Erasmus University Rotterdam, a practitioner with about 8 years of consulting experience in inter-disciplinary and multi-sector with special focus in water, sanitation, urban, public and municipal finance sectors in various emerging nations, and in teaching.

Anil's career commenced in School of Planning and Architecture (Hyderabad, India) where he gained experience working on research-oriented projects. With his passion to disseminate knowledge, he dedicated some of his time teaching spatial analysis (GIS based) and its application in urban and regional planning at School of Planning and Architecture (Hyderabad, India).

He further worked in semi-government organisations and Big-four consulting firms, where he gained experience working with urban local bodies (ULBs), State governments, and Central government in preparing city development plans, sanitation plans, feasibility studies for urban infrastructure and public/ municipal finance project. He was also actively involved in training various State government officials on various topics/ subjects. Anil has hand-on experience in transaction advisory role, project monitoring and evaluation role, and procurement expert role for wide variety of infrastructure projects across the globe.

Professional Membership.

Associate of Institute of Town Planners, India (Reg. No. 2016-331)

Countries of Experience.

India, Netherlands, United Kingdom, Nepal, Srilanka, Uganda, Maldives, Mongolia

Certifications.

Auto CAD, Arc GIS, SPSS, STATA, MS-Project, MS-Excel

Languages.

English, Hindi, Telugu, Spanish

Publications.

Palakodeti A.K. (2020) "S.I.T.E" (Societal-Institutional-Technical-Economic) Valuation Framework: A Case of Drinking-Water Facilities and Services in Slum Areas of the Hyderabad Region, India. In: Singh R., Srinagesh B., Anand S. (eds) Urban Health Risk and Resilience in Asian Cities. Advances in Geographical and Environmental Sciences. Springer, Singapore. DOI: https://doi.org/10.1007/978-981-15-1205-6_2

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Awards.

Dean's Award for multi-disciplinary excellence for the most creative and feasible research proposal at the Dean's Master Class – "The Work". Presented by the Dean of Erasmus Graduate School of Sciences and Humanities – prof. dr. Liesbet van Zoonen, Erasmus University Rotterdam.

Best out-going student 2005-09 in B.Tech in Urban and Regional Planning, convocation at School of Planning and Architecture, JNT University, 2010.

Best out-going endowment gold medal 2005-09" in B.Tech in Urban and Regional Planning, convocation at School of Planning and Architecture, JNT University, 2010.

Secured rank #01 (Gold Medal) in B.Tech in Urban and Regional Planning for each academic year, 2005-06, 2006-07, 2007-08, 2008-09.

Third prize for paper presentation on "sustainable cities", 2008 at NOSPLAN (National level Technical fest).

Third prize for sustainable concepts on "eco-friendly cities", 2007 at NOSPLAN (National level Technical fest).

