Planning Citywide Inclusive Sanitation

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Mapping the paradigm shift in the Global and Indian context

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These images depict the complexity of urban sanitation in India.

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Dedicated to the CWIS champions around the world

Summary

Sanitation is fundamental to a city's health, liveability, and social and economic development. Yet, as the world continues to urbanise, progress in urban sanitation is outpaced by rapid urbanisation and population growth. Today, about 40% of the world's urban residents do not have safely managed sanitation, with a vast majority of them are living in low- and middle-income countries (LMICs). In the last five decades, numerous international development agendas on urban sanitation have been set and failed to reach the expected sanitation outcomes in LMICs. Reasons for this failure include poor planning, narrow infrastructure focussed approach, inadequate consideration of contextual factors, lack of attention to policy and institutions, and absence of community involvement.

Nevertheless, urban sanitation approaches have been evolving to overcome the aforementioned limitations. This evolution led to the advent of Citywide Inclusive Sanitation (CWIS), a paradigm shift in the approach to urban sanitation. The goal of CWIS is for everyone to have access to equitable, and safely managed sanitation through a range of different solutions tailored to the local realities of cities, including sewered and non-sewered options. CWIS is explained through the six Manila Principles: (i) equity, (ii) environmental and public health, (iii) mix of technologies, (iv) comprehensive planning, (v) monitoring and accountability, and (vi) mix of business models. Since CWIS was a joint sectoral effort built through consensus, it has received significant uptake in research and practice, with several billion USD invested on CWIS projects globally.

Although CWIS gained significant attention in practice since the beginning, there was little academic literature on the concept itself. The foundations of CWIS were fragmented and varying interpretations of the approach existed. There remained an academic gap to clearly define CWIS and delineate its principles while building sectoral consensus. The next major academic gap is related to planning CWIS, which is more complex than traditional urban sanitation interventions, since the former incorporates multi-dimensional targets of equity, safety, sustainability, responsibility, accountability etc. Existing sanitation planning approaches are either top-down or bottom-up, both of which have their own advantages and disadvantages. For planning CWIS, the advantages of both types of approaches are necessary to ensure that the multi-dimensional targets are achieved. However, there are no sanitation planning approaches that bridge top-down and bottom-up approaches to meet the demands of CWIS.

In order to situate this research on CWIS, a transdisciplinary case study approach is beneficial since the practical complexities of urban sanitation can be explored in detail. India is chosen as the case study owing to the diverse technical, social, institutional and environmental aspects of sanitation that exists in its mega and secondary cities. In the last decade, alternate sanitation systems such as Faecal Sludge Management (FSM) and Small Sanitation Sanitation (SSS) have gained prominence in Indian cities. Furthermore, the public attention and political priority sanitation received in recent years, due to the Swachh Bharat Mission (SBM), has made India an interesting case.

The overarching goal of this thesis is to construct an understanding of CWIS, and develop a novel planning methodology for it in both the global and the Indian context. Therefore, there are three research questions to answer: (1) What is CWIS?, (2) What is the urban sanitation situation in India from a planning perspective?, and (3) How can we plan CWIS by bridging top-down and bottom-up approaches?. A mix of qualitative and quantitative methodologies was adopted to answer the three research questions. These include key informant interviews, workshops, Social Network Analysis (SNA),

Shit Flow Diagrams, and policy analysis among others. The case study research also involved multiple field visits to four mega and secondary cities in India namely, Bangalore, Chennai, Coimbatore and Mysore.

The first question on understanding CWIS is answered by first mapping the evolution of urban sanitation approaches since 1970s to 2020s, from a centralised 'sewer only' narrative to a multi-technology and multi-disciplinary approach. Advancements in the sanitation sector since the turn of the century provides the background to the development of low-cost technologies and participatory planning approaches. These advancements and the increasing emphasis on equitable, environmentally and financially sustainable sanitation outcomes eventually led to the advent of CWIS.

CWIS is defined as an approach to urban sanitation, where all members of the city have equitable access to adequate and affordable improved sanitation services through appropriate systems of all scales (sewered & non-sewered), without any contamination to the environment along the entire sanitation value chain. Through qualitative and collaborative methods, the six Manila Principles are conceptualised and provide the holistic understanding of the CWIS. The varying global manifestations of each of these principles are elucidated through a lighthouse case study and a related research summary.

The second question on urban sanitation in India is analysed from a historical, governance and planning perspective. Sanitation in India is historically governed by laws, policies, and schemes ranging from the Total Sanitation Campaign (1999) to the Swachh Bharat Mission (2014). The unique challenges of politics, caste, slums, community involvement, and the governing dynamics between central, state and city level governments are presented. Major policy shifts around FSM and SSS took place in the last two decades and have created significant impact on uptake, which the landscaping review provides. While widespread implementation of SSS in India was triggered by a policy, the national FSM policies were a retrospective regulation to the already widespread implementation.

As a methodological contribution, this thesis presents a novel validation procedure for SNA that can overcome the challenge of incomplete data especially in LMICs that results in unreliable network graphs. The novel validation procedure for incomplete SNA data systematically builds on information from select insiders and outsiders with expert knowledge of the network and widens the perspective of the SNA. It is tested in the governance of SSS in India, where the challenges of coordination in sanitation governance and the differences between mega and secondary cities, such as community involvement, institutions involved etc., are highlighted. Through this SNA, the multiple institutions involved in the SSS governance is mapped and the utility/municipal corporation is identified as the appropriate custodian agency for monitoring instead of the pollution control board that currently plays this role. Finally, sanitation planning practices in India are analysed and eight barriers are identified including inadequate planning capacities, poor community involvement, absence of a planning framework, poor coordination, scheme-based approach and unreliable political and financial support.

The third question on developing a planning approach that bridges top-down and bottom-up approaches for CWIS, is answered by the development of the "Bridged Approach to Inclusive Sanitation" (BAIS). The newly introduced CWIS Planning Framework is based on the Manila Principles, and has operational outcomes, functional linkages, and the 4S pillars of comprehensive planning i.e., Situation analysis, Stakeholder participation, Synergies with other sectors and Strategy for long term. BAIS is developed from this framework, and in addition has theoretical justifications from planning theories, generic sanitation planning steps, and the planning triangle (with the three corners of technocratic, bureaucratic and democratic approaches).

BAIS is a ten-step planning approach that incorporates the 4S pillars and leads to the creation of a CWIS Action Plan. It has the following steps: (1) Preliminary context analysis, (2) Demand generation, (3)

Creation of Sanitation Task Force, (4) Planning methodology, (5) Detailed diagnostics, (6) Operationalisation of the CWIS targets, (7) Detailed optioneering, (8) Consultative evaluation, (9) Town hall, and (10) CWIS action plan. These steps are iterative and involve both top-down and bottom-up stakeholders in various relevant steps. BAIS is a systematic set of guidelines that help arrive at a contextually appropriate and specific planning methodology, but does not include the steps for implementation and monitoring in its current version.

The 4S pillars of comprehensive planning provide a pathway to overcome the previously identified barriers to sanitation planning. In addition, new planning approaches and tools face the challenges of leadership, resources, capacities, contexts, and institutions. The applicability of BAIS in India is tested through a driver-barrier analysis for each of the ten steps and most are identified to be in line with the established national policies. The major barriers are seen around the meaningful empowerment of non-governmental stakeholders, and resource allocation for planning. The enabling environment for the uptake of BAIS and CWIS is discussed at the National, State and City levels.

The main contributions of this research are relevant for both science and society. Scientifically, this research provides the much-needed foundations for CWIS – definition, principles and investigations on the latter. Further research can build on these conceptual foundations and explore specific contexts and sanitation solutions in light of implementational experience from the CWIS approach. The analysis on India provides insights into its sanitation policies, governance and planning practices. With the launch of SBM 2.0 that is looking at the sanitation service chain beyond toilets, and prominence SSS and FSM have gained in the recent past in terms of policy and uptake, there is significant potential for scaling CWIS in India. Comprehensive planning is critical for implementing CWIS as sanitation planning in India faces several aforementioned barriers, including the lack of a planning framework. Therefore, the development of a dedicated CWIS planning approach such as BAIS, is beneficial to scale CWIS in India.

Finally, the development of BAIS as a planning approach that systematically bridges top-down and bottom-up approaches fills a long-founded gap in the sanitation planning literature. The inclusion of different levels of stakeholders in various steps, detailed situational analysis in the preparatory and diagnostic steps, exploring synergies with other sectors and incremental planning for the long term, all of which build on the 4S pillars, integrates the advantages of both top-down and bottom-up approaches. BAIS also serves as the first planning approach that specifically address the multi-dimensional targets that CWIS places, and in the process provides generic steps for planning CWIS, including the addition of preparatory steps that previous sanitation planning literature lacked. However, it relies on the enabling environment and willingness of cities for its uptake.

The implications of this research on practice begins with its bridge to science through this transdisciplinary approach. This research on CWIS has also helped capacity development programs and advocacy for the uptake of the approach. In intangible ways, it has contributed to several CWIS projects under implementation and the global CWIS initiative at large.

This research has tried to balance the breadth of the globally relevant CWIS concept with the depth of the Indian case study. This thesis acts as an academic cornerstone for the paradigm shift towards CWIS. Further research on its implementation in various contexts and the associated practical challenges can refine the approach and help it scale.

Zusammenfassung

Die Abwasserentsorgung ist von grundlegender Bedeutung für die Gesundheit, die Lebensqualität sowie die soziale und wirtschaftliche Entwicklung einer Stadt. Doch während die Welt immer weiter verstädtert, werden die Fortschritte bei der städtischen Abwasserentsorgung durch die rasche Urbanisierung und das Bevölkerungswachstum überholt. Heute verfügen etwa 40 % der Stadtbewohner weltweit nicht über eine sichere Abwasserentsorgung, wobei die überwiegende Mehrheit von ihnen in Ländern mit niedrigem und mittlerem Einkommen (LMICs) lebt. In den letzten fünf Jahrzehnten wurden zahlreiche internationale Entwicklungspläne für die städtische Abwasserentsorgung aufgestellt, ohne dass die erwarteten Ergebnisse in den LMICs erreicht wurden. Zu den Gründen für dieses Scheitern gehören schlechte Planung, ein eng auf die Infrastruktur ausgerichteter Ansatz, eine unzureichende Berücksichtigung kontextbezogener Faktoren, mangelnde Aufmerksamkeit für Politik und Institutionen sowie eine fehlende Einbeziehung der Bevölkerung.

Nichtsdestotrotz haben sich die Ansätze zur städtischen Abwasserentsorgung weiterentwickelt, um die oben genannten Einschränkungen zu überwinden. Diese Entwicklung führte zur Einführung der Citywide Inclusive Sanitation (CWIS), einem Paradigmenwechsel im Bereich der städtischen Abwasserentsorgung. Ziel von CWIS ist es, allen Menschen Zugang zu einer gerechten und sicheren Abwasserentsorgung zu verschaffen, und zwar durch eine Reihe verschiedener Lösungen, die auf die lokalen Gegebenheiten der Städte zugeschnitten sind, einschließlich kanalisierter und nicht kanalisierter Optionen. CWIS wird anhand der sechs Manila-Prinzipien erläutert: (i) Gerechtigkeit, (ii) Umwelt und öffentliche Gesundheit, (iii) Technologiemix, (iv) umfassende Planung, (v) Überwachung und Rechenschaftspflicht und (vi) Mix an Geschäftsmodellen. Da es sich bei CWIS um eine gemeinsame sektorale Anstrengung handelte, die auf einem Konsens beruhte, hat es in der Forschung und in der Praxis großen Anklang gefunden, wobei weltweit mehrere Milliarden USD in CWIS-Projekte investiert wurden.

Obwohl CWIS in der Praxis von Anfang an große Beachtung fand, gab es nur wenig akademische Literatur über das Konzept selbst. Die Grundlagen von CWIS waren fragmentiert und es gab unterschiedliche Interpretationen des Ansatzes. Es blieb eine akademische Lücke, um CWIS klar zu definieren und seine Grundsätze abzugrenzen und gleichzeitig einen sektoralen Konsens zu schaffen. Die nächste große akademische Lücke betrifft die Planung von CWIS, die komplexer ist als herkömmliche Maßnahmen der städtischen Abwasserentsorgung, da erstere mehrdimensionale Ziele wie Gerechtigkeit, Sicherheit, Nachhaltigkeit, Verantwortung, Rechenschaftspflicht usw. umfasst. Die bestehenden Planungsansätze für die Abwasserentsorgung sind entweder Top-Down oder Bottom-Up, die beide ihre eigenen Vor- und Nachteile haben. Für die Planung von CWIS sind die Vorteile beider Arten von Ansätzen notwendig, um sicherzustellen, dass die mehrdimensionalen Ziele erreicht werden. Es gibt jedoch keine Planungsansätze für die Abwasserentsorgung, die eine Brücke zwischen Top-down- und Bottom-up-Ansätzen schlagen, um den Anforderungen von CWIS gerecht zu werden.

Um diese Forschung zu CWIS zu verorten, ist ein transdisziplinärer Fallstudienansatz von Vorteil, da die praktischen Komplexitäten der städtischen Abwasserentsorgung im Detail untersucht werden können. Indien wurde aufgrund der vielfältigen technischen, sozialen, institutionellen und ökologischen Aspekte der Abwasserentsorgung in seinen Mega- und Sekundärstädten als Fallstudie ausgewählt. In den letzten zehn Jahren haben alternative Abwassersysteme wie Fäkalschlamm-Management (FSM) und kleine Abwassersysteme (SSS) in indischen Städten an Bedeutung gewonnen. Darüber hinaus hat die öffentliche Aufmerksamkeit und die politische Priorität, die die Abwasserentsorgung in den letzten

Jahren aufgrund der Swachh Bharat Mission (SBM) erhalten hat, Indien zu einem interessanten Fall gemacht.

Das übergreifende Ziel dieser Arbeit ist es, ein Verständnis für CWIS zu entwickeln und eine neuartige Planungsmethodik sowohl für den globalen als auch für den indischen Kontext zu erarbeiten. Daher sind drei Forschungsfragen zu beantworten: (1) Was ist CWIS?, (2) Wie sieht die Situation der städtischen Abwasserentsorgung in Indien aus planerischer Sicht aus? und (3) Wie können wir CWIS planen, indem wir Top-down- und Bottom-up-Ansätze miteinander verbinden? Zur Beantwortung der drei Forschungsfragen wurde eine Mischung aus qualitativen und quantitativen Methoden eingesetzt. Dazu gehören u. a. Interviews mit Schlüsselinformanten, Workshops, soziale Netzwerkanalyse (SNA), Shit-Flow-Diagramme und politische Analysen. Die Fallstudienforschung umfasste auch mehrere Besuche vor Ort in vier indischen Mega- und Sekundärstädten, nämlich Bangalore, Chennai, Coimbatore und Mysore.

Die erste Frage zum Verständnis von CWIS wird beantwortet, indem zunächst die Entwicklung der Konzepte für die städtische Abwasserentsorgung seit den 1970er Jahren bis in die 2020er Jahre dargestellt wird, von einer zentralisierten "Nur-Kanalisation"-Erzählung zu einem multitechnologischen und multidisziplinären Ansatz. Die Fortschritte im Abwassersektor seit der Jahrhundertwende bilden den Hintergrund für die Entwicklung kostengünstiger Technologien und partizipativer Planungsansätze. Diese Fortschritte und die zunehmende Betonung gerechter, umweltfreundlicher und finanziell nachhaltiger Sanitärlösungen führten schließlich zur Einführung von CWIS.

CWIS ist definiert als ein Ansatz für die städtische Abwasserentsorgung, bei dem alle Stadtbewohner gleichberechtigten Zugang zu angemessenen und erschwinglichen verbesserten Sanitärdienstleistungen durch geeignete Systeme aller Größenordnungen (mit und ohne Kanalisation) haben, ohne dass die Umwelt entlang der gesamten Wertschöpfungskette der Abwasserentsorgung belastet wird. Mittels qualitativer und kooperativer Methoden werden die sechs Manila-Prinzipien konzeptualisiert und liefern ein ganzheitliches Verständnis des CWIS. Die unterschiedlichen globalen Ausprägungen jedes dieser Prinzipien werden anhand einer Leuchtturm-Fallstudie und einer entsprechenden Forschungszusammenfassung erläutert.

Die zweite Frage zur städtischen Abwasserentsorgung in Indien wird aus historischer, politischer und planerischer Sicht analysiert. Die Abwasserentsorgung in Indien wird seit jeher durch Gesetze, Strategien und Programme geregelt, die von der Total Sanitation Campaign (1999) bis zur Swachh Bharat Mission (2014) reichen. Es werden die besonderen Herausforderungen der Politik, der Kaste, der Slums, der Beteiligung der Bevölkerung und der Dynamik zwischen der Zentralregierung, den Landes- und Stadtregierungen dargestellt. In den letzten zwei Jahrzehnten haben sich wichtige politische Veränderungen in Bezug auf FSM und SSS vollzogen, die sich erheblich auf die Einführung ausgewirkt haben, was in der Übersicht über die Landschaftsgestaltung dargestellt wird. Während die weit verbreitete Einführung des Kurzstreckenseeverkehrs in Indien durch eine Politik ausgelöst wurde, war die nationale FSM-Politik eine nachträgliche Regelung der bereits weit verbreiteten Einführung.

Als methodischen Beitrag stellt diese Arbeit ein neuartiges Validierungsverfahren für SNA vor, mit dem die Herausforderung unvollständiger Daten insbesondere in LMICs, die zu unzuverlässigen Netzwerkgraphen führen, überwunden werden kann. Das neuartige Validierungsverfahren für unvollständige SNA-Daten stützt sich systematisch auf Informationen von ausgewählten Insidern und Outsidern mit Expertenwissen über das Netzwerk und erweitert die Perspektive des SNA. Es wird an der Verwaltung von SSS in Indien erprobt, wo die Herausforderungen der Koordinierung bei der Verwaltung der Abwasserentsorgung und die Unterschiede zwischen Mega- und Sekundärstädten, wie z. B. die Beteiligung der Bevölkerung, beteiligte Institutionen usw., hervorgehoben werden. Durch

diese SNA werden die zahlreichen Institutionen, die an der Verwaltung von SSS beteiligt sind, kartiert und das Versorgungsunternehmen bzw. die städtische Gesellschaft als geeignete Überwachungsbehörde anstelle der Umweltbehörde, die derzeit diese Rolle spielt, identifiziert. Schließlich werden die Praktiken der Sanitärplanung in Indien analysiert und acht Hindernisse identifiziert, darunter unzureichende Planungskapazitäten, unzureichende Einbindung der Bevölkerung, Fehlen eines Planungsrahmens, schlechte Koordinierung, schemabasierter Ansatz und unzuverlässige politische und finanzielle Unterstützung.

Die dritte Frage nach der Entwicklung eines Planungsansatzes, der Top-Down- und Bottom-Up-Ansätze für CWIS verbindet, wird durch die Entwicklung des Bridged Approach to Inclusive Sanitation" (BAIS) beantwortet. Der neu eingeführte CWIS-Planungsrahmen basiert auf den Manila-Prinzipien und umfasst operative Ergebnisse, funktionale Verknüpfungen und die 4S-Säulen einer umfassenden Planung, d. h. Situationsanalyse, Beteiligung von Interessengruppen, Synergien mit anderen Sektoren und langfristige Strategie. BAIS wurde auf der Grundlage dieses Rahmens entwickelt und enthält darüber hinaus theoretische Begründungen aus Planungstheorien, allgemeine Planungsschritte für die Abwasserentsorgung und das Planungsdreieck (mit den drei Ecken des technokratischen, bürokratischen und demokratischen Ansatzes).

BAIS ist ein zehnstufiger Planungsansatz, der die 4S-Säulen umfasst und zur Erstellung eines CWIS-Aktionsplans führt. Er umfasst die folgenden Schritte: (1) Vorläufige Kontextanalyse, (2) Bedarfsermittlung, (3) Bildung einer Sanitär-Taskforce, (4) Planungsmethodik, (5) Detaillierte Diagnose, (6) Operationalisierung der CWIS-Ziele, (7) Detaillierte Optionsplanung, (8) Konsultative Bewertung, (9) Gemeindeversammlung und (10) CWIS-Aktionsplan. Diese Schritte sind iterativ und beziehen sowohl Top-down- als auch Bottom-up-Akteure in die verschiedenen relevanten Schritte ein. BAIS ist eine systematische Reihe von Leitlinien, die dazu beitragen, eine kontextabhängige und spezifische Planungsmethodik zu entwickeln, die jedoch in ihrer aktuellen Fassung keine Schritte zur Umsetzung und Überwachung enthält.