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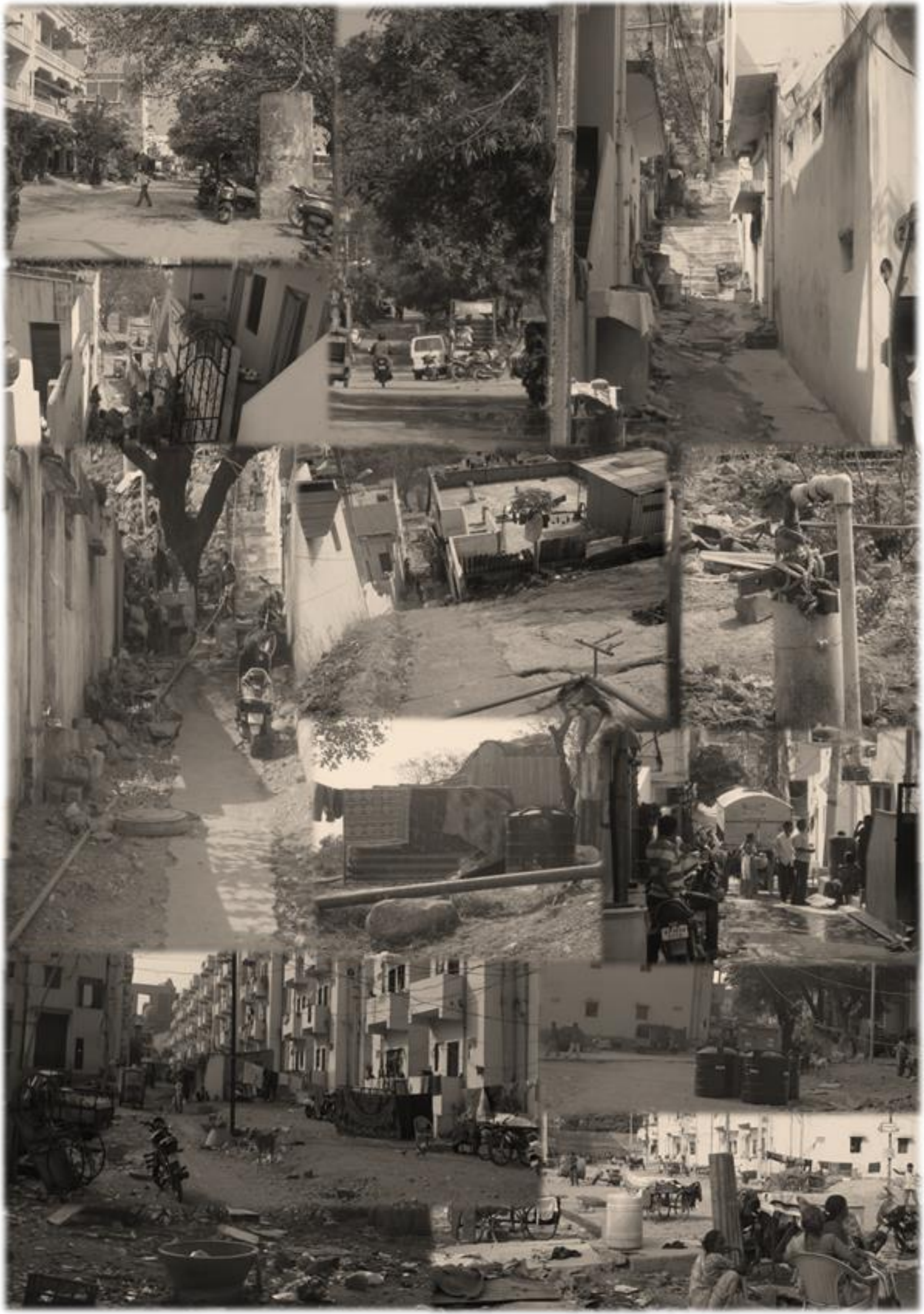

This thesis was developed by the author, between 2015-2019, in consultation with multiple stakeholders of the Erasmus University Rotterdam, Hyderabad Metropolitan Water Supply Sewerage Board, Greater Hyderabad Municipal Corporation and Urban poor communities in Hyderabad city region.

An integrated approach in water governance and management of Hyderabad Metropolitan Water Supply Sewerage Board was required that combined all the values of all the stakeholders in decision making procedures. S.I.T.E valuation provide a means to a systematic and integrated decision support to provide safe and adequate drinking water facilities to the urban poor communities.

This thesis presents an approach of *S.I.T.E valuation* to combine multiple disciplinaries in the decision-making procedure. In S.I.T.E valuation, societal, institutional, technical and economic aspects were taken into consideration during the decision making procedures to provide drinking water facilities and services to the urban poor communities. This has the potential to increase the end-user's satisfactory levels, reduce the externalities and disparities in providing drinking water facilities and services to the urban poor communities.

Although a lot of care has been taken to check errors and misprints, it is difficult to claim perfection. Any errors, omissions and suggestions for the improvements to this thesis, brought to author's notice, will be thankfully acknowledged and incorporated. Author alone is responsible for any errors which may remain.