Die 4S-Säulen der umfassenden Planung bieten einen Weg zur Überwindung der zuvor ermittelten Hindernisse für die Planung der Abwasserentsorgung. Darüber hinaus stehen neue Planungsansätze und -instrumente vor den Herausforderungen von Führung, Ressourcen, Kapazitäten, Kontexten und Institutionen. Die Anwendbarkeit von BAIS in Indien wird durch eine Analyse der Faktoren und Hindernisse für jeden der zehn Schritte geprüft, und die meisten davon stehen im Einklang mit der bestehenden nationalen Politik. Die größten Hindernisse werden in der sinnvollen Befähigung nichtstaatlicher Akteure und in der Bereitstellung von Ressourcen für die Planung gesehen. Das günstige Umfeld für die Einführung von BAIS und CWIS wird auf nationaler, bundesstaatlicher und städtischer Ebene erörtert.

Die wichtigsten Beiträge dieser Untersuchung sind sowohl für die Wissenschaft als auch für die Gesellschaft von Bedeutung. In wissenschaftlicher Hinsicht liefert diese Untersuchung die dringend benötigten Grundlagen für CWIS - Definition, Grundsätze und Untersuchungen zu CWIS. Weitere Forschungen können auf diesen konzeptionellen Grundlagen aufbauen und spezifische Kontexte und Sanitärlösungen im Lichte der Umsetzungserfahrungen mit dem CWIS-Ansatz untersuchen. Die Analyse Indiens bietet Einblicke in die Sanitärpolitik, die Verwaltung und die Planungspraktiken des Landes. Mit der Einführung von SBM 2.0, das die Sanitärversorgungskette über Toiletten hinaus betrachtet, und der Bedeutung, die SSS und FSM in der jüngsten Vergangenheit in Bezug auf Politik und Akzeptanz erlangt haben, besteht ein erhebliches Potenzial für die Ausweitung von CWIS in Indien. Eine umfassende Planung ist für die Umsetzung von CWIS von entscheidender Bedeutung, da die Planung der Abwasserentsorgung in Indien auf mehrere bereits erwähnte Hindernisse stößt, darunter das Fehlen eines Planungsrahmens. Daher ist die Entwicklung eines speziellen CWIS-Planungsansatzes wie BAIS für die Verbreitung von CWIS in Indien von Vorteil.

Schließlich füllt die Entwicklung von BAIS als Planungsansatz, der systematisch Top-down- und Bottom-up-Ansätze verbindet, eine seit langem bestehende Lücke in der Literatur zur Sanitärplanung. Die Einbeziehung verschiedener Ebenen von Interessenvertretern in verschiedenen Schritten, die detaillierte Situationsanalyse in den Vorbereitungs- und Diagnoseschritten, die Erkundung von Synergien mit anderen Sektoren und die inkrementelle Planung auf lange Sicht, die alle auf den 4S-Säulen aufbauen, vereinen die Vorteile sowohl von Top-down- als auch von Bottom-up-Ansätzen. BAIS ist auch der erste Planungsansatz, der speziell auf die multidimensionalen Ziele von CWIS eingeht und dabei allgemeine Schritte für die Planung von CWIS vorsieht, einschließlich der Hinzufügung von Vorbereitungsschritten, die in der bisherigen Literatur zur Sanitärplanung fehlten. Voraussetzung für die Einführung von CWIS ist jedoch ein günstiges Umfeld und die Bereitschaft der Städte.

Die Auswirkungen dieser Forschung auf die Praxis beginnen mit der Brücke zur Wissenschaft durch diesen transdisziplinären Ansatz. Die Forschung zu CWIS hat auch zu Programmen zum Kapazitätsaufbau und zur Förderung der Übernahme des Ansatzes beigetragen. Auf immaterielle Weise hat sie zu mehreren laufenden CWIS-Projekten und zur globalen CWIS-Initiative im Allgemeinen beigetragen.

Im Rahmen dieser Untersuchung wurde versucht, die Breite des weltweit relevanten CWIS-Konzepts mit der Tiefe der indischen Fallstudie in Einklang zu bringen. Diese Arbeit dient als akademischer Eckpfeiler für den Paradigmenwechsel zu CWIS. Weitere Forschungen zur Umsetzung in verschiedenen Kontexten und den damit verbundenen praktischen Herausforderungen können den Ansatz verfeinern und zu seiner Verbreitung beitragen.

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Finally, to the One who makes my life serendipitous, by placing the dots that I can connect only in hindsight. Thank you.

தொட்டனைத் தூறும் மணற்கேணி மாந்தர்க்குக் கற்றனைத் தூறும் அறிவு.

The more you dig, the more the water springs. The more you learn, the more your wisdom springs.

- Thiruvalluvar (100 BC)

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01

Introduction

> **The blessing of sanitation is that it cuts across so many sectors; but that is also its curse**
>
> ***– Martin Gambrill***

1.1 The Sanitation Conundrum

If you are reading this thesis, chances are that you have a well-functioning flush toilet at your home and your workplace. This is not the case for over half the world. Imagine walking several hundred yards, to a poorly lit, unsafe and waterless toilet that is shared with tens of others; or even worse, having to openly defaecate before sunrise; an unfortunate reality for millions of people around the globe in many cities of low and middle-income countries.

Sanitation is a cross-cutting field that affects all humans in diverse ways – health, safety, dignity, economy, environment and even the climate (Hyun et al., 2019). Despite its well established contributions to improving human life, right from children's health (Checkley et al., 2004; Mara et al., 2010) to girl's education (Adukia, 2017), the issue of universal sanitation remains an elusive dream.

Given the fundamental importance of safely managed sanitation[1], it is no surprise that it is now globally recognised as a Human Right (UN GA, 2010), and found as a separate target in the Sustainable Development Goals (SDG) (Goal 6.2) (UN GA, 2015). According to the Joint Monitoring Program (JMP) run by UNICEF and WHO, in 2020, for the first time the world has more people using safely managed sanitation than unsafely managed (UNICEF & WHO, 2021). Yet, globally over 3.6 billion people still lack access to safely managed sanitation, occurring mostly in Central and Southern-Asia, Sub-Saharan Africa, and Latin America (Figure 1.1). At this rate, only 67% of the population will have safely managed sanitation by 2030; meaning that the efforts have to more than triple (3.3x) in order to achieve SDG 6.2.

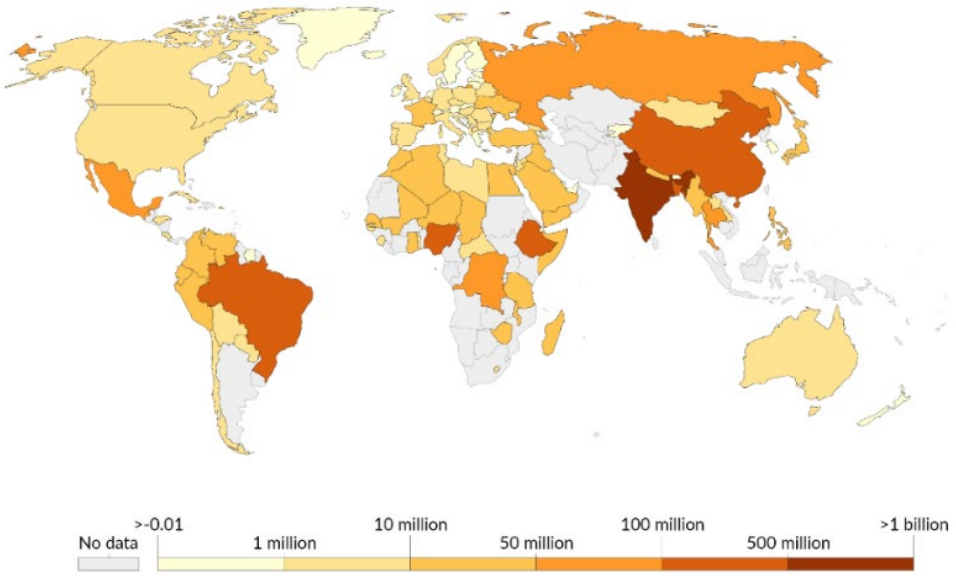


Figure 1.1: Map of number of people without access to safely managed sanitation in 2020. Source of Data (UNICEF and WHO 2021). CC BY: OurWorldinData.Org

1 Safely managed sanitation is defined as use of improved sanitation facilities which are not shared with other households, and the excreta produced is treated either in-situ or off-site, when carried through sewers or mechanically after emptying from a temporary storage (UNICEF and WHO, 2016).

The links between poor sanitation and environmental pollution have been clear for centuries, with documented steps that go back to the Roman and the Indus Valley civilisations (Markham, 2019). Still close to 80% of municipal wastewater is discharged into the environment without any treatment (UN Water, 2017). This situation is pervasive even in high income countries today (Maxcy-Brown et al., 2021).

Studies show varying positive returns on sanitation investments from its offset of health costs and productivity loss. The returns have varied from 1.22 times for an FSM investment in Tamil Nadu, India (Tan-Soo, 2021), to 5.5 times on average globally (Hutton, 2013). Yet, the financing gap remains colossal with a 60% shortfall of the 46 billion USD needed to achieve safely managed sanitation and hygiene in urban areas (UN Water, 2019; WB; and UNICEF, 2017).

1.2 Urban Sanitation Plight and Planning

According to the disaggregated data on progress between rural and urban sanitation, in almost every country, urban sanitation does better than rural sanitation in terms of coverage (UNICEF and WHO, 2019). Still, this research chooses to focus on urban sanitation, since the problems in urban sanitation are more complex and pressing than the rural counterpart. Reasons for this complexity and urgency include (i) the rapid urbanisation occurring in the Global South (UN DESA, 2018), (ii) urban migration and population density (Soll, 2012), (iii) informal settlements and tenure issues (McFarlane et al., 2014), (iv) inequities that rise thereof (Chaplin, 1999), (v) higher costs of implementation (Daudey, 2018), (vi) increased health risks for infectious diseases (Penrose et al., 2010) and (vii) systemic governance and institutional challenges in basic service provisions (van Welie et al., 2019) (See Figure 1.2).

Figure 1.2: Urban Sanitation needs to deal with social and environmental complexities. CC BY: EU/ECHO/Anouk Delafortie

These aforementioned pressures elucidate the multi-dimensionality of urban sanitation that needs to account for the complexities of changing growth patterns and population density, heterogeneous settlement and demographic typologies, and need for appropriate institutional service delivery mechanisms. In order to manage such complexities among others, urban sanitation needs advanced and concerted planning.

Planning urban sanitation is a key process to achieving sustainable outcomes, yet cities and utilities seldom give planning the necessary time and importance (McConville, 2010). Due to inadequate planning resulting in inappropriate technology choice, poor user acceptance, discordance with other services etc., sanitation interventions fail (Kennedy-Walker et al., 2014; Reymond et al., 2016; Spuhler and Lüthi, 2020). To navigate the complexity of sanitation provision in highly dense and urbanising cities, previous research works have described the individual benefits for planning being multi-disciplinary, participatory, systematic, contextualised, and synergistic (Kennedy-Walker et al., 2014; Lüthi et al., 2011b; Scott et al., 2019; Spuhler et al., 2020).

Multi-disciplinary since, urban sanitation traverses multiple disciplines right from health, economy, environment, development and urban planning (Hyun et al., 2019), and cannot be tackled in isolation. Therefore its planning is also required to be multi-disciplinary and involve specialists from various domains including engineering, urban planning, economics, public health and behavioral science (Kennedy-Walker et al., 2014) in order to ensure long-term sustenance of sanitation interventions (Ramôa et al., 2016).

Participatory planning has been documented to be effective in the case of sanitation from a variety of global contexts (Lüthi et al., 2010; McConville, 2010; Rini Dwi Ari et al., 2018; Roma and Jeffrey, 2010). It is also deemed a necessity in urban informal settlements in particular where solutions need to be tailored in detail and equity has to be operationalised (Banana et al., 2015; Georgiadou et al., 2016; Okeefe et al., 2015; van Welie et al., 2019). This however comes with many challenges of participatory planning such as capacity of planners, data collection challenges, reconciling differences, managing power dynamics etc., (Das, 2015; McFarlane et al., 2014; Mtika and Tilley, 2020).

Systematic planning helps understand the demands of varying local contexts in a city, considers different technical solutions and helps make structured decisions by balancing trade-offs (Spuhler and Lüthi, 2020). It also allows for the consideration of a growing number of novel technologies that are otherwise left out of the option space in conventional sewer based master planning (Spuhler et al., 2020).

Contextualised planning is another key aspect of systematic planning, since it moves away from a “one-size fits all” approach towards more appropriate technology selection, which accounts for local needs beyond just the physical characteristics. For example, a urine diversion dry toilet that was deemed environmentally and economically sustainable in the context of an informal neighborhood in Buenos Aries, Argentina, was socially inappropriate as the users did not want to physically or mentally engage in sanitation management (del Carmen Morales et al., 2014). Similarly, social acceptability of resource oriented sanitation systems have been studied in India to have barriers of uptake (Simha et al., 2018).

Synergistic sanitation planning considers those interacting sectors, which interact and influence the functioning of urban sanitation systems, such as water supply, solid waste, stormwater management, climate resilience among others (Narayan et al., 2021a). A recent Delphi survey confirmed that better outcomes in sanitation could be achieved by integrating it with other basic urban services. (Scott et al., 2019). The Sanitation Cityscape conceptual framework describes the functional linkages between sanitation and other basic urban services, which helps to assess and plan in order to align and integrate within the service delivery framework (Scott and Cotton, 2020). Other decentralised modes of planning integrated basic services as part of citywide planning have also been proposed earlier (Kraemer et al., 2010).

Besides these aforementioned desirable characteristics in urban sanitation planning, there are two predominant normative modes of planning, top-down and bottom-up, based on the stakeholder participation levels and decision-making process. Debates have long existed between these two, with advantages of time, replicability, scalability (Mara, 2018), and ability to tap into synergies in the top-down, and higher acceptability due to the participation and contextualisation potential of bottom-up planning (Mcgranahan, 2013). Similarly, the limitations in top-down approaches include, poor contextual understanding and low stakeholder acceptance leading to unsustainable and inappropriate technology selection (Kennedy-Walker et al., 2014). Bottom-up approaches on the other hand require more time, money, expert moderation, and do not readily scale (Doe, 2004; Lüthi et al., 2010). While these debates remain unsettled (Annamalai et al., 2016; Reymond et al., 2016), a planning framework that bridges both these approaches meaningfully would be beneficial, but has not yet been proposed in academic literature.

1.3 Bellagio to Manila

Since the 1970s, urban sanitation featured as a part of the international development discourse including the first UN conference on Water at Mar del Plata, Argentina (see Kalbermatten et al., 1980). There was a slow but significant move from conventional sewerage as the universal panacea, towards a more locally appropriate and people-centric “sustainable sanitation” that included non-sewered solutions. The Water Supply and Sanitation Collaborative Council outlined this concept of Sustainable Sanitation and endorsed it as the way forward with the formulation of the Bellagio Principles (Schertenleib et al., 2003). The concept gained momentum in academic circles with the development of relevant guidelines and tools such as Household Centered Environmental Sanitation (HCES) and Community-led Urban Environmental Sanitation (CLUES) (Schertenleib et al., 2021). However, it did not adequately shift the minds of the development partners to implement the principles of sustainable sanitation at scale.

BOX 1.1

The Bellagio Principles for Sustainable Sanitation (2000)

- Human dignity, quality of life and environmental security at household level should be at the centre of the new approach, which should be responsive and accountable to needs and demands in the local and national setting.
- In line with good governance principles, decision making should involve participation of all stakeholders, especially the consumers and providers of services
- Waste should be considered a resource, and its management should be holistic and form part of integrated water resources, nutrient flow and waste management.
- The domain in which environmental sanitation problems are resolved should be kept to the minimum practical size (household, community, town, district, catchment, city) and wastes diluted as little as possible.

Boxes 1.1 and 1.2 : The Bellagio and Manila Principles (Schertenleib et al., 2003; Narayan and Luthi, 2020)

BOX 1.2

The Manila Principles for Citywide Inclusive Sanitation (2019)

- Equity: Everyone in an urban area — including communities marginalized by gender, social, and economic reasons — benefit from equitable, affordable, and safe sanitation services.
- Environment and public health: Human waste is safely managed along the entire sanitation service chain, starting from containment to reuse and disposal.
- Mix of technologies: A variety of sewered and non-sewered sanitation solutions coexist in the same city, depending on contextual appropriateness and resource recovery potential.
- Comprehensive planning: Planning is inclusive and holistic with participation from all stakeholders including users and political actors — with short- and long-term vision and incremental perspective and is synergistic with other urban development goals.
- Monitoring and accountability: Authorities operate with a clear, inclusive mandate, performance targets, monitoring requirements, human and financial resources, and accountability.
- Mix of business models: Sanitation services are deployed through a range of business models, funding sources, and financial mechanisms to reach all members equitably.

In the following two decades, this concept of sustainable sanitation simultaneously evolved to include equity, service accountability, consideration of the entire sanitation value chain and a service based approach as against infrastructure focused, end of pipe solutions (Tilley et al., 2014). Many other advancements in planning such as, non-sewered technologies, decentralised management, resource recovery, institutional and governance systems, monitoring mechanisms, private sector involvement, and a general sense of holistic approach to sanitation, have taken place in the sanitation sector[2] (Narayan et al., 2021a). All this led to a paradigm shift in the thinking towards urban sanitation, and with a strong partnership between research and practice, the concept of Citywide Inclusive Sanitation (CWIS) emerged (Gambrill et al., 2020; Lüthi and Narayan, 2018; Schrecongost et al., 2020).

1.4 The CWIS Paradigm

CWIS as an approach brings various strings of aforementioned elevated thoughts together, and creates a unified vision for the future direction of urban sanitation. The concept is best explained with the Manila Principles on CWIS (Narayan and Lüthi, 2020). CWIS aims to achieve safely managed sanitation with a mix of technologies and service models that are appropriate for the local context, while ensuring equitable, environmentally and financially sustainable outcomes. CWIS as a concept has gained significant traction in the sanitation sector since its conceptualisation in 2016. The approach has the backing of several research and development partners and the founding members include The Bill & Melinda Gates Foundation, Emory University, Plan International, The University of Leeds, WaterAid, the World Bank (BMGF et al., 2017). Since then, even more international organisations including ADB, Eawag, GIZ, UNICEF, WHO, WSUP among many others are actively aligning their efforts with the CWIS principles (World Water Week, 2021). It is useful to note that one of the key reasons for the quick uptake of CWIS by most of these organisations is that, CWIS is not a radically new concept. Rather it has individual parts which most organisations were already advocating for (for example on equity and planning see: Hawkins et al., 2013b; Reymond et al., 2016).

Today, the World Bank[3] has a portfolio of water and sanitation projects amounting to several billion USD, that have incorporated CWIS. The Asian Development Bank too has incorporated CWIS in their urban sanitation projects across the Asia-Pacific region[4]. There are several tools and capacity development programmes that are now geared towards planning and designing CWIS (Narayan and Spuhler, 2021). Furthermore, there are several degree programmes, diploma programmes and tailor-made courses on sanitation now with a strong alignment towards the CWIS approach[5,6]. All these developments on CWIS in the short span of four years indicate that this approach has gained significant momentum and is likely to scale and become more mainstream in urban sanitation theory and practice. (See Figure 1.3)

2 See Chapter 2 for more detailed commentary on these developments
3 Visit World Bank Group's CWIS Knowledge Hub at www.worldbank.org/cwis
4 Visit the ADB's Knowledge Hub at https://adb.eventsair.com/online-adb-sanitation-dialogue-2021/cwis-knowledge-hub
5 Visit the Global Sanitation Graduate School at https://sanitationeducation.org/
6 Visit the Consultant Capacity Development Program on CWIS at www.sandec.ch/concad

Figure 1.3: The pillars of CWIS when it was first conceptualised (BMGF et al., 2017)

1.5 The Great Indian Sanitation Spectacle

India houses one in every six people in the world, thereby accounting for roughly 17% of the global faecal waste generation. But that is not the reason why exploring India as a case study is worthwhile for this research. India is an interesting case for exploring CWIS because of the relevant multi-dimensional aspects that include diverse socio-cultural factors, caste issues, varied technical systems, multi-level institutional set-ups, political priority, community-based initiatives, private sector presence, planning policies among many others (see Chapter 3 for a detailed narration on India's sanitation journey).

Sanitation in the country has historically been a prominent issue (also closely tied with caste (Shankar and Swaroop, 2021)), which even prompted the Father of the nation, Mahatma Gandhi to declare "*sanitation is more important than independence itself*". Ironically, only 30 years after his death, i.e., since the 1980s, was this followed by a series of sanitation campaigns. Yet, in 2015, India was home to half the world's 946 million people who practice open defaecation (UNICEF and WHO, 2017).

However, in the last decade, the landscape of sanitation in India has been rapidly changing; with the introduction of several sanitation reforms such as the National Urban Sanitation Policy, Prohibition of Manual Scavenging Act, National Faecal Sludge and Septage Management Policy and most prominently, the Swachh Bharat Mission (SBM). SBM is the world's largest sanitation campaign, in

terms of funds and number of people mobilised, which helped the country declare itself open defaecation free in 2019. Furthermore, there were major policy shifts in India that facilitated the uptake of alternate sanitation solutions that include faecal sludge management and small-scale or decentralised sanitation systems at scale (NITI-Aayog, 2021; Reymond et al., 2020).

Despite these developments, India still faces a sanitation crisis of sustaining the gains made from SBM (Exum et al., 2020; Gupta et al., 2019), safely managing the faecal waste generated in the newly built toilets (Devaraj et al., 2021; NITI-Aayog, 2021), and being equitable in the process of delivering sanitation to different sections of the urban population (Chaplin, 2011; Dempsey et al., 2018; Kulkarni et al., 2017). In 2020, over 60% of the urban population lacked safely managed sanitation (UNICEF & WHO, 2021) (Figure 1.4). Furthermore, only 30% of the captured wastewater from 32% of the urban population (that is sewered) was being treated and left a large section of urban households (including those relying on non-sewered solutions) with no safe disposal strategy (NITI-Aayog, 2018). However, every public crisis is also a public policy opportunity. In this case, there is a real opportunity for the uptake of CWIS in India as part of the SBM Urban 2.0 (GoI, 2021) to ensure equitable and sustainable access to safely managed sanitation for over 400 million urban residents in the country, and benefit from the support and momentum CWIS has garnered in the development sector internationally.

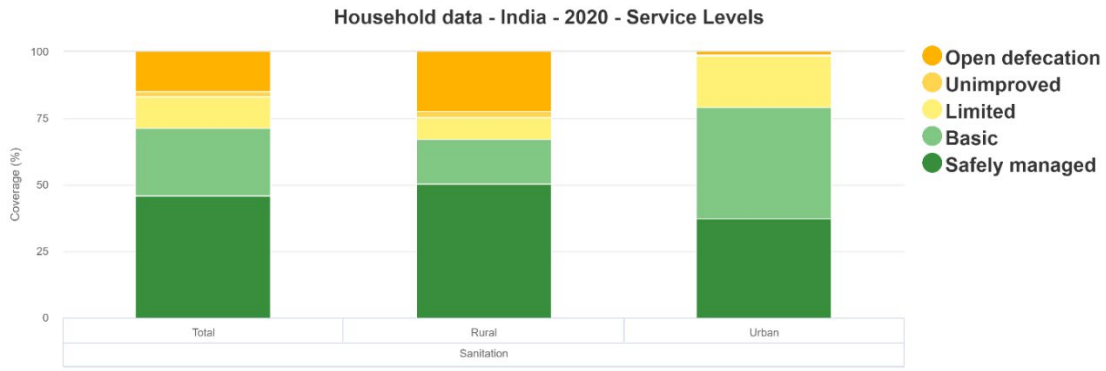


Figure 1.4 - Household Sanitation Levels in India in 2020. Data from (UNICEF and WHO, 2017). Figure made by Author using www.washdata.org

Therefore, in addition to the multi-dimensional aspects of sanitation in India, this research explores urban sanitation, particularly CWIS in the Indian context due to:

(i) Diverse and complex technical, social and institutional environment for sanitation in large Indian cities (million plus in terms of population), which give scope for analysing sanitation comprehensively with various influencing factors.

(ii) Public attention received by sanitation in the recent times due to its political priority, which helps in researching the subject with stakeholder involvement, in an otherwise context where sanitation is a taboo.

(iii) Data availability from previous research in sanitation and access to key stakeholders, which helps build on secondary data that is necessary considering the expansive scope of CWIS

(iv) Relevance of CWIS in the current SBM times due to national policy making avenues and renewed focus on managing the entire sanitation value chain, which enables potential for the research to contribute to real-world impact in India.

While this thesis explores urban sanitation in India in detail, the generic aspects of the research including conceptualisation of CWIS and the planning approaches greatly benefited from the author's involvement in several other CWIS research in various countries including Kenya, Bangladesh, Uganda, Ethiopia, Zambia, Bangladesh, Nepal, and Colombia among others. These involvements came through collaboration with the World Bank, Gates Foundation and Swiss Agency for Development and Cooperation, GIZ and other complimentary projects in Eawag-Sandec.

1.6 Research Design

1.6.1 Research Gaps

Since the Call to Action on CWIS in 2017 (BMGF et al., 2017), CWIS was rolled out in implementation programmes globally, widely discussed in sanitation conferences and significant financial commitments were made as seen in section 1.4. However, there was no specific academic literature on the concept of CWIS in itself. There were several important academic publications on the need for a different approach to achieve sustainable sanitation and the SDGs on urban sanitation, and indications of what such an approach would look like (for example - Andersson et al., 2016; Mara and Evans, 2018; Reymond et al., 2016; Tilley et al., 2014). Despite these academic and practitioner foundations and individual interpretations of the future of urban sanitation as seen in section 1.3, and the preparations for a paradigm shift as outlined in section 2.1, there remained an academic gap to clearly define CWIS and delineate its principles through sectoral consensus. This leads to the first research question of "**What is CWIS**?".

Since the Call to Action (BMGF et al., 2017), the first publication on CWIS was a policy brief introducing the concept and its relation to the SDGs (Lüthi and Narayan, 2018). Soon, more expert thinking on the concept came about with several articles exploring the concept and its principles since the CWIS conclave in Manila (see Gambrill et al., 2020a; Lüthi et al., 2020; Narayan and Luthi, 2020; Schrecongost et al., 2020). This helped clarify the concept further and bring various interpretations of CWIS converge since its inception. As more implementation programmes on CWIS began, there came a striking need for guidance on operationalisation of the CWIS principles. Today, various organisations and sanitation experts have made policy briefs, guidance notes on various aspects of CWIS such as monitoring, accountability, and business plan development available (see ADB, 2021; ESAWAS, 2020; IWA, 2020; Magawa, 2021).

While the conceptual understanding on CWIS is growing, another research gap becomes more prominent - how to plan for implementing CWIS. As seen in section 1.2, planning needs to be multi-disciplinary, participatory, systematic, contextualised, and synergistic. Section 1.2 also justified the benefits of bridging top-down and bottom-up approaches, and till date there exists no such bridged approach at a citywide scale in academic literature. Furthermore, since the introduction of CWIS, the targets of urban sanitation became more explicitly complex as shown by the Manila Principles on CWIS.

Therefore, existing sanitation planning methodologies including top-down approaches such as Sanitation 21, City Sanitation Plan (CSP) and Strategic Sanitation Approach (SSA) and bottom-up approaches such as HCES, CLUES, and Urban-Community Led Total Sanitation (UCLTS), (GIZ, 2016; Lüthi et al., 2011a; Myers, 2016; Parkinson et al., 2014; Tayler and Parkinson, 2005) do not meet the demands of the comprehensive CWIS principles. This is because, by design, these approaches were not aligned with CWIS, or that the approaches did not focus at the citywide level (such as CSP and HCES)

or did not get to the operational aspects (such as SSA and Sanitation 21). This brings out a specific research gap on "**How to plan CWIS by bridging top-down and bottom-up approaches**?".

As seen in section 1.5, this research presents India as the case study to explore urban sanitation and CWIS in depth. Therefore, there are specific questions to answer simultaneously in order to contextualise the research. Urban sanitation in India is well researched from various theoretical perspectives ranging from political economy to engineering technologies (Chaplin, 2011; Kalbar et al., 2012; Kulak et al., 2017; Wankhade, 2015; WSP, 2008) (see Chapter 3 for detailed review). However, there was no academic study that explored urban sanitation in India from a planning perspective. Therefore, the question of "**How is urban sanitation planned in India?**" has become relevant.

1.6.2 Research Questions and Objectives

The overarching goal of this thesis is to construct an understanding of CWIS, and develop a novel planning methodology for it – in both the global and the Indian context. As highlighted in the sections 1.2, 1.3 and the research gaps, this thesis first explores the paradigm shift in urban sanitation that led to the evolution of the concept of CWIS and then academically defines it. Next, instead of directly pursuing the CWIS planning question, the research needs to be strongly situated in a case study, which in this case is India's urban sanitation. Therefore, the thesis dives into the Indian sanitation situation, and presents key findings on urban sanitation planning. With the answers to these two mutually exclusive research pursuits, we can then develop a bridged methodology geared towards planning of CWIS globally and analyse its applicability in the Indian context. Therefore, the main research questions are threefold:

- **What is Citywide Inclusive Sanitation (CWIS)?**
- **What is the urban sanitation situation in India from a planning perspective?**
- **How can we plan CWIS by bridging top-down and bottom-up approaches?**

During the PhD research, to answer these three main research questions and achieve the overall aim of the research, five specific objectives were defined as follows.

- **Objective 1:**
  - To construct an understanding of CWIS in terms of its definition, principles and emergence.
- **Objective 2:**
  - **Objective 2a:**
    To analyse urban sanitation in India from historical, governance and planning perspectives.
  - **Objective 2b:**
    To develop a novel validation methodology for social network analysis, and test it an analysis of governance of (small-scale) sanitation in India.
  - **Objective 2c:**
    To analyse the key barriers to urban sanitation planning in India.
- **Objective 3:**
  - To develop a novel CWIS planning methodology that bridges top-down and bottom-up approaches and analyse its applicability in India.

The overall research objective of understanding Citywide Inclusive Sanitation and developing a novel planning approach for it, which in this research has been introduced as Bridged Approach to Inclusive Sanitation (BAIS), has a similarity to the development of HCES/CLUES approach based on the concept of Sustainable Sanitation as outlined by the Bellagio Principles (Figure 1.5).

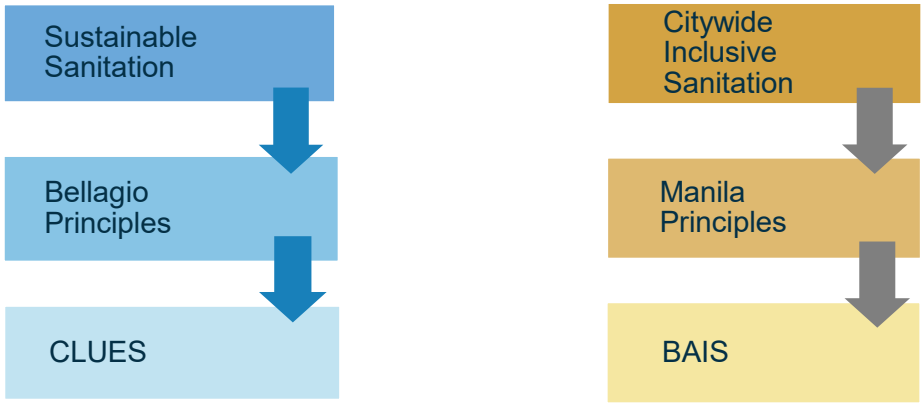


Figure 1.5 Comparing the development of CLUES with the development of the BAIS

1.6.3 Transdisciplinarity in Research Design

This PhD research falls in the intersection of environmental engineering, urban planning and development studies. This research is not only inter-disciplinary since it traverses the aforementioned disciplinary boundaries but is also transdisciplinary since it studies a societally relevant issue with the inclusion of stakeholders in the research. A seminal call for sustainability science stresses the need for participatory research that brings academia, practice and society together (Kates et al., 2001). Transdisciplinarity is defined as "a reflexive, integrative, method-driven scientific principle aiming at the solution or transition of societal problems and concurrently of related scientific problems by differentiating and integrating knowledge from various scientific and societal bodies of knowledge" (Lang et al., 2012). Simply put, it is an interdisciplinary research, which brings the scientific and societal actors together (Figure 1.6).

This inter- and transdisciplinary approach was necessary to research Citywide Inclusive Sanitation, due to the involvement of several disciplines and its high relevance to society. The first research question on what is CWIS, involved building consensus with several actors from science, society and practice. The second research question on what is the urban sanitation situation in India, followed an informal grounded theory approach (Bryant and Charmaz, 2007). This was needed to first understand the complexities and eventually respond to the complex questions using diverse qualitative and quantitative methods (e.g., social network analysis, shit flow diagrams, workshops, interviews and others that are explained in each of the chapters). The final research question on how to plan CWIS using a bridged approach was answered by building on the analysis of the previous two questions and basing it on the theoretical foundations of planning. The validation of the new Bridged Approach was explored for drivers and barriers in the case of India using primary data collected in earlier field missions for this purpose.

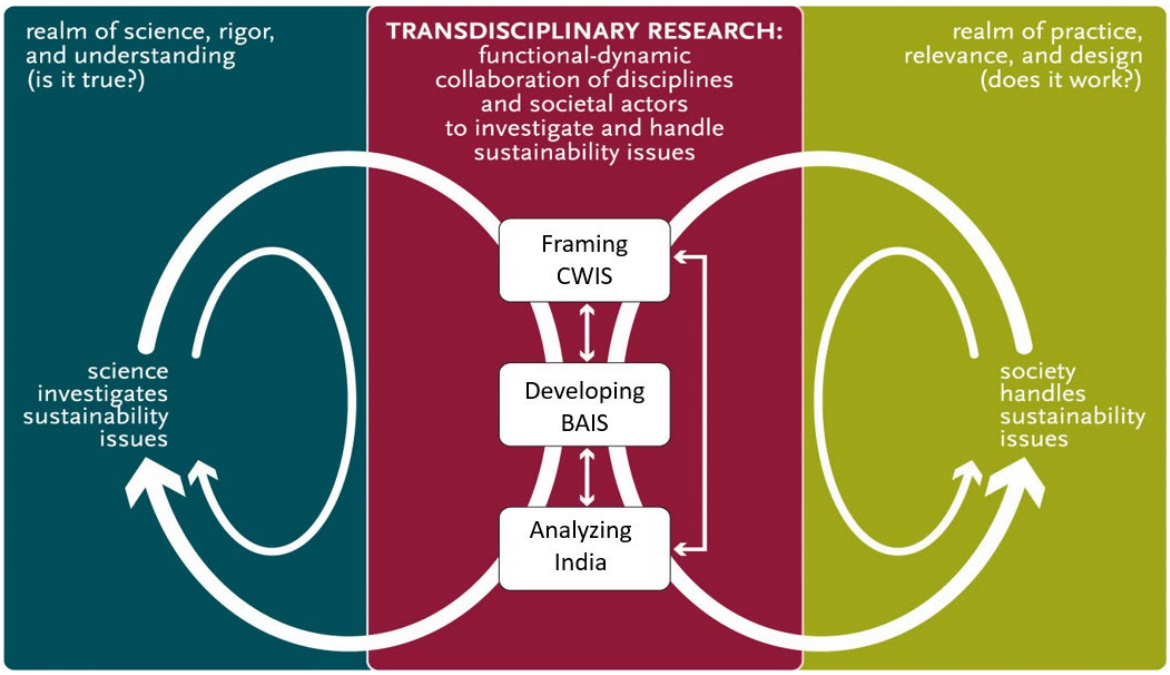


Figure 1.6: The transdisciplinary research process connects science and society in this research. Adapted from (Pohl et al., 2017).

Overall, the research needed an abductive approach that was reflexive and integrative of the findings and new developments. Although the resulting Bridged Approach to Inclusive Sanitation (BAIS) was developed from both theoretical foundations and primary data from Indian cities, which are locally diverse yet unique, the aim is to provide an approach for planning CWIS that is of global relevance. Therefore, this thesis has the difficult task of balancing both external and internal validity; the former in the globally relevant chapters (2 and 6), and the latter in locally relevant chapters (3, 4 and 5).

Therefore, the readers of this thesis could consider the transdisciplinary nature of the research which resulted in the following epistemological implications (adding to Rosenqvist, (2018)): (i) original contributions to knowledge have broader societal impact, (ii) reflexivity and responsiveness are espoused throughout the research, (iii) the societal relevance influences the direction of inquiry, and (iv) the breadth of engagement with different topics and contexts in the research causes a natural limitation on depth in use of certain methods.

1.6.4 Research Method

In order to research the set objectives, a mix of qualitative and quantitative methodologies was adopted, with an emphasis on the former. The first research objective (Objective 1) on constructing an understanding of CWIS was answered through a review of academic and grey literature, supplemented by interviews with sanitation experts who had contributed in shaping the sector. This helped understand the context in which CWIS emerged. The formulation of the definition and principles of CWIS was carried out through independent scholarly work, participation in the transdisciplinary CWIS Conclave in Manila. The synthesis from the conclave was used to further develop and validate the principles supplemented by expert interviews and workshops. It is worthwhile noting that CWIS as a

topic garnered huge interest in the sector in the last four years, as seen in section 1.4. Several other independent inquiries simultaneously took place on the topic (see section 1.4 and Chapter 2). Therefore, this research to the best of my abilities was reflexive and integrative of these rapidly arising developments on CWIS.

Research work on each of the six principles was carried out either independently or through collaborations with Master students and other academics. Depending on the specific research questions for each of the principles, a diverse set of methods was used which includes water quality analysis, complex system mapping, costing analysis and political economy analysis. Details of these methods are provided in Chapter 2 under each principle.

The second research objective (Objective 2a) on analysing sanitation and its planning in India needed more elaborate mix of methods. Firstly, a literature review of various policy documents and research papers was carried out to detail out the key policy shifts in sanitation in India with a specific attention to the alternate systems of Faecal Sludge Management (FSM) and Small-Scale Sanitation (SSS). Since FSM in India has been well studied (Devaraj et al., 2021; NITI-Aayog, 2021; WaterAid, 2016; WSP, 2008), this research gave more attention to SSS and borrowed existing literature on FSM.

The steady rise of SSS in India was poorly documented (Klinger et al., 2020), its governance needed to be studied closely, which another project at Eawag-Sandec focussed on (Chandragiri et al., 2019; Reymond et al., 2020). Social network analysis (SNA) is an underutilised yet powerful tool to understand information flows, governance effectiveness and coordination mechanisms (Hauck et al., 2016), which is relevant in the sanitation sector since it is cuts across several agencies in its planning and implementation. The secondary SNA data collected as part of the aforementioned project (Chandragiri et al., 2019) was further built on to develop a new validation approach for the social network. This new methodology was then tested to understand the institutional actors and their roles in the complex governance system of SSS in India. This answered the research objective 2b.

Objective 2c which analysed the urban sanitation planning practices in India was answered through eighty-four key informant interviews, participant observations, four expert workshops, social network analysis, shit flow diagrams (SFDs), policy and document analyses over two years. Based on the primary data collected through an elaborate mix of methods mentioned above, key barriers to sanitation planning in India were identified and analysed. These three inquiries helped achieve the three research objectives (Objectives 2a, b and c) specific to urban sanitation in India.

The final research objective (Objective 3) of developing a bridged approach to CWIS and analysing its applicability in India was based on inductive theory development using the primary data collected for the two earlier objectives (Objectives 1 and 2a, b, c). This resulted in the development of a theoretical framework for CWIS planning, then a procedural methodology that was rooted in fundamental planning theories. Ideally, such a methodology should be empirically validated. However, such a validation process would need significant time, funding and opportunity in terms of local stakeholders' interest, all of which were limited and uncertain (let alone the unprecedented COVID-19 pandemic). Therefore, the validation of BAIS has been out of the scope of this thesis from the very beginning. Nevertheless, its applicability in the Indian context is analysed using a driver-barrier analysis.

As mentioned earlier, this thesis follows a transdisciplinary research design, which is best explored through a case study approach, since it offers in-depth and multi-faceted exploration of a complex issue such as CWIS (Crowe et al., 2011; Scholz et al., 2006). Within India, four cities Bangalore, Chennai, Coimbatore and Mysore were chosen representing mega and secondary city contexts in two different states. A total of four field campaigns were carried out between 2018 and 2021 totalling ten months, with the last two visits in 2020-21 limited by the pandemic.

Finally, it is useful to note that the qualitative methods for the thesis including key informant interviews, expert workshops, participant observations etc., followed protocol from (Bryman, 2012). Individual chapters provide further details on specific methods, wherever necessary.

1.7 Lago di Como Thesis Structure

I wrote this thesis in Bellagio, the town located in the mid-point of Lake Como in Italy, given its historical significance to sanitation[7]. Therefore, I took inspiration from the unique inverted-Y shape of the lake to describe the structure of this thesis. The three branches of the lake denote the three research objectives of the research (Figure 1.7). Also, note that the first two independent research objectives on CWIS and Sanitation in India, were pursued in parallel, which ultimately contributed to the development on the third research objective on developing BAIS.

Figure 1.7: The structure of the thesis resembles Lake Como and its three branches

[7] The principles on Sustainable Sanitation were drafted in Rockefeller Foundation's Bellagio Centre, hence the name Bellagio Principles.

First, we start in the southwest branch, which represents answers to what is Citywide Inclusive Sanitation. **Chapter 2** provides an explanation for the emergence of CWIS, definition and principles of the concept, and its relation to the SDGs. For each of the CWIS principles, the chapter provides a lighthouse case study that operationalised it and a summary of a related research project that provides further depth on the principle.

Next, in the southeast branch, we have answers to the second research question on sanitation in India. **Chapter 3** begins with tracing the journey of sanitation in India, which maps the major policy shifts till date. It also provides critical perspectives based on the review of key literature exploring aspects of politics, governance, marginalisation, caste, and informal settlements, in relation to urban sanitation in India. The chapter ends with two sections summarising the FSM and SSS landscapes in India,

Chapter 4 has a combined objective of introducing Social Network Analysis (SNA) as a useful method for analysing sanitation governance, testing a novel validation methodology for SNA, and exploring the differences in sanitation governance between mega and secondary cities in India using Small-Scale Sanitation (SSS) as the focal point.

Chapter 5 is dedicated to analysing sanitation planning in India at the national, state and city levels. Based on policy and document analyses in addition to extensive fieldwork with interviews, workshops with a wide range of stakeholders, we present eight barriers to sanitation planning in India.

The northern tip of the lake Como represents the Bridged Approach to Inclusive Sanitation (BAIS). **Chapter 6** first introduces the three theoretical foundations of planning – typologies of planning theories, the planning triangle (with technocratic, bureaucratic and democratic corners), and the CWIS Planning Framework. Building on this foundation is the ten-stepped BAIS, which the chapter presents in detail.

In the intersection of the three branches is **Chapter 7**, which reflects on the applicability of such a framework in India. It contains a discussion on the challenges for the uptake of new sanitation approaches in India, how the CWIS planning framework can overcome the barriers to sanitation planning (presented in Chapter 4), stepwise drivers and barriers for BAIS, and the enabling environment for BAIS in India.

Finally, the conclusion of the thesis discusses the potential of CWIS and BAIS in India and beyond, critically reflects on the limitations of this research, presents ideas for future research and provides final remarks.

1.8 Relevance to Science and Society

This thesis makes direct contributions to scientific knowledge and societal issues. Academically, this research provides foundational knowledge on CWIS, a groundbreaking concept that had little clarity when its first global call to action was launched. The academic definition, refinement of the Manila principles on CWIS and the research on individual principles have contributed to filling academic gaps on CWIS. The formulation of the Bridged Approach to Inclusive Sanitation fills in a long-founded gap in urban sanitation planning, overcoming the limitations of traditional top-down and bottom-up planning approaches. The introduction of SNA and the validation approach as a practical methodology for governance analysis for the water, sanitation and hygiene (WASH) sector is useful from a methodological perspective. The novel validation method has already been picked up by academic inquiries in other data constrained sectors such as climate adaptation and healthcare in low- and middle-income countries (Etemadi et al., 2021; Nagel, 2020). On the case study front, this research

makes updates to the latest policy shifts in India especially since the Swachh Bharat Mission, and further documents the rise of FSM and SSS in the last two decades. Urban sanitation in India is analysed for the first time from planning perspective, and the key barriers to its success are identified.

In terms of broader societal impacts, this research worked to bring together various academic, policy and practice actors who are involved in CWIS initiative, potentially having a positive impact on their future CWIS activities and increased collaboration. Examples include the working group on Cities in the Sustainable Sanitation Alliance (SuSanA) and the recent collaborative session at the Stockholm World Water Week 2021 (Figure 1.8), both of which helped catalyse the process of creating a unified vision towards CWIS. The academic contributions to the concept are used in capacity development initiatives including the training of sanitation consultants on CWIS in six countries[8], targeted sessions to multilateral development banks and international agencies, and also deployed in Massive Online Open Course on sanitation design with a reach of over 25,000 learners[9]. During the four years of PhD research, more than 50 presentations were made on the topic ranging from keynotes to research seminars. This is not only useful in promoting and clarifying the concept, but also positively impacts research, as one study reveals the connection between public outreach activities and research outcomes (Kassab, 2019). Furthermore, with CWIS experts in several major development agencies championing the cause, the concept has gained huge traction, and billions of dollars of grants, loans, and investments are now aligned with the CWIS principles. While several CWIS projects are in the pipeline, the CWIS planning framework, and BAIS could be modified to needs or directly used to plan urban sanitation comprehensively.

Finally, this research work albeit foundational, is only a small part of the CWIS puzzle. Therefore, there is huge scope to further build on several relevant aspects of CWIS that this research merely touches on.

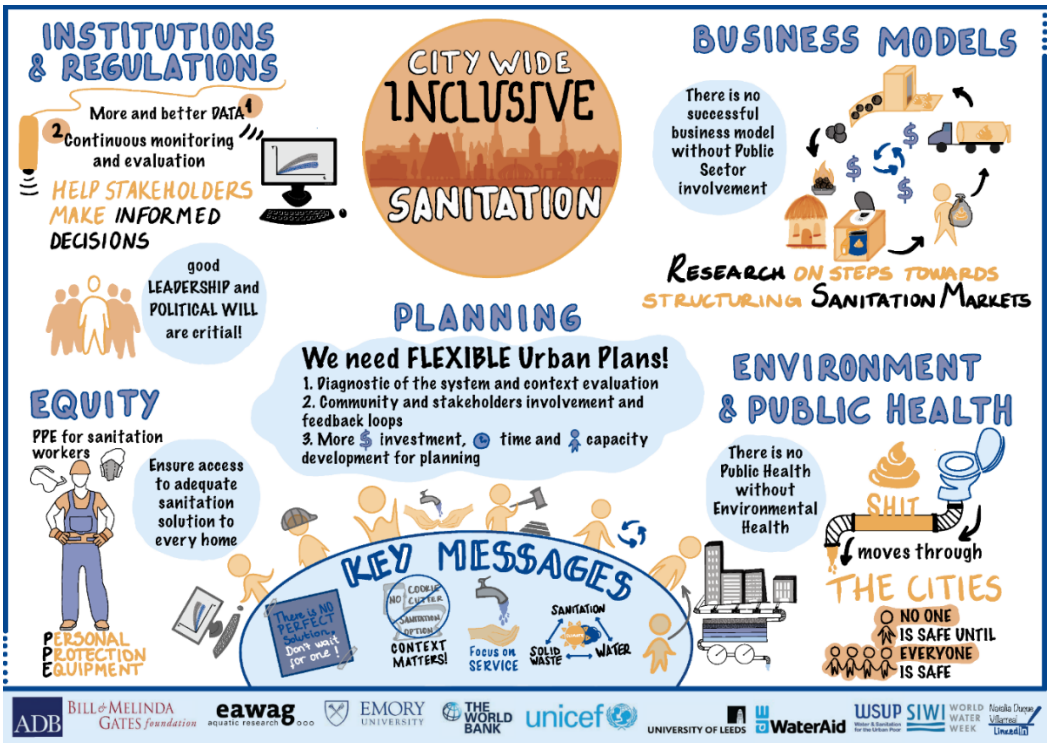


Figure 1.8: An Illustrative summary of the collaborative CWIS session at the World Water Week. CC BY: Author. Design credits Natalia Duque.

8 Visit www.sandec.ch/concad

9 Visit www.coursera.org/learn/sanitation

1.9 Critical Reflections

When I started this PhD on CWIS, it was a brand-new concept with little academic literature on it, but had a lot of enthusiasm from all fronts. Therefore, there were many possible research directions to venture. This was a double-edged sword; on one side, I had great support from policy and practice, since it was something exciting, but on the other side, it was also daunting since everyone I initially interviewed or collaborated with had widely different views on what CWIS should be. Furthermore, there were varying academic foundations to ground my research but none specifically on CWIS. However, just as the development of every new concept, a continuous triple loop learning took place (Tosey et al., 2011). The first loop is secondary learnings from past inquiries on sustainable sanitation. The second loop is primary field-specific learnings from various methods employed. And the third and bigger learning loop is the inductive reflection that helped develop larger concepts such as BAIS, make corrections to previous field-specific learnings, and also reflect upon the epistemological approach to the research itself.

This thesis also has had the difficult task of balancing multiple demands (Figure 1.9). Transdisciplinary research typically has to balance the rigor needed to produce robust scientific outputs, and the needs of the sanitation sector, which are simple and usable knowledge products in the field. To meet these dual needs, different formats of targeted scientific and socially relevant outputs were made (see section 1.10). Similarly, the scope of CWIS and BAIS are global with varying contexts, but the research needs to be rooted in a few contexts (such as mega and secondary cities in different states in India) to explore the complexities in depth. Therefore, Chapters 2 and 6 have a wide scope and high external validity, while Chapters 3, 4 and 5, remain specific to India, with few generalisable results.

The methodologies used in the thesis, although diverse, offer only limited range of results. Since the thesis relies majorly on a qualitative approach (complimented by few quantitative methods), and due to the nature of the research questions, there may be selection and information biases in play (Norris, 2007). For example, the selection of key informants could lead to an echo chamber effect or the information elicited on a politically sensitive topic such as sanitation could lead to polished statements and misinterpretation by the researcher. However, steps were taken to mitigate these as much as possible by being strict with research protocol, triangulation, diversification of case studies and respondents, reflexivity in learnings and taking a multi-perspective approach. Finally, ethical considerations are made throughout the thesis, including informed consent, anonymity, and credit provision. According to Eawag Ethical Review of Projects involving human subjects (PD-16-09), this is deemed minimal risk.

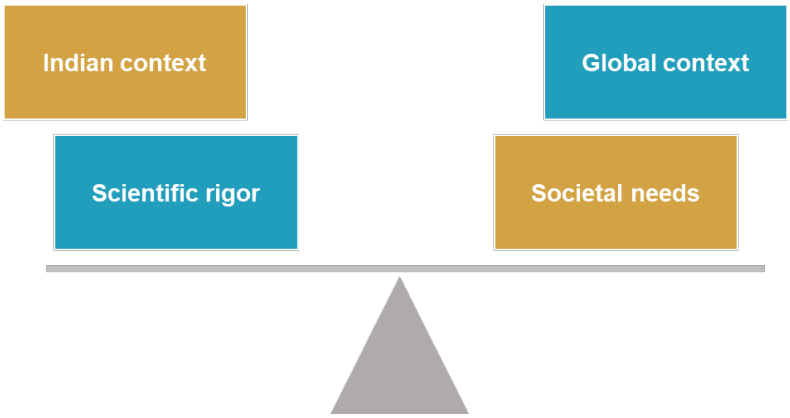


Figure 1.9: The balancing act in this thesis

1.10 Author Contributions

This thesis draws from the author's contributions in a variety of formats that includes journal articles, book chapters, conference articles, policy briefs, scientific reports, and grey literature. Thus, this thesis builds on a broad body of knowledge developed and written to reach different audiences including – scientists, policy makers, practitioners, and the general public (Figure 1.10). In order to make a coherent and up to date thesis, certain sections are modified and others are directly inserted. The original contributions are clarified at the start of every chapter following the Contributor Roles Taxonomy (CRediT[10]), but an overview of various sources is provided here (Table 1.1). Since this thesis structure falls between monographic and cumulative styles, there are cross-references and boxes to guide the reader through the various chapters and sections.

Collaboration is key in transdisciplinary research, and this thesis too builds on collaborative research work. Almost all the published work presented here have been in collaboration with academics and/or practitioners. Furthermore, my supervisors Dr. Christoph Lüthi and Prof. Max Maurer come from different scientific fields and provided expert and complimentary feedback. They significantly shaped the entire research by providing intellectual guidance, feedback, and helped in the formulation of the thesis and all publications in it.

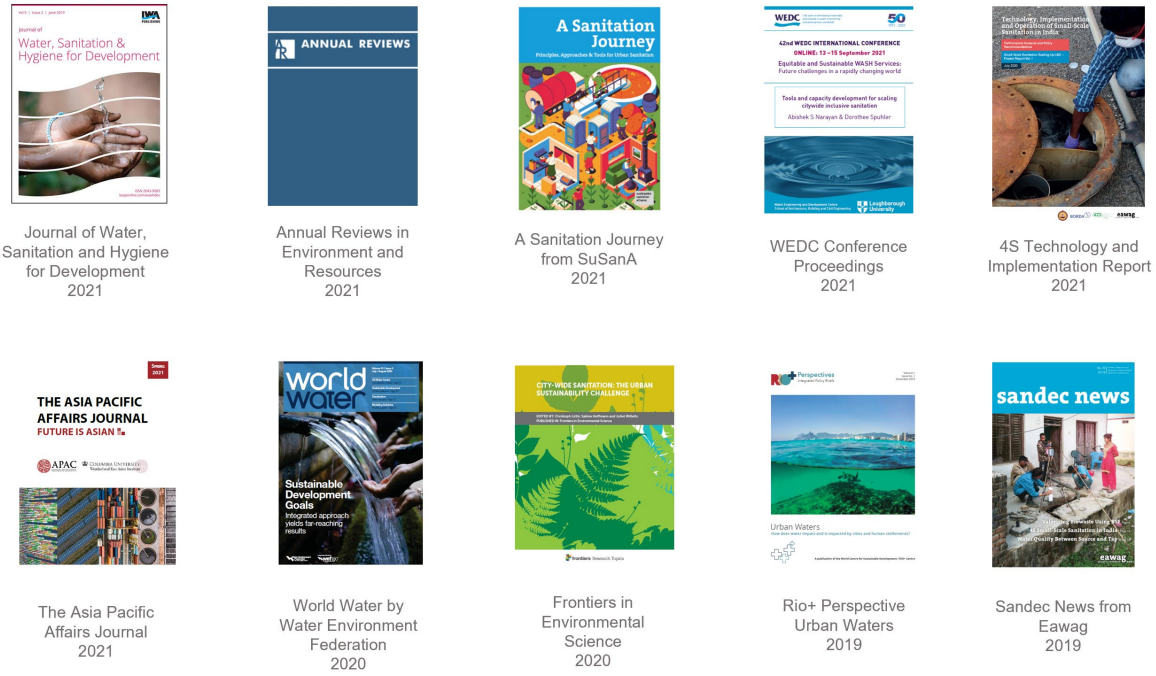


Figure 1.10: Key publications that the thesis draws from includes a mix journal articles and grey literature

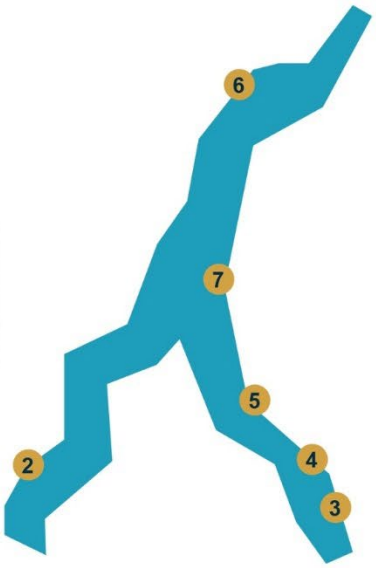
10 Visit www.credit.niso.org

Table 1.1: Overview of sources *for each chapter*

CHAPTER	SECTIONS	SOURCE(S)
2	Emergence Landscape of urban sanitation Definition & Principles Relation to SDGs	(Narayan and Luthi, 2019) (Schertenleib et al., 2021) (Narayan et al., 2021a) (Lüthi and Narayan, 2018) (Narayan and Lüthi, 2020)
	Summaries of Research on Principles: Equity Environmental and Public Health Mix of Technologies Comprehensive Planning Monitoring and Accountability Mix of Business Models	(Narayan and Agarwal, 2021) (Navamany et al., 2022) (Mitra et al., 2022) (Narayan et al., 2021a) (Saker and Narayan, 2022) (Dutta, 2020)
3	Policy Shifts	Original Unpublished Contribution
	Landscape of FSM Landscape of SSS	Original Unpublished Contribution (Klinger et al., 2020)
4	SNA for WASH : Sanitation Governance in India	(Narayan et al., 2020)
5	Sanitation Planning in India	(Narayan et al., 2021b)
6	CWIS Planning Framework Bridged Approach	(Narayan et al., 2021b) Original Unpublished Contribution
	Tools and Capacity Development for CWIS	(Narayan and Spuhler, 2021)
7	Applicability of BAIS in India Applicability of CWIS Planning Framework	Original Unpublished Contribution (Narayan et al., 2021b)
	City Sanitation Plan	(Schertenleib et al., 2021)

Hi there!
I'm your boatman.
I will navigate you through
Lake Thesis.

Lake Thesis is shaped like
an inverted Y.
The southwest end has
stops on CWIS.
The southeast end has stops
on Sanitation in India.
The North end has stops on
the Bridged Approach



In each town we
visit, I will
summarise the
highlights!

Hop on!

02

Evolution towards Citywide Inclusive Sanitation

> **CWIS is old wine in a new bottle – but hopefully one that will be consumed much more widely**
>
> ***– Roland Schertenleib***

This Chapter draws from several previously published and submitted versions of research articles:

Section 2.1 is an original contribution to this thesis. But it draws from the work previously published in: Schertenleib, R., Lüthi, C., Panesar, A., Büürma, M., Kapur, D., Narayan, A. S., Pres, A., Salian, P., Spuhler, D., and Tempel, A. (2021). A Sanitation Journey – Principles, Approaches & Tools for Urban Sanitation. Dubendorf: Sustainable Sanitation Alliance. The contents of this section were jointly conceptualised by R.S., C.L., M.B., D.S., A.S.N, A.P., and A.S.N. This section's original draft was jointly written by R.S., M.B., D.S., and A.S.N. Supervision, funding acquisition and reviews were provided by C.L. and A.P.

Section 2.2 has been published in: Narayan, A. S., Marks, S. J., Meierhofer, R., Strande, L., Tilley, E., Zurbrügg, C., and Lüthi, C. (2021a). Advancements in and Integration of Water, Sanitation and Solid Waste for Low- and Middle Income Countries. Annu. Rev. Environ. Resour. 46, 193–219. doi:10.1146/annurev-environ-030620-042304. This section was jointly conceptualised by A.S.N, C.L., and L.S. The original draft was written by A.S.N. Formal analysis was jointly carried out by A.S.N, C.L., and L.S. Project administration and managing reviews and editing was done by A.S.N.

Section 2.3 and 2.4 have been published in two parts: (1) Narayan, A. S., and Luthi, C. (2019). Citywide Inclusive Sanitation - Old wine in New bottle ? Sandec News, 21–22. and (2) Narayan, A. S., and Lüthi, C. (2020). Solving urban sanitation - sustainably and equitably. World Water 43. Both publications were jointly conceptualised by A.S.N. and C.L. The original drafts, data analysis and reviews were managed by A.S.N. Supervision and resources were provided by C.L.

Section 2.5 is a collection of original summaries written from research articles published or submitted:

Section 2.5.1 is published as: Narayan, A. S., and Agarwal, M. (2021). Equity in Sanitation - The forgotten pillar. Asia Pacific Aff. J. 8. A.S.N and M.A. jointly conceptualised this publication. A.S.N. wrote the original draft and managed the reviews and editing.

Section 2.5.2 is a summary of the submitted version of: Navamany, G. C., Narayan, A. S., and Scholten, L. (2022). There is no Environmental Health without Public Health - Establishing the links between sanitation and waterbody health in Bengaluru, India. Submitt. to Environ. Urban. C.G.N, A.S.N. and L.S jointly conceptualised this publication. C.G.N. carried out the investigation, data curation, visualisation and project administration. A.S.N. and L.S. provided resources and supervision.

Section 2.5.3 is a summary of the submitted version of: Mitra, A., Narayan, A. S., and Luthi, C. (2022). Sanitation Potpourri: Criteria for Planning Mix of Technologies for CWIS. Submitted to Environ. Plan. B. A.M, A.S.N, and C.L., jointly conceptualised this publication. A.M. carried out the investigation, data curation, visualisation and project administration. A.S.N and C.L. provided resources and supervision.

Section 2.5.4 is a summary of the published version of: Narayan, A. S., Marks, S. J., Meierhofer, R., Strande, L., Tilley, E., Zurbrügg, C., and Lüthi, C. (2021a). Advancements in and Integration of Water, Sanitation and Solid Waste for Low- and Middle Income Countries. Annu. Rev. Environ. Resour. 46, 193–219. doi:10.1146/annurev-environ-030620-042304. A.S.N, S.M, R.M., L.S., E.T., C.Z., and C.L. jointly conceptualised this publication. A.S.N. wrote the original draft in this section, managed the reviews and editting, analysis and visualisation of results.

Section 2.5.5 is a summary of the submitted version of Saker, A., Pedraza, A.B., and Narayan, A. S. (2022). Regulating Citywide Inclusive Sanitation in Colombia. Submitt. to Int. J. Env. Res Pub. Heal. A.S., A.S.N jointly conceptualised this publication. A.S. and A.B.P carried out the investigation, data curation and validation. A.S. wrote the original draft and analysed the data. A.S.N. and Micheal Rouse provided supervision and resources.

Section 2.5.6 is a summary of the submitted version of: Dutta, R. (2020). Costing and Planning Analysis of CWIS in India. MSc Thesis. ETH Zürich, Switzerland. R.D. and A.S.N. jointly conceptualised the research. R.D. conducted the investigation, wrote the original draft, curated the data, created the visualization and programmed the software. A.S.N, and C.L., acquired funding, and provided supervision and resources.

2.1 Emergence of the CWIS paradigm

In order to understand how CWIS emerged and why it gained significant traction in the sanitation sector and beyond (as seen in section 1.4), it is first important to understand the historical context of urban sanitation as a development agenda (Figure 2.1). The following sections map the evolution of the urban sanitation discourse since the 1960s from the context of international development and cooperation.

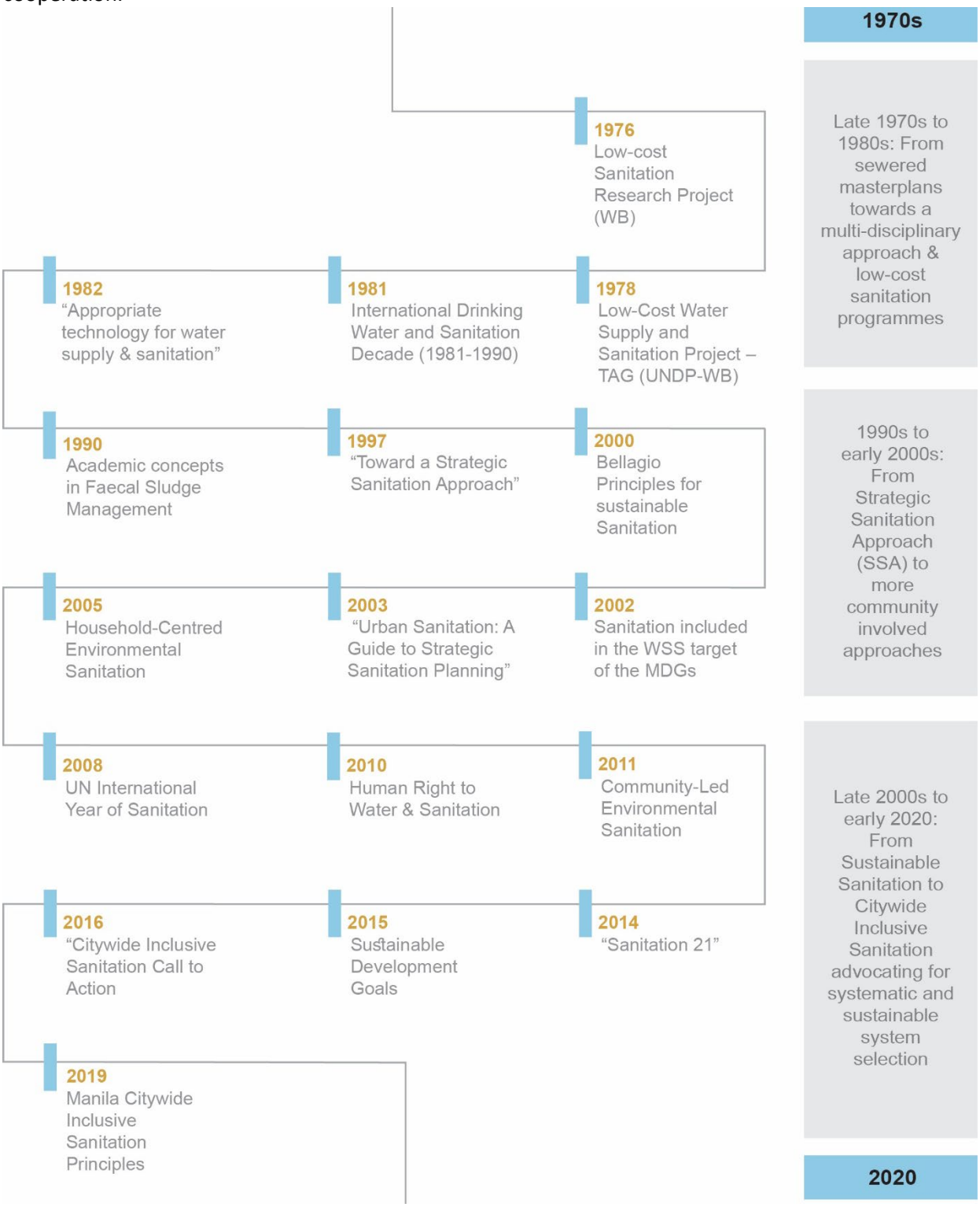


Figure 2.1: Timeline on the evolution of the urban sanitation agenda with relevant developments highlighted in this figure. Adapted from (Schertenleib et al., 2021).

2.1.1 Evolution of Urban Sanitation

Although the number of people in the cities of Global South with access to improved sanitation increased significantly over the last three decades, progress has been outpaced by rapid urbanisation and population growth. Currently, 103 out of the 119 countries surveyed have slow or even negative progress to achieve universal access to basic sanitation (UNICEF & WHO, 2021). One reason for the progress not keeping up with the demands is that, in most countries, this progress has selectively served segments of the population; people belonging to the higher income categories who benefit from expansion of centralised sewer based sanitation and leaving behind the urban poor (Hawkins et al., 2013b; Saroj et al., 2020; WSUP and EY, 2018). A recent global study revealed that only 6% of the WASH subsidies reach the poorest quintile of a country in contrast to the 56% that benefit the richest quintile (World Bank, 2019).

2.1.2 Decades of initial research on low-cost sanitation (late 1960s - 1980s)

Between 1960 and 1980, the urban sanitation development agenda set conventional sewerage as the universal panacea since it served the high-income countries well in the 20th century. However, the high capital and operational costs prevented its reach to most of the urban population that lived in LMICs (Schertenleib et al., 2021). Nevertheless, this agenda changed with early research done on low cost urban sanitation, and the World Bank - UNDP's Technical Advisory Group (TAG) recommendation of alternative non-sewered sanitation solutions to the conventional sewer paradigm, with a special focus on service outcomes (Kalbermatten et al., 1980). This set up the basis for strategic sanitation planning, promoting the concept that sanitation challenges need to be addressed not only through a multi-technology approach, but also through a multi-disciplinary approach (Kennedy-Walker et al., 2014).

2.1.3 Decades of development of the sanitation planning concepts (1990s to early 2000s)

In the 1990s, the concept of Strategic Sanitation Approach (SSA), more clearly put the above thinking into three key aspects: (i) user preferences and willingness to pay (ii) unbundling of sanitation services into household and trunk services, (iii) co-producing services using informal and formal institutions (Wright, 1997). In 2000, a group of sanitation experts (representing the Environmental Sanitation Working Group of the Water Supply and Sanitation Collaborative Council (WSSCC) now the Sanitation and Hygiene Fund), synthesised the Bellagio Principles on Sustainable Sanitation (Schertenleib et al., 2003). This was one of the first times that the sector unified itself and endorsed a community-centric, citywide, comprehensive planning based, top-down and bottom-up bridged approach to sanitation.

The Bellagio Principles led to the conception of two prominent sanitation planning approaches namely; Household-Centric Environmental Sanitation (HCES) (Eawag, 2005) and the Community-Led Urban Environmental Sanitation (CLUES) (Lüthi et al., 2011a). The HCES approach was never tested in its integrity for citywide sanitation planning since no appropriate pilot site could be found with the required enabling environment (Schertenleib et al., 2021). CLUES was tested widely but successful at a neighbourhood level and remained difficult to scale to a city level.

2.1.4 Decades of advancements in the global sanitation agenda (late 2000s - early 2020s)

Since the late 2000s, sanitation received significantly more global impetus. The UN declared 2008 as the International Year of Sanitation. The Sustainable Sanitation Alliance (SuSanA) was formed. The UN declared Sanitation to be a Human Right in 2010 (UN GA, 2010). Finally, safely managed sanitation featured prominently in the Sustainable Development Goals and, WHO and UNICEF jointly established a monitoring programme for benchmarking and comparing service levels across countries (UN GA, 2015; UNICEF and WHO, 2016). During this time, several planning support systems such as guidelines and tools were being developed. They include the City Sanitation Planning (CSP), Sanitation 21, Concerted Municipal Strategy (CMS), Shit Flow Diagrams (SFD), Citywide Service Delivery Assessment (CSDA), WHO's Sanitation Safety Planning Guidelines, and the Faecal Sludge Management (FSM) ToolBox among others (GIZ, 2016; Parkinson et al., 2014; Peal et al., 2014; WHO, 2015).

During the 2010s, more specifically, in the second half of the decade, urban sanitation programmes gained prominence with many development agencies and research institutes giving special attention to urban sanitation (Schertenleib et al., 2021). In addition, the Human Rights, FSM and cross-sector inter-linkages, resulting from the SDGs (i.e. SDG 6 on water and SDG 11 on cities), laid the ground for the development of a unifying concept that builds on the various lessons learnt in the past five decades and leverages the available knowledge and implementation resources.

2.1.5 Advent of CWIS

All these aforementioned factors led to the eventual development of Citywide Inclusive Sanitation (CWIS) and its corresponding Manila principles. CWIS is based on the understanding that previous attempts at solving the urban sanitation challenge through the existing approaches have not been fully successful, and that new approaches are needed to reach the goal of 100% safely managed sanitation for all as stated in the SDG 6 (Gambrill et al., 2020; Lüthi and Narayan, 2018; Schrecongost et al., 2020).

However, CWIS is not a radically new approach; rather it brings various strands of elevated thought on urban sanitation under one umbrella. Each of the six principles have been previously been espoused by the sector in many sanitation interventions and knowledge products. For example, equity in terms of poverty, gender, decentralisation etc have been well explored (Burt et al., 2016; Garcia and Rajkumar, 2008; Gounden et al., 2006; Mehta and Mehta, 2013). Similarly, the environmental health and value chain approach have been more widely standardised since the early 2000s, and the Compendium, SFD and other aforementioned tools in section 2.1.4 are evidence. Comprehensive sanitation planning in terms of inclusion of multiple stakeholders, community participation, and demand generation have also been widely acknowledged as essential much before the advent of CWIS. The strength of CWIS is that, these different principles have been systematically unified in a single approach, and has built significant consensus within the sector (see sections 1.4 and 2.3) as the way forward.

Therefore, in order to understand at greater depth the evolution of urban sanitation in terms of discourse, technology, planning in the last two decades, a review is presented in the following section, before diving into the details of CWIS in section 2.3.

2.2 Review of recent advancements in sanitation

2.2.1 Introduction

Sanitation, as a field of development, underwent significant changes in the past two decades. After receiving prominence in the Millennium Development Goals (7C), which set to halve the population without access to basic sanitation, the subsequent Sustainable Development Goals (6.2 and 6.3) set far more ambitious targets which aim to provide safely managed sanitation for all. Achieving the new targets by 2030 will require providing universal access to improved sanitation for more than double the number achieved during the MDGs, and four times for safe management of faecal waste, all at an estimated cost of at least USD 71 billion per year (Mara and Evans, 2018). The benefits of improved sanitation particularly on health, but also on social and environmental development has been well documented (Mara et al., 2010). Likewise, the economic benefits of sanitation are now also internationally acknowledged (Hutton, 2013b). The attention that sanitation received in the past decade has galvanised countries to take actions towards providing improved sanitation leading to institutional behaviour change, for example, through the Clean India Mission, which aimed to end open defaecation in India over a five year period (Curtis, 2019).

Such a step-change has been driven by an evolution of thinking of sanitation beyond access to toilets, to the safe management of the entire sanitation service chain, and a service delivery approach rather than mere infrastructure provision (Hyun et al., 2019; Reymond et al., 2016). Perhaps, the most significant shift is the increased acceptance of non-sewered and decentralised sanitation systems as adequate and long-term options, on par with sewer-based centralised treatment systems (Dodane et al., 2012; Gambrill et al., 2020). Evidence of this acceptance is seen by increased incorporation in development agendas, and the rapid rise of non-sewered solutions, including faecal sludge management (FSM) (Strande et al., 2014), container-based sanitation (CBS) (Russel et al., 2019), and decentralised/small-scale sanitation systems (SSS) (Reymond et al., 2020).

Although rural areas in most countries are yet to catch up with sanitation progress in urban settings, the complexity of challenges in the latter due to rapid urbanisation, poverty, and population density has resulted in urban sanitation gaining more attention than the rural counterpart. In urban sanitation, there has been a recent trend to break sectoral silos and look for interlinkages with other basic urban services towards a citywide approach (Scott et al., 2019). An important realisation of the past decade is that, end-of-pipe sewered systems will not be able to cover the huge spatial footprint of rapidly urbanising areas of Africa and Asia. In the future, non-sewered solutions from onsite to small-scale (or decentralised) solutions will be implemented in parallel as networked solutions, or as an alternative to expensive sewer-based systems (Gambrill et al., 2020). These changes have resulted in the paradigm shift towards Citywide Inclusive Sanitation (CWIS). The goal of CWIS is for everyone to have access to equitable, safely managed sanitation through implementation of a range of solutions tailored to the realities of rapidly growing cities, including sewered and non-sewered, decentralised, and centralised technologies (Gambrill et al., 2020; Narayan and Lüthi, 2020; Schrecongost et al., 2020).

2.2.2 Technology

A broad range of technology solutions are required for CWIS. Centralised, sewer-based technologies are well established with a long-record of research, knowledge, and implementation, and guidelines for onsite containment of excreta for rural areas are well accepted (Jenkins and Wanner, 2014; Wagner et al., 1958). The concept of integrated faecal sludge management in urban areas is, in comparison, relatively new but recent acceptance has led to research funding from foundations, increasing scientific journal publications, and rapidly evolving technology development along the sanitation service chain (Strande et al., 2014; Velkushanova et al., 2020; WHO, 2018)

There is no 'one size fits all' solution, and new technologies are greatly needed to meet the demand, and reduce the required footprint for treatment in urban areas. As technologies are advancing, they can be considered, from a risk management perspective, as (i) established (e.g. existing guidelines for operation), (ii) transferring (e.g. borrowing from established treatment of other waste streams), and innovative (e.g. still in development) (WHO, 2018). Innovations at the level of onsite containment, include technology developments for the collection and containment of excreta with a container-based approach for collection (Russel et al., 2019), and improved emptying technologies for pit latrines (Chipeta et al., 2017). The closed-loop solutions being investigated within the "Reinvent The Toilet Challenge" are designed to simultaneously contain and treat excreta onsite with technologies including hydrothermal carbonisation, microwave technology, supercritical oxidation, pyrolysis, and electrochemical processes (Hiolski, 2019). Successful scaling up of these innovations could result in a profound change to the entire service chain. Technologies being transferred from the wastewater and the paper and pulp industry include the use of conditioners, presses, and geotextiles for dewatering (Velkushanova et al., 2020).

In the last decade there was a shift toward resource recovery in the hopes that it would 'close the loop' and offset the financial costs of sanitation provision. This re-imagined thinking drove advances in resource recovery that have greatly expanded the list of possibilities, including energy (e.g. fuel, heat) (Andriessen et al., 2019; Krueger et al., 2020), food (e.g. animal fodder from plants, protein production from BSF) (Lalander et al., 2013), nutrients (e.g. soil conditioner, fertiliser) (Nikiema et al., 2014), and water (reclamation from effluent) (Strande et al., 2014). Market demand for treatment products can also help drive operation of the service chain to meet customer demand. However, the potential revenue will, realistically, only offset disposal costs and a fraction of operating costs depending on demand, end products, and chosen technologies (Diener et al., 2014). The recent shift towards non-sewered, onsite and decentralised solutions has expanded the room for private sector engagement in the sector. This diversified sanitation landscape allows for the creation of new business models with high returns on investment (ADB, 2020; Russel et al., 2019).

2.2.3 Planning

Sanitation planning is also a rapidly evolving field and the past decade has seen the evolution of integrated planning guidelines and frameworks that address aspects of inclusiveness and stakeholder engagement (Kennedy-Walker et al., 2014). Planning-related challenges range from a lack of human resources, narrow aspirations toward conventional sewered solutions (which result in socially-segregated service levels), to the lack of a planning culture apparent in many LMIC settings (Satterthwaite et al., 2019).

The concept of the sanitation service (or value) chain provides a 'systems approach' to the flow of waste from capture to disposal (Mara et al., 2007). This concept has been standardised through the Compendium of Sanitation Systems and Technologies (Tilley et al., 2014b). More recently, the communicative planning processes that could increase community ownership and empowerment by improving the long-term sustainability of basic urban services has been popularised (Lüthi et al., 2011a; Myers, 2016). Community involvement and demand creation are now recognised as critical steps in sanitation planning and implementation in unserved and underserved areas (Murray and Ray, 2010), including the widely known Community Led Total Sanitation (CLTS) approach which targeted rural communities (Kar and Chambers, 2008). The value of coproduction and the incorporation of local knowledge have been documented as key factors for long-term sustenance (McGranahan and Mitlin, 2016). With the advent of CWIS, planning is required to be even more inclusive and comprehensive, since sanitation solutions need to be equitable, sustainable, and contextualised with multiple modes of service delivery (Gambrill et al., 2020).

2.3 Unpacking Citywide Inclusive Sanitation

The following sections include texts that are adapted from the author's contributions in the publications that introduced and explored the concept of CWIS (Lüthi and Narayan, 2018; Narayan and Luthi, 2019, 2020).

2.3.1 History of CWIS

It is evident from the sections above that the evolution of urban sanitation (section 2.1) and its recent advancements (section 2.2) led to CWIS. Various different threads of change include move away from infrastructure focus to service based, from waste management mentality to resource recovery mentality, from single "one size fits all" approach to more contextually appropriate approach, and from top-down to more inclusive planning. Despite these lighthouse changes, urban sanitation remained an elusive challenge in the Global South. This prompted for a paradigm shift in urban sanitation, towards a 'business as unusual' concept (Gambrill et al., 2020).

The emergence of CWIS traces back to a sanitation conference in Atlanta in 2016, where sanitation sector experts conceptualised CWIS (Narayan and Luthi, 2019). This was followed by a Call for Action at the Stockholm World Water Week in 2017 where CWIS was broadly put forth under four pillars: (i) Human Rights, (ii) Economy, (iii) Partnerships and (iv) Sanitation value chain (BMGF et al., 2017). The Bill & Melinda Gates Foundation, Emory University, Plan International, The University of Leeds, WaterAid, the World Bank signed this Call to Action. The following year, at the Beijing Toilet Expo, Bill Gates from his Foundation and Jim Kim, then President of the World Bank committed to unlocking 2 billion USD of funds towards CWIS projects. It is only after this, that a conclave on CWIS took place in Manila where experts from academia, international development agencies, NGOs, National Governments gathered and loosely conceived the Principles on CWIS (Narayan and Lüthi, 2020). Academia then caught up with practice and a series of fundamental knowledge outputs on CWIS were launched (see publication collection from Lüthi et al., (2020)).

At present in 2021, there are a number of pilot projects on CWIS worldwide at various scales. Several billion dollars have been invested on CWIS projects by multi-lateral development banks (World Water Week, 2021). The Gates Foundation has several city partnerships across South Asia and Sub-Saharan Africa where CWIS is being rolled out along with the necessary institutional support. WaterAid, WSUP and other global NGOs are supporting local governments in the implementation of CWIS in several countries including India, Kenya and Bangladesh. Universities such as Leeds and Emory are developing novel tools to support decision makers and planners for designing CWIS solutions. Eawag has developed capacity development and training modules for graduate programmes, private consultants and public sector to build CWIS capacities in six countries in Asia and Africa (See Figure 2.2).

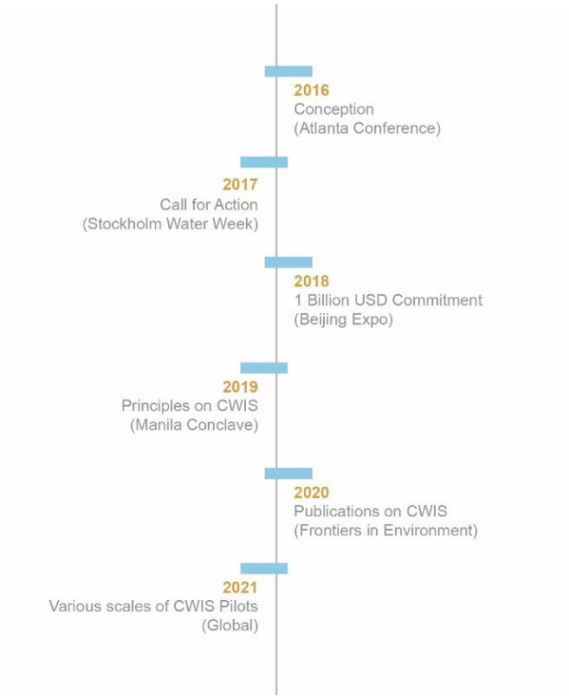


Figure 2.2: Emergence and Uptake of CWIS from 2016-2021

2.3.2 Building consensus on the CWIS concept

While CWIS gained a lot of attention, it also resulted in diverse interpretations of the concept by a range of actors who supported it. When this study began in 2018, there was not much academic background on CWIS specifically. There was a need for developing a clear definition and a set of principles to ensure that the concept of CWIS remained unified and was not interpreted with huge variations by different organisations and individuals.

Therefore, 30 semi-structured interviews with leading urban sanitation experts and CWIS proponents were carried out. In addition, the Manila Conclave on CWIS was opportunistically used to collect workshop data and the conclave's synthesis document was used to arrive at a basis for the definition and principles. Following this, a Working Group meeting with the Sustainable Sanitation Alliance (SuSanA), which gathered 35 members who were familiar with the CWIS approach, was carried out in 2019 at the Stockholm World Water Week. This process, over 2 years in 2018-2019, not only helped arrive at an academically sound definition for CWIS, but also created the much-needed consensus on the Manila Principles on CWIS.

Today, three important documents on CWIS exist, which justify the emergence and clarify the concept in detail (Gambrill et al., 2020; Narayan and Lüthi, 2020; Schrecongost et al., 2020). They have slight variations between them, but are fundamentally similar in terms of their meaning and principles. Throughout this thesis, the author's own aforementioned work will be used when referring to CWIS and its principles.

2.3.3 Definition

Citywide Inclusive Sanitation (CWIS) is defined as an approach to urban sanitation, where all members of the city have equitable access to adequate and affordable improved sanitation services through appropriate systems of all scales (sewered & non-sewered), without any contamination to the environment along the entire sanitation value chain (Narayan and Lüthi, 2020).

2.3.4 Manila Principles on CWIS

1. Equity:
   Everyone in an urban area — including communities marginalised by gender, social, and economic reasons — benefit from equitable, affordable, and safe sanitation services.

2. Environment and public health:
   Human waste is safely managed along the entire sanitation service chain, starting from containment to reuse and disposal.

3. Mix of technologies:
   A variety of sewered and non-sewered sanitation solutions coexist in the same city, depending on contextual appropriateness and resource recovery potential.

4. Comprehensive planning:
   Planning is inclusive and holistic with participation from all stakeholders including users and political actors — with short- and long-term vision and incremental perspective and is synergistic with other urban development goals.

5. Monitoring and accountability:
   Authorities operate with a clear, inclusive mandate, performance targets, monitoring requirements, human and financial resources, and accountability.

6. Mix of business models:
   Sanitation services are deployed through a range of business models, funding sources, and financial mechanisms to reach all members equitably.

2.3.5 CWIS and the SDGs

CWIS is directly linked to the SDG 6 on clean water and sanitation. The specific targets and indicators include 6.2 of safely managed sanitation, 6.3 of wastewater treatment, 6a of capacity building and 6b of community participation. Clearly, citywide inclusive sanitation is cross-sectoral in nature and can contribute to the progress of other SDGs such as good health and wellbeing (SDG 3), gender equality (SDG 5), reduced inequalities (SDG 10) and sustainable cities (SDG 11). Through resource recovery and encouraging a circular waste economy, it adds to Goals 7 and 12 which are, clean energy and responsible consumption (SuSanA, 2017). As a corollary, the consequences of inadequate sanitation affect everyone as human waste and its pathogens recognise no boundaries and spread freely across urban areas, therefore affecting many development goals.

2.4 Operationalising CWIS and lighthouse cities and towns

The CWIS principles provide a framework for action by setting the broad vision for sustainable and inclusive urban sanitation. However, there is no single approach for reaching these goals. Each case needs contextualised targets and an operational approach embracing the CWIS principles. Therefore, no case study exists (yet) that binds all six principles to serve as an example of success. However, exemplary projects and lighthouse cities exist for each of the CWIS principles, which are inspiring in this regard.

1. Lighthouse city for equity: eThekwini

The eThekwini Municipality in South Africa (formerly Durban) embraced a novel approach to providing adequate and affordable sanitation services to all of its population in 2004, including under-serviced informal settlements and peri-urban districts in the hinterland. The municipal water services department was looking for a cost-effective alternative to waterborne sewage for its vast peri-urban settlements, which were unlikely to be connected to the city's sewerage in the medium term. All households outside the sewered town center have been provided with urine-diversion dry toilets (UDDTs), thanks to a national subsidy scheme called the Municipal Infrastructure Grant (MIG) to subsidise high-quality UDDTs for these households. To date, more than 95,000 UDDTs have been installed in the peri-urban settlement areas of eThekwini. Further reading: (Gounden et al., 2006).

2. Lighthouse city for environmental and public health: Sinnar

Sinnar is a small city near Mumbai in India where the priorities go beyond open-defaecation-free status to management of the entire sanitation value chain, from access to toilets to treatment of faecal waste streams. Apart from providing subsidies and credit for individual household latrines, efforts were taken in the last few years to build and maintain community and public toilets. Scheduled desludging services provided by the city government and a global positioning system (GPS)-enabled vehicle tracking system ensures that the faecal sludge is transported directly to the treatment facility and not dumped into the environment. There are ongoing plans of settled sewers to capture grey water for treatment and reuse in industries. Further reading: (Mehta et al., 2019).

3. Lighthouse city for mix of technologies: Addis Ababa

Addis Ababa is the fast-growing capital city of Ethiopia. Although the city has not yet achieved improved sanitation for all, it is taking bold steps in the right direction. Among many innovations for pro-poor sanitation services, the city government has decided to provide a mix of sanitation systems. Since only 10 percent of the city is currently sewered and the rest relies on non-sewered faecal sludge management systems, the city also built decentralised water resource recovery facilities to support the high-density clustered urban development. Further reading: (Narayan and Charles, 2017).

4. Lighthouse town for comprehensive planning: Nala

Nala, a small town in Nepal, used a comprehensive planning approach for improving environmental sanitation using the people-centered CLUES approach. The planning was inclusive and participatory and resulted in high ownership of project implementation. User preference, technical feasibility, and financial factors were used to analyse viable service combinations through a series of consultative meetings. Two main service combinations were analysed: (1) offsite: blackwater treatment using a decentralised water resource recovery facilities (Dewats) combined with simplified sewerage and (2) onsite: a combination of urine diversion waterless system and a pour flush system with twin pits, with provisions of faecal sludge management. Ten years after implementation, Nala is one of the few small towns in Nepal with 100-percent sanitation coverage using a combination of simplified sewers and urine diversion waterless toilets. Further reading: (Lüthi et al., 2011a).

5. Lighthouse city for monitoring and accountability: Warangal

Warangal is a South Indian city which pioneered in the implementation of faecal sludge management regulations. These regulations included licensing of masons and desludging operators, personal protective equipment of sanitation workers, planning guidelines, and service level agreements with private service providers, among others. The use of information technology (IT)-enabled tools has made real-time monitoring and enforcement of regulations possible. The commitment demonstrated by local government through fund allocation and awareness campaigns have made Warangal a model sanitation city in India. Further reading: (Chary et al., 2018).

6. Lighthouse town for mix of business models: Naivasha

Naivasha is a fast-growing town with a population of 200,000 at the heart of Kenya's flower-growing industry. Since 2015, the municipality has been testing innovative service delivery models to achieve total sanitation coverage. This includes a wastewater treatment plant and a design, build, and operate faecal sludge treatment facility run by the social enterprise Sanivation. In Sanivation's circular economy approach, 100 percent of received waste from latrines and septic tanks is treated and used to create solid biomass fuel and treated effluent for irrigation purposes. The facility safely and cost-effectively treats faecal sludge from pit latrines and septic tanks. The biomass fuel is sold to local flower and milk processing industries, among others. Further reading: (Ddiba et al., 2020).

2.5 Research on CWIS Principles

The concept of CWIS is wide spanning and its principles are abstract at first look. The Manila principles on CWIS were formed based on several years of urban sanitation implementation experience. The justification for each of these principles fall outside the scope of this thesis and has been done elsewhere (Gambrill et al., 2020a; Lüthi and Narayan, 2018; Schrecongost et al., 2020). However, with the advent and wide uptake of CWIS, the scope for researching specific aspects of each of these principles is used to explore these topics. Summaries from the work on these six principles that the author was part of (in terms of direct supervision and/or collaboration) are adapted and presented here (Table 2.1). These publications resulted out of research projects with Master students and other collaborators during the course of the doctoral research.

Table 2.1: Various publications exploring specific aspects of the Manila principles on CWIS

PRINCIPLE	TITLE	CASE STUDY	PUBLICATION
1. EQUITY	Equity in Sanitation - The Forgotten Pillar	South Asia	(Narayan and Agarwal, 2021)
2. ENVIRONMENTAL AND PUBLIC HEALTH	There is no Environmental Health without Public Health - Establishing the links between sanitation and waterbody health	Bangalore, India	(Navamany et al., 2022)
3. MIX OF TECHNOLOGIES	Sanitation Potpourri: Criteria for Planning Mix of Technologies for CWIS	Chennai, India	(Mitra et al., 2022)
4. PLANNING	Advancements in and Integration of water, sanitation and solid waste for low and middle income countries	Global	(Narayan et al., 2021a)
5. ACCOUNTABILITY AND REGULATIONS	Regulating CWIS	Tumaco, Colombia	(Saker and Narayan, 2022)
6. MIX OF BUSINESS MODELS	Costing and Planning Analysis of CWIS in India	Coimbatore, India	(Dutta, 2020)

2.5.1 Equity in Sanitation - The Forgotten Pillar

Summary from published version of (Narayan and Agarwal, 2021).

Introduction

In the Asia-Pacific region, more than a billion people still lack access to basic sanitation services (UNICEF and WHO, 2019). The sanitation sector has yet another unique challenge, which is, the taboo it faces in most Asian cultures. Therefore, in addition to the disease and economic burden, the communities deprived of sanitation also face a significant cultural burden associated with raising this issue. India, for example, tackled this problem by launching the world's largest behavioural change campaign (Curtis, 2019), which included the release of a high-grossing Bollywood movie focused on improving sanitation and hygiene.

Sanitation is a public good that is largely serviced by the state. However, due to domestic politics, corruption, and competing priorities, public funds provide private sanitation services that often do not reach the bottom of the pyramid (Chaplin, 2011). Across the board, the poorest quintile of every country is disproportionately worse off when it comes to access to sanitation services (UNICEF and WHO, 2019). The inequities that arise from this, compounded by rapid urbanisation and water insecurity due to a changing climate, place the poor in an increasingly vulnerable position.

Subsidies – An ineffective mechanism

Subsidies are financial instruments that allow users to pay less for a product or service, while the rest of the costs are covered by the government or future generations. The demographic differences that arise from users' income levels are tackled primarily through subsidies. Every year over USD 300 billion is spent on subsidising water and sanitation services (World Bank, 2019). However, a recent report released by the World Bank found that 56% of such subsidies go to the richest quintile of the population while a meagre 6% is left for the poorest quintile (World Bank, 2019).

This shows how the mechanism is working against the poor: they are the ones subsidising expensive sewers for the rich, and on top of that, they also end up paying a higher price for substandard service levels of communal toilets and faecal sludge emptying. Further, since in most countries in the Asia-Pacific, sanitation fees are collected as part of the water tax, the poor also pay for services that they do not necessarily receive.

What is equity in sanitation?

Firstly, it is important to understand the difference between the concepts of equality, equity and justice in the context of the water and sanitation sector. Consider rich and poor settlements in a generic town, where the rich households are nearer to the river, a water source (Figure 2.3). If equality is enforced, despite equal lengths of pipes, the poor do not have the same access to water. If equitable measures are taken, then both the rich and poor enjoy equal standards of access. However, for justice to be achieved, the environment must also be considered and locally appropriate solutions must be implemented, which in the case of sanitation could be non-sewered solutions as well. For example, a vacuum truck could do the work of a sewer.

Figure 2.3: Understanding the difference between Equality, Equity and Justice in the Water and Sanitation Sectors. © Eawag-Sandec

Why is it important?

Inequity in the sanitation sector can arise as a result of marginalisation based on income level, gender, urban-rural divide, disabilities, religion, and caste, among other issues. It is important to ensure that these factors are not overlooked when designing and implementing sanitation solutions to ensure communities are not left behind. For example, women are disproportionately impacted by the day-to-day burden of water and sanitation-related tasks, yet are underrepresented in policy framing and decision-making (Burt et al., 2016). Due to the differences in biological, social, and cultural needs, solutions need to take gender into account when considering location, number of stalls, toilet designs as well as menstrual hygiene, pregnancy, childcare, and privacy (Reddy et al., 2019).

In South Asia, two distinct dimensions of inequity exist: (1) the unavailability of sanitation infrastructure in rural areas, and (2) the inaccessibility of standard facilities in urban areas, which exclude access to communities with low socio-economic levels and also cannot be used by physically disabled people. Rural areas in Afghanistan, Pakistan and Nepal have some of the highest levels of open defaecation and lack of basic sanitation in the region (UNICEF and WHO, 2019). While India declared that the Clean India Mission had achieved its initial targets, there is still much debate considering whether toilet coverage directly translates to usage (Agarwal and Boehman, 2020). Urban areas struggle from the absence of infrastructure rather than poor planning and management. In many cities across India, public toilets are poorly designed, and this affects usage. This includes toilets built in unsecure locations, insensitively placed next to religious structures, or lacking disability access.

How to operationalise equity?

Firstly, equity must be prioritised to ensure that marginalised groups have access to sanitation services. This will require a significant shift from the 'one-size fits all' approach, coupled with the implementation of creative initiatives to ensure that these services can be accessed by all. Equity and inclusion go hand in hand. The sanitation planning process must be comprehensive and must ensure that various stakeholders are involved, while amplifying the voices of marginalised and vulnerable communities. This will be possible only when there are clear, inclusive targets. Conventional top-down planning methodologies fall short in taking into account the dimensions of equity. Therefore, new planning frameworks and policies, that are consciously equitable, need to be developed.

One encouraging trend in the sector is Citywide Inclusive Sanitation (CWIS), which is shifting the understanding of this challenge by focusing on equity as a key pillar in successful sanitation systems (Narayan and Luthi, 2020). Several sanitation projects in the Asia-Pacific region that are funded by international development organisations are currently taking this approach, and have the potential to systematically operationalise equity in their interventions. This however requires further research and development of frameworks to help in designing and implementing equitable sanitation.

2.5.2 There is no Environmental Health without Public Health - Exploring the links between sanitation and waterbody health

Summary of submitted version of (Navamany et al., 2022)

Introduction

At present, over 70% of the surface water in India is polluted by human excreta and other wastes, and less than 35% of urban wastewater is treated (NITI Aayog, 2019). Despite public and environmental health being closely linked, they are not managed in an integrated manner. Faecal sludge overflows from these on-site sanitation systems in combination with partially/untreated wastewater end up in the waterbodies. CWIS principles provide the necessary systems thinking perspective towards safely managed urban sanitation, that goes beyond infrastructure provision, and takes a multi-level service based approach, accounting for inclusive planning, regulations, and business models. It is therefore a useful theoretical lens to study the systemic links between urban sanitation and environment in a complex city such as Bengaluru. This research helps (i) identify the faecal pathways into the environment and qualitatively assesses their relative contributions into waterbodies, (ii) map the complex sanitation system that includes socio-economic, political, institutional and environmental factors and (iii) define the key levers of change.

Methods

The study adopted a mixed-method approach, comprising of quantitative flow mapping, water quality testing and a qualitative analysis that included key informant interviews and then developing a conceptual system dynamics model.

Pollution Pathways

Water quality sampling in the representative lake and qualitative analysis on the semi-structured interview data, suggest that a significant amount of municipal wastewater ends up in Bengaluru lakes through three main pathways (Figure 2.4).

Figure 2.4: Sampling points in Komaghtta Lake, Bengaluru

Pathway 1: Sewage in stormwater drains: The primary pollution pathway in terms of pollution loads discharged into the lake are the stormwater drains; it was observed that the main inlet discharged around 3000 cubic meter during the 14 hours of sampling. The peak flow times reflect pertinent domestic water use periods.

Pathway 2: Partially treated or untreated wastewater from sewer lines: Due to underperformance of STPs, sewage is partially treated and contributes to nutrient load into lakes. In peri-urban regions, due to the lack of trunk sewers or STPs, sewers are connected to stormwater drains leading to discharge of untreated sewage in the lakes.

Pathway 3: Unregulated disposal of faecal sludge and leakage of on-site sanitation systems: Unregulated disposal of faecal sludge by desludging trucks that is dumped into lakes or stormwater drains that flow into lakes. Additionally, the overflow/leaks from on-site sanitation systems into the aquifer leading to contaminated groundwater act as a pollution pathway into the lake.

System levers for urban sanitation in Bengaluru

After identifying the pollution pathways that are relevant for Kommaghatta lake, the interviews informed whether these pollution pathways are representative of Bengaluru lakes and the reasons behind their existence. The outcomes of the why-analysis helped capture the various casual links which form the basis for existence of the identified three pollution pathways. The resulting conceptual systems diagram is shown in Figure 2.5.

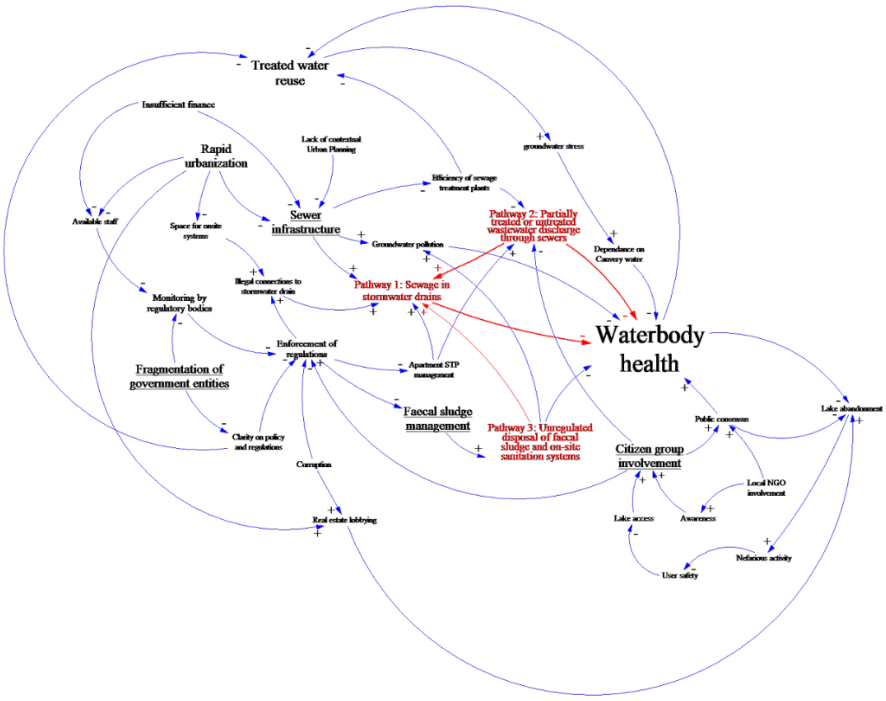


Figure 2.5: Conceptual systems diagram of reported causal links between urban sanitation and waterbody health in Bengaluru. Positive and negative signs indicate positive or negative reinforcement.

CWIS as a possible solution

CWIS provides a useful approach to leverage the levers for creating systemic change (Narayan and Lüthi, 2020). Figure 2.6 provides the relevance of the six principles to the case of urban lake pollution in Bengaluru.

Equity	Environmental health and public health	Mix of sanitation systems	Comprehensive planning	Monitoring and regulation	Mix of business models
Access to safely managed sanitation for all citizens, specially urban poor To equally share benefits of urban lake by all classes of people	Closing the loop of wastewater and hence reducing the stress on groundwater Boosting the urban economy and limiting pollution of urban waterbodies	Address impacts of rapid urbanization which currently pollutes the lakes Helps in contexualization of sanitation solutions by decision makers	To help involve all stakeholders right from planning to implementation Aids in Knowledge sharing and collaboration between different government agencies	Address the current monitoring and regulation gaps with respect to sanitation and waterbodies Restricts illegal discharge of sewage into the lake	Address the issue with lack of finace and capacity of sanitation infrastructure PPP partnerships to enhance operation, maintainence and treatment of sewage and faecal sludge

Figure 2.6: Relevance of CWIS for the city's sanitation issues and waterbody health

2.5.3 Sanitation Potpourri: Criteria for Planning Mix of Technologies for CWIS

Summary from submitted version of (Mitra et al., 2022)

Introduction

Indian mega-cities are inherently heterogeneous entities and exhibit variation across socio-economic, political, environmental, and infrastructural dimensions. This directly results in the complexity of planning sanitation in India which is also influenced by political and financial will, capacities, and coordination (Narayan et al., 2021b). Despite the heterogeneity, sanitation planning tends to be top-down, technology-driven, and focused on implementation of regional master plans (Kennedy-Walker et al., 2014). Inappropriate technology choices for varying physical and social environments result in long term failure of sanitation interventions (Spuhler and Lüthi, 2020; Tilley et al., 2014a).

While CWIS advocates for contextually appropriate technologies, the strategy for the implementation of a mix of technologies remains absent. It is not possible to go for a "one-size fits all" approach as we have regions within cities where sewers are not possible due to technical and financial (from user end) limitations (Mara et al., 2007). Faecal Sludge Management (FSM) and Container Based Sanitation (CBS) are alternates that function well in many urban contexts due to their economic viability, ease of operation, low operating costs, and potential to recover resources (Russel et al., 2019; Strande et al., 2014). Small-Scale Sanitation systems (SSS) are a strong option for urbanising cities with the right population density (Eggimann et al., 2016) and have shown great potential to scale up in India (Klinger et al., 2020). Planners would benefit from a clear set of criteria to consider in choosing appropriate technologies to achieve CWIS. This paper aims to formulate a criteria catalogue to help planners and decision-makers implement a mix of technologies.

Methods

The research used a case study approach while using mixed of qualitative and quantitative methods including Shit Flow Diagram, Social Network Analysis, surveys and key-informant interviews. Collection of data for demographics, stakeholder mapping, driver and barrier identification, criteria catalogue development and testing catalogue in the case study was performed through a review of a broad range literature and virtual key-informant interviews with expert weighting.

Drivers and Barriers

The identified drivers and barriers act as guiding points when planning the non-sewered sanitation systems in the city. These factors were also considered during the design of the criteria catalogue.

Table 2.2: Drivers and Barriers for the implementation of non-sewered technologies in Chennai.

DRIVER	NO. OF INTERVIEWEES	BARRIER	NO. OF INTERVIEWEES
LOCAL RECYCLE AND REUSE	9	Sewer aspirations	9
LOWER INVESTMENT COSTS	8	Poor monitoring and accountability	9
GOVERNMENT MANDATE	6	Political will	8
INTERIM SOLUTION	5	Quality enforcement	8
NATIONALLY SUPPORTED INNOVATIONS UNDER SBM	4	Low awareness on non-sewered technologies	6
HORIZONTAL INFRASTRUCTURAL DEVELOPMENT	1	Perceived ineffectiveness	6

SCALABILITY	1	Poor coordination between major stakeholders	3
		Systemic Corruption	2
		Low public Willingness	1

Criteria Catalogue

Fourteen criteria spanning physical, technical, institutional, and financial aspects were selected to be part of the catalogue (Table 2.3). Some natural limitations of these criteria are data availability and threshold definitions. Additionally, some of these criteria would be negotiable, and others non-negotiable. These threshold values and their negotiability will be decided based on the context. This catalogue only presents the factors to consider when making the decision on the type of sanitation system for the given area.

Table 2.3: Criteria catalogue contextually formulated for implementation of a mix of sanitation technologies

CLASS	NO.	CRITERIA	DEFINITION (ON A WARD LEVEL)
Physical/Spatial	1	Water requirement	Water available per capita per year.
	2	Groundwater depth	Depth of Groundwater from surface level.
	3	Area requirement	Surface area per capita required for ensuring a functional sanitation system (excluding conveyance).
	4	Population density	Population living per hectare in the ward.
Technical	5	Vulnerability to Power supply disruption	Frequency of >8h energy disruption in a year within a ward.
	6	Vehicular access	The availability of a road network for motor vehicle access to the emptying point.
	7	Odour emissions	Number of intense odour emission events from sanitation system.
	8	Effluent quality	Treated effluent quality from respective system meeting the regulatory standards.
Institutional	9	Level of decentralised management	The lowest level of decision making for the whole system (city/ward/household).
	10	O & M demands	Hours and skill level required of O & M required to keep technology functional on a ward level.
	11	User awareness	Degree of knowledge required for operating the technology.
Financial	12	Capital Costs	Capital cost for installation of system per capita served in the ward.
	13	Operating costs	Operating cost running the system per capita served in the ward.
	14	Income of beneficiaries	Average per capita income per year of ward population served by the system.

Theoretical testing in a specific ward in Chennai showed that sewered solutions were appropriate due to the local conditions. It also shows that the criteria catalogue is not biased towards only non-sewered systems, rather encourages the planners to consider a mix of sanitation systems to co-exist wherever appropriate.

2.5.4 Advancements in and Integration of water, sanitation and solid waste

Summary from published version of (Narayan et al., 2021a)

Introduction

Water, sanitation and solid waste are inextricably linked and form the fundamentals of basic service provision across the world. These services are not only essential for the protection of both public and environmental health but also for economic development, especially in low-income contexts where exposure to environmental pollution and disease is a major cause of morbidity and mortality (Bartram and Cairncross, 2010; Ziraba et al., 2016). There are numerous parallels that can be drawn between the water, sanitation and solid waste sectors; from service delivery mechanisms to end users' needs and preferences. There are clear physical interactions between the three service chains through the source, transport, storage, treatment and reuse/disposal stages (Figure 2.7). For example, the consumption of supplied drinking water leading to wastewater production and inadequate solid waste disposal resulting in trash-blocked sewers, stormwater drains and surface waters.

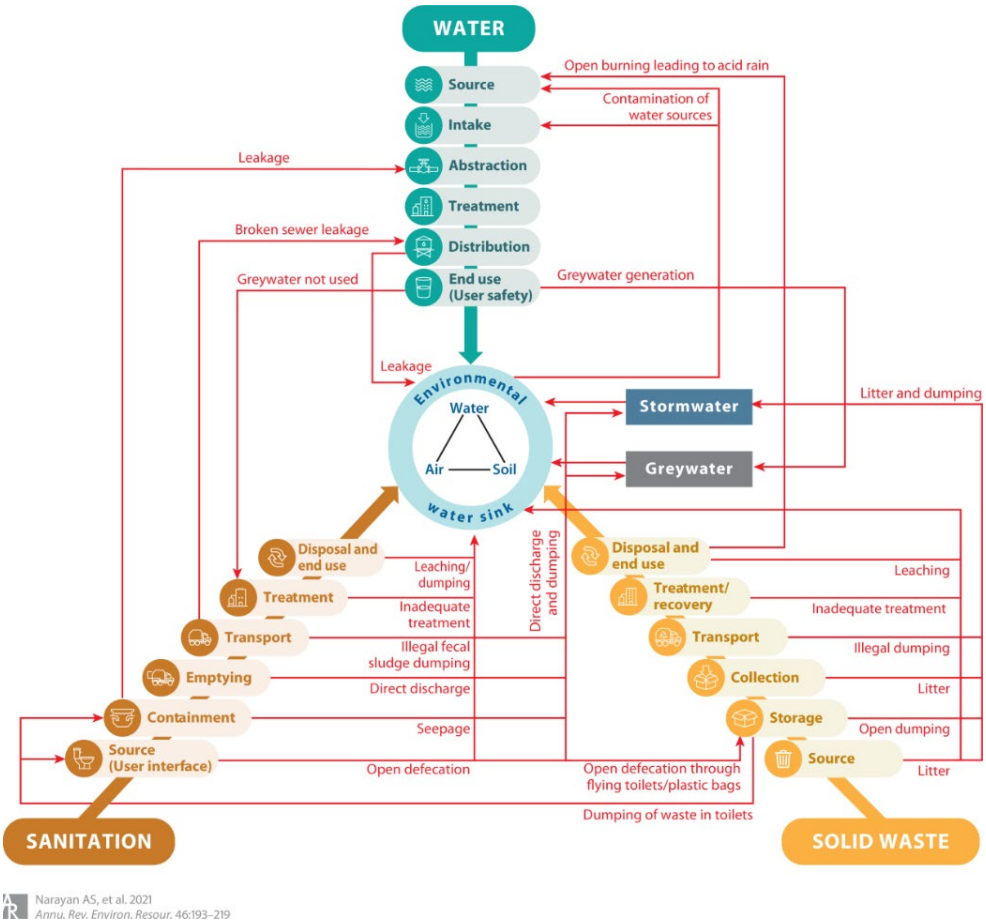


Figure 2.7: An illustration of the various undesirable interactions that are taking place between the three different service chains of water, sanitation and solid waste

Currently, negative outcomes as a result of these interactions remain the norm in many LMICs, such as cross-contamination, incomplete (or non-existent) treatment, and linear end uses. However, there is great potential to foster more positive interactions in support of circular economy-based value chains instead (Schroeder et al., 2019; Valcourt et al., 2020a). However, these sectors' activities remain largely siloed and seldom unify holistic interventions planned and implemented in development contexts. With the advent of CWIS, there is a scope for integrated planning, since the Manila Principles encourage sanitation interventions to build on the synergies between the interacting sectors.

Trends in planning

The need for holistic planning exists not only for different stages of the service chain, but also accounting for cross-cutting social, economic and environmental factors (Lüthi et al., 2011a; Valcourt et al., 2020b; Wilson et al., 2013). All three sectors are steadily moving away from supply-driven infrastructure provision to a more demand-responsive service approach. Community involvement has been widely deemed as necessary in development interventions for two reasons: (i) incorporating local knowledge and preferences, and (ii) building a sense of local ownership. Inclusive planning frameworks and tools are more widely available and implemented in the water and sanitation sectors, while there are new frameworks emerging for solid waste (UNEP and ISWA, 2015).

Integrated approaches to WASH and SWM are not new, however they have rarely been operationalised or mainstreamed due to the complexity on the ground and the lack of institutional leadership from local governments (Tilley et al., 2014a; Valcourt et al., 2020a). A WASH and SWM system comprises all the social, technical, institutional, environmental and financial factors, actors, motivations and interactions that influence WASH and solid waste service delivery in a given context (Huston and Moriarty, 2018).

Enabling Environment for Integrated Planning

An enabling environment for an integrated approach include (i) political leadership, (ii) shared objectives (iii) effective policies, (iv) institutional coordination, (v) integrated planning (vi) monitoring and accountability, (vii) strengthened capacity and (viii) stakeholder support. This will allow for synergistic positive interactions between the three service chains of water, sanitation and solid waste (Figure 2.8).

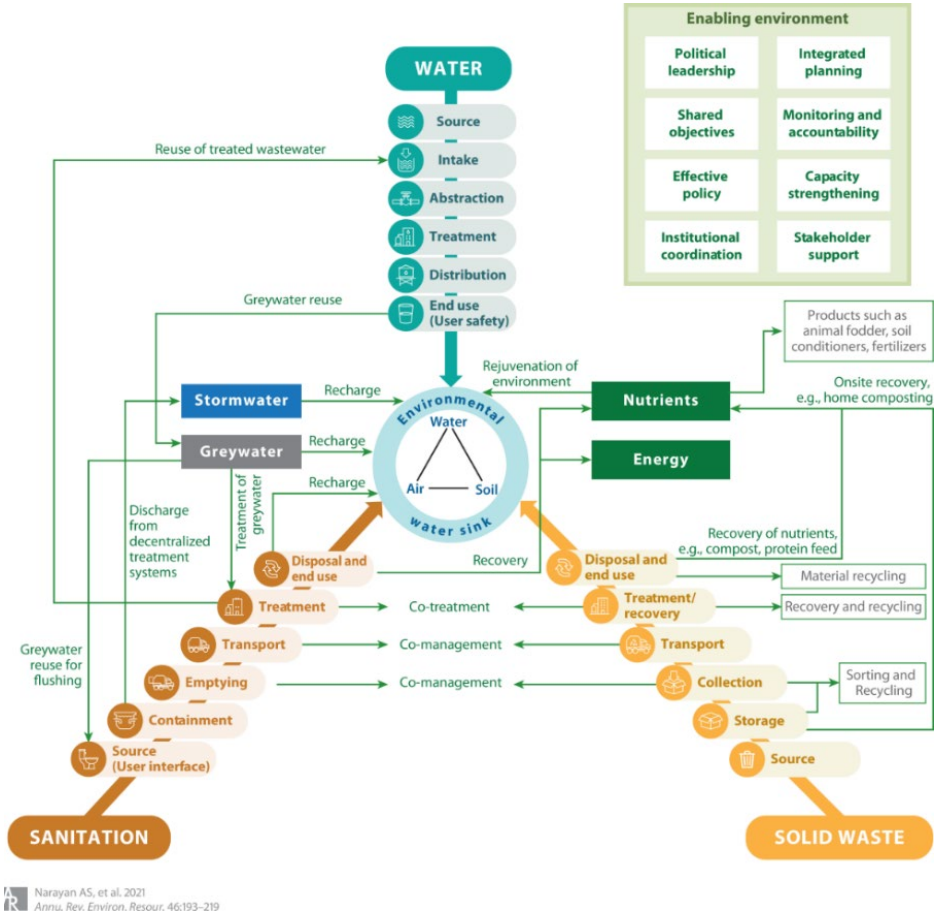


Figure 2.8: An illustration of the various positive interactions that could take place between the value chains for water, sanitation and solid waste (indicated by green arrows and boxes). It shows the required enabling environment with eight factors.

2.5.5 Regulating Citywide Inclusive Sanitation in Colombia

Summary from submitted version of (Saker, Pedraza and Narayan, 2022)

Introduction

An adequate policy and strategy that includes a suitable regulatory framework is essential to implement CWIS (Magawa, 2021; WSUP, 2019). Nonetheless, there is inadequate knowledge on how to structure a regulatory framework for CWIS, as regulations are still directed at the conventional approach. This research focuses on the Colombian case study to analyse if the regulatory framework is appropriate to implement CWIS. Colombia is a relevant setting to explore as it already has 92.5% access to basic sanitation but only 16.6% of safely managed sanitation, and fairing as one of the countries with the lowest coverage in South America (UNICEF & WHO, 2021). Government representatives have shown the political will to create differentiated service provision schemes for underserved areas in complex contexts and embraced the CWIS approach (IWA, 2021).

Methods

This research employed a descriptive case study approach using a qualitative methodology to evaluate the appropriateness of the current regulatory framework for CWIS in Colombia. A policy review was conducted to analyse if there are barriers contained in the existing regulatory framework. Secondly, semi-structured interviews and workshops were conducted to analyse the different points of view of the key stakeholders involved in designing, monitoring, and implementing the regulatory framework.

Policy Review

Eight laws, five decrees and six resolutions were found to be related to urban sanitation. The sector is mainly governed by law 142 of 1994, which sets the responsibilities and principles on delivering residential public services. This law defines sanitation as “the municipal collection of residues mostly liquid through pipes and channels and also the complimentary activities of transportation and final disposal of such residues”. This narrow definition of sanitation prevents the direct usage of non-sewered solutions. The rest of the policies were divided into five categories to conceptualise the different aspects involved in sanitation service delivery: service delivery, land management, environmental, financial, and technical (See original paper for detailed review).

Regulatory Barriers for CWIS

At a national level, it was stressed that regulations needed to be changed in some way to accommodate CWIS. At a local level, all the experts agreed that the regulatory framework was a barrier to implementing a non-conventional alternative for sanitation provision in difficult to reach zones. The only aspect where there was general agreement was the desirability of amending law 142 of 1994 to give a legal basis and more clarity about new technologies and new service delivery models for sanitation. The current definition for sanitation in the law poses restrictions to implement CWIS, leaving out non-sewered and alternative service delivery models. Experts stated that it was politically difficult to modify because amending this law would change many aspects that would later have to be regulated and require immense effort and coordination to modify this law successfully. This again emphasizes the need for regulatory guidelines and research to help utilities and governments to transition from conventional sewer based approach to CWIS. Table 2.4 provides barriers based on expert’s points of view.

Table 2.4: Barriers based on the various regulatory aspects

CATEGORY	BARRIER
Service delivery	• Allows only sewered solution as per Law 142 of 1994 • Technical parameters can be relaxed only while there is a 'provisional scheme' • No incentives for service providers to extend coverage to low-income and informal areas • Complex tariff calculation
Land management	• Questionable legality on service provision for informal zones • Land documents needed for certification for funding application • Regulations do not permit temporary solutions
Environmental	• Expensive permits for sanitation infrastructure • Overly stringent regulations that do not allow non-conventional solutions • Need time consuming water quality models and soil characterisation for permits • Environmental authority has lack of capacity for monitoring on-site solutions
Other	• Political will required to update policies to allow CWIS implementation • Regulators resist change in technological and service regimes • Lack of institutional capacity and coordination

Way Forward

An enabling regulatory framework alone is not enough for CWIS. It is necessary to provide legal foundations that incentivise this new approach. As stated previously, the required reforms need political will to coordinate the initiative with other parties and to get a congressional approval. It is unlikely that this government will prioritise the reforms required to move forward CWIS at present. It is therefore important to consider the political economy related to sanitation to evaluate the feasibility of regulatory changes (Hawkins et al., 2013a; Magawa, 2021).

Multilateral and external organisations have a role to encourage CWIS with governments to promote it as an urban sanitation policy. These organisations can support in the form of sharing of experiences from other countries, participation in international workshops and possibly including agreements to implement alternatives in the loan contracts. Experiences like the implementation of condominial sewerage in Tumaco show that there is a perception that the regulations are made based on a reality that does not adequately represent the context. That is why it is fundamental to develop the regulations based on the local needs and adapting them to the specific geographical, socio-political and economic contexts.

2.5.6 Costing and Planning Analysis of CWIS options in India

Modified excerpts from submitted version of (Dutta, 2020)

Introduction

CWIS is based on the fundamental understanding that sanitation is a complex systemic issue that must be tackled via clear service outcomes through the proper management of the entire value chain while also taking into account system feasibility including financial considerations (Schrecongost et al., 2020). Various context specific business and service models are required for reaching 100% safely managed sanitation in complex settings of cities in LMICs (Cairns-Smith et al., 2014). It is also clear that private sector participation is essential for reducing the inequities in access to sanitation services (Mason and Mosello, 2017). In a detailed review of lifecycle cost of urban sanitation solutions, it is shown that conventional sewer systems are the most expensive option in most cases (Daudey, 2018). Other on-site solutions have been shown to be cost effective and maximise inclusion of low-income households (Burt et al., 2019).

The CWIS approach proposes that a mix of solutions can be used to achieve equity and sustainability service outcomes (Lüthi and Narayan, 2018). This is based on the assumption that the costs related to the CWIS approach is lower than the conventional sewer-only approach. In order to test this hypothesis, an analysis of costing and planning related to CWIS for a real example, in this case – a secondary city in a LMIC setting, is carried out. This also explores the on-ground potential of CWIS in terms of achieving equity of service.

Methods

This study follows a mixed-method approach on a case study. The qualitative research entails case research, key-informant and stakeholder interviews, and document and field-survey analysis. The quantitative research was carried out through the analysis of pre-existing financial data and collection of neoteric costs (and estimates) related to sanitation system solutions. Consolidated data figures were then fed to the CWIS Costing and Planning tool, developed by the World Bank, as an aid to analyse and compare different sanitation solutions based on their costs. In order to compare and validate the results obtained from the CWIS tool, a more established manual analysis of data was also carried out on Microsoft Excel.

Case study

Coimbatore is a secondary city in Tamil Nadu, India with a population of over one million. Owing to the 2011 expansion of the municipal corporation limits there's a spike in the growth rate. Coimbatore also has a mix of sanitation systems already in place – sewers, on-site systems, and FSM. Approximately, 28% of the population is covered by the centralised underground sewerage network and 66% of the households in Coimbatore are dependent on onsite sanitation systems. Overall 76% of the faecal waste is safely managed according to the SFD (GIZ and Eawag, 2019). Coimbatore is an ideal case study since the city has a mix of sanitation systems, and needs to cater to the sanitation needs of its rapidly expanding population.

Scenarios

Three scenarios were developed to comparatively analyse the capital and operational costs for sanitation provision: 1. Status Quo retained (the baseline scenario), 2. Sewerage Focus (the municipality's ambition) and 3. Co-existence focus (a CWIS scenario). Table 2.5 presents the three scenarios and their respective percentages of sewered, small-scale systems and on-site systems.

Table 2.5: Scenarios of sanitation development in Coimbatore (Dutta, 2020)

TYPE OF SYSTEM	% OF POPULATION SERVED		
	Status Quo Retained	Sewerage Focus	Co-Existence Focus
Sewer	28	90	58.55
Small-Scale Sanitation	6	10	10
On-site Sanitation	66	0	20.28
On-site Sanitation for informal settlements	0	0	11.17

Cost Analysis

Through the results obtained from both the analyses (tool and manual), it is clear that a sanitation future with a sewerage focus has higher costs in comparison to a sanitation plan that promotes the coexistence of sanitation system solutions. This result proves that costs related to a CWIS approach that proposes a mix of solutions are feasible. The co-existence focus scenario considered costs related to service options that explicitly serve the urban poor and the overall costs related to such a sanitation future are still lower than that of a future that aspires to obtain the municipality's ambition of 'gold standard' of sewerage. The results do not show a very high cost difference between sewers and CWIS, because, even in scenario 3, there are significant amount of sewers built and refurbished. A limitation of this study was the poor quality of data and the omission of costs of expansion of existing STPs, construction of pumping stations etc., which may have skewed the results to reduce this difference.

It is also important to note that the costs related to maintaining the sanitation status quo are the least. The low costs are a result of continuing with inefficient systems like containment components such as lined tanks with impermeable walls and open bottoms and unlined pits that have lower capital costs but pose substantial risks to both public and environmental health. The status quo retained scenario also does not account for sanitation options that are explicit measures taken to provide access to the urban poor.

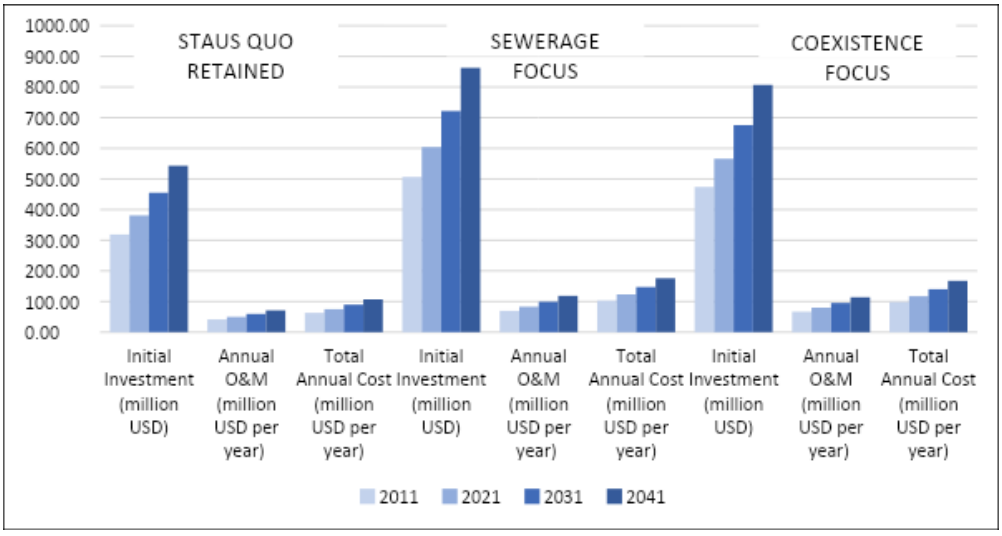
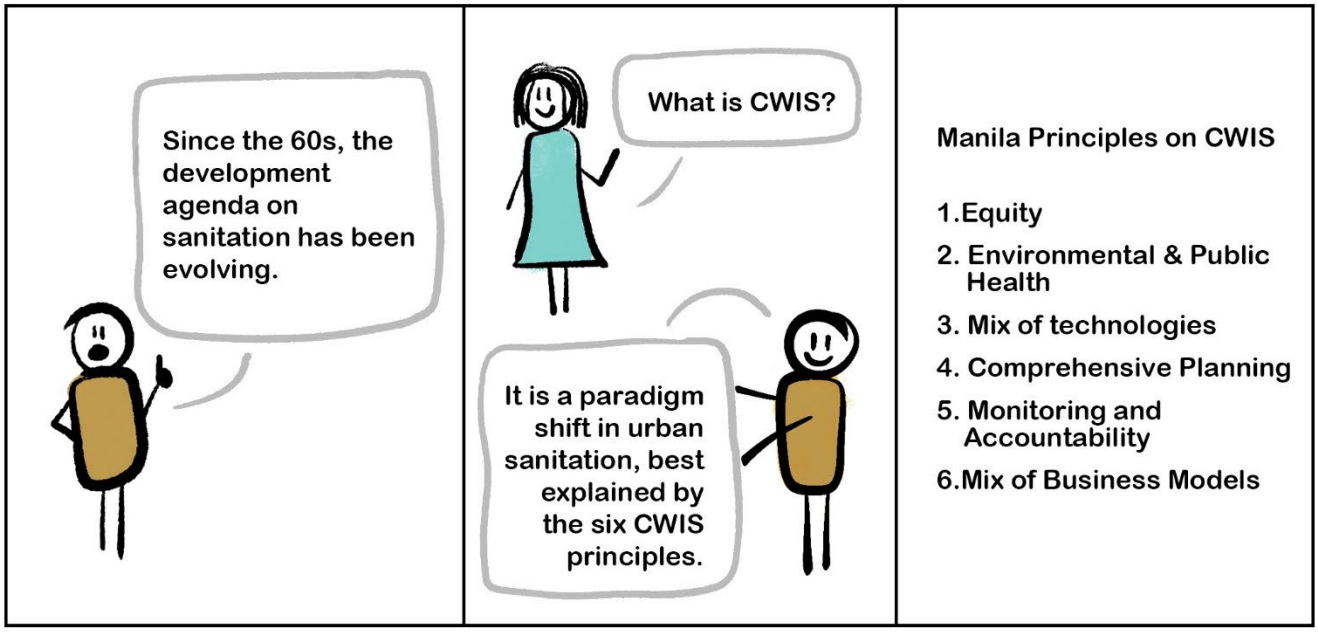
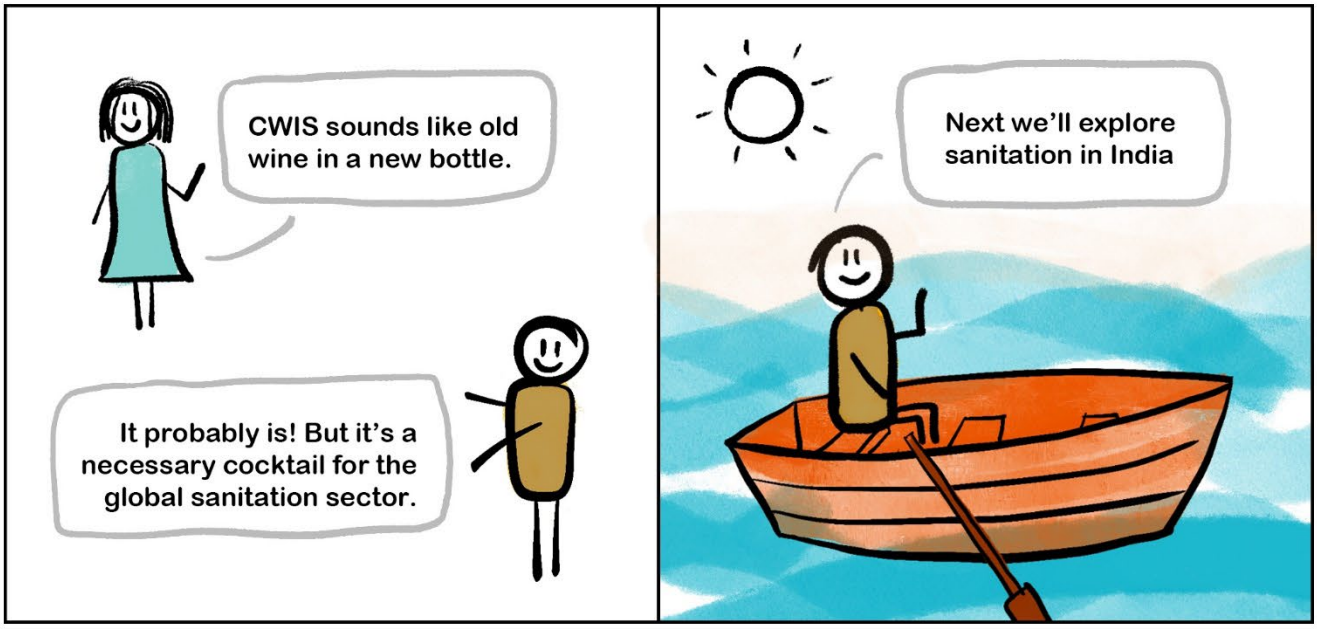


Figure 2.9: Cost Analysis of various sanitation scenarios in Coimbatore from 2011-204


Sanitation is still a challenge for half the world. Business as usual isn't working.
Welcome to CWIS
WC


Since the 60s, the development agenda on sanitation has been evolving.
What is CWIS?
It is a paradigm shift in urban sanitation, best explained by the six CWIS principles.
Manila Principles on CWIS
1.Equity
2. Environmental & Public Health
3. Mix of technologies
4. Comprehensive Planning
5. Monitoring and Accountability
6.Mix of Business Models


CWIS sounds like old wine in a new bottle.
It probably is! But it's a necessary cocktail for the global sanitation sector.
Next we'll explore sanitation in India

03

India's Sanitation Journey

> **The Swachh Bharat Mission is a shot in the arm for the world striving to achieve the SDGs**
>
> ***– Param Iyer***

Sections 3.1 to 3.3 are original contributions for this thesis and have not been previously published.

Section 3.4 on FSM, A.S.N. conceptualised this section and wrote the original draft. Anant Mitra provided assistance in data curation of FSM policy documents during his internship and created the first draft of Table 3.2 on prominent FSM Technologies. The analysis, review, validation was done by A.S.N. Christoph Luthi (C.L.) provided resources and supervision.

Section 3.5 on SSS is previously published as a Chapter in the 4S project report: Klinger, M., Ulrich, L., Wolf, T. A., Reynaud, N., Narayan, A. S., Siemsen, P., Lüthi, C., and Philip, L. (2020). Technology, Implementation and Operation of Small-Scale Sanitation in India - Performance Analysis and Policy Recommendations. L.U. and A.S.N. jointly conceptualised this chapter. A.S.N. wrote the original draft. Data curation and formal analysis was jointly done by L.U., Philippe Reymond, Pradeep Kuttuva., Rohit Chandragiri, M.K., and A.S.N. Project administration, resources and funding acquisition was managed by C.L and L.U .

This chapter traces the journey of sanitation in India at a national level, with various laws, policies, schemes, and related milestones highlighted. A detailed list of these laws, policies, programmes etc., and their funding and features is provided in Appendix I. In this chapter, key aspects of sanitation in India such as the policy shifts, caste issues, success factors for schemes among others are discussed based on a detailed literature review. A specific focus has been brought on the landscape of Faecal Sludge Management (FSM) and Small-Scale Sanitation Systems (SSS).

3.1 Legal Basis

Until the turn of the century, sanitation has not always been a subject of public importance in independent India despite a majority of the urban population facing a profound lack of it, and despite many political references to the importance of sanitation (Chaplin, 1999). The foundations of sanitation in India lie in two primary legislations – (i) Water Act (1974) which prevents and controls the pollution of water (thereby preventing discharge of faecal waste) and (ii) Environmental Protection Act (1986) which created institutions to monitor and enforce protection of variants of the environment including water, land etc. (Cullet and Bhullar, 2015).

Although the Constitution of India does not explicitly recognise the right to sanitation, the higher judiciary have interpreted the fundamental right to life under Article 21 of the Constitution to include the right to sanitation (Joy and Bhagat, 2016). This judicial validation provided the legal basis for municipalities across the country to prioritise sanitation service provisions regardless of budgetary constraints to avoid litigation and even *suo moto* cognizance (Bhullar, 2013).

3.2 Major Policy Shifts

Since the turn of the century, several important policies and programmes were implemented to tackle the sanitation crisis in India (see Figure 3.1). One such early and major effort in this regard was the Total Sanitation Campaign. But due to low political priority, flawed monitoring, distorted accountability and corruption, the campaign failed to achieve its aim of universal sanitation by a huge margin (Hueso and Bell, 2013). The successor of the Total Sanitation Campaign was the Nirmal Bharat Abhiyan which focused on rural areas, also followed suit and received only little success. This was primarily due to lack of clear implementation strategy, poor capacities on ground, lack of financial incentives and political interference (Kumar, 2015; Routray et al., 2017).

An important national funding scheme that helped boost the sanitation infrastructure provision in cities was the Jawaharlal Nehru National Urban Renewal Mission (JNNURM). This was the first national scheme to prioritise basic sanitation services to the urban poor, and to allow cities to get significant financial support to expand their service provision. Investments in urban sanitation during the five years of the scheme was more than the investments made in the previous 50 years (Wankhade, 2015). However, most of these investments went towards expansion of sewers in the major cities with a million-plus population, while less than six percent of the investment went towards treatment infrastructure.

The most remarkable moment for India's urban sanitation journey came with the launch of the National Urban Sanitation Policy (NUSP) (GoI, 2008). NUSP is a comprehensive policy that aimed at raising the prominence of urban sanitation and its linkages with public and environmental health. This was a significant shift in the sanitation policy domain in India, since NUSP had several features which are at par with the latest developments in the global sanitation arena such as Citywide Inclusive

Sanitation (CWIS) (Narayan et al., 2021). It had a clear approach that included managing the entire sanitation value chain, preparing state sanitation strategies, city sanitation plans, highlighted the importance of operations, and removed tenure status as a barrier for sanitation for informal settlements.

As of 2015, India had the largest share of open defaecators in the world, with close to half its population which approximately accounted for 560 million people (UNICEF and WHO, 2017). However, with the launch of the flagship Swachh Bharat Abhiyan or the Clean India Mission (SBM) in 2014, and consistent efforts through the mission's five-year period, the country declared itself open defaecation free in 2019. Despite reservations on the mission's success from sustenance, poor uptake, and narrow focus (Exum et al., 2020; Jain et al., 2020; Kumar, 2017), significant health benefits and sanitation outcomes have been documented by SBM, as the world's largest sanitation campaign (in terms of people and money mobilised) (Andres et al., 2020; Curtis, 2019; Dandabathula et al., 2019).

SBM, unlike other sanitation schemes in the past, had (i) high political priority that moved the state machinery at the national and local levels, (ii) earmarked funding that mobilised for the infrastructure, (iii) massive communication and behavior change components accompanying the implementation (Anuradha et al., 2017; Curtis, 2019; Mohapatra, 2019; Singh and Jain, 2018). These three factors were major contributors to the success of the scheme's vision of constructing 100 million toilets and eradicating open defaecation. The Swachh Bharat Mission showed that with disruptive leadership that leverages behavior change strategies and uses modern monitoring technology, ambitious targets of eliminating open defaecation can be achieved (Curtis, 2019).

The JNNURM was succeeded by Atal Mission for Rejuvenation and Urban Transformation (AMRUT) which aimed to complement the Swachh Bharat Mission. Earlier, the Ministry of Urban Development used to give project specific funding. In AMRUT, this practice has been replaced by the approval of aState Annual Action Plan where whole sets of sanitation strategic projects are funded, thereby expediting infrastructure project cycles. The priority infrastructure funding goes to water supply, sewerage network, and stormwater systems. The funding scheme is open only to the largest 500 cities, out of the 4000 cities in India (Ministry of Urban Development, 2015). The Smart Cities Mission is another complementary scheme that aimed at comprehensive urban development, where smart water and wastewater management are one of the many focus areas. Other focus areas include air pollution, mobility, climate resilience, and energy (Bhattacharya et al., 2015).

The Swachh Bharat Mission led to a rapid increase in the need for Faecal Sludge Management (FSM). The constant advocacy from international development agencies and national NGOs also helped provide the necessary impetus to shift policies towards enabling FSM. Between 2017 and 2020, several key national policies and operation guidelines were announced. The National Faecal Sludge and Septage Management Policy, the Standard Operating Procedure for cleaning of Septic Tanks, the on-site and off-site sewage management practices are noteworthy. This spurred further policy developments at the state and city levels, with high uptake of FSM in India (Chary et al., 2018; Devaraj et al., 2021). (More details on FSM Landscape in India are mentioned in the following section 3.4).

The latest developments in the WASH landscape in India is the introduction of the Jal Jeevan Mission and the Swachh Bharat Mission 2.0. The former is an ambitious USD 50 billion USD scheme that aims to provide piped drinking water to every household in the country. The Swachh Bharat Mission (Urban) 2.0 was launched during late 2021 with a budget of USD 20 billion and with the aim of sustaining the gains made from the earlier mission and extending it to managing the entire sanitation value chain. It also has a bigger focus on solid waste management than the previous SBM.

Figure 3.1: Timeline of sanitation milestones in India

3.3 Critical Perspective from Literature

India's sanitation has been studied from various perspectives ranging from policy and governance (Reymond et al., 2020; Wankhade, 2015) to caste and economics (De, 2020; Sharada Prasad and Ray, 2019). Various studies have uncovered numerous ways forward in achieving universally equitable and sustainable sanitation in India, sometimes with conflicting recommendations (for example, on the decentralization of wastewater treatment in India see Sato et al., (2007) and Starkl et al., (2013)). Such varying recommendations and solutions also indicate the diversity in contexts that sanitation operates in the country.

3.3.1 Politics and Governance

When discussing India's sanitation, the political ecology perspective is hard to miss. Chaplin (1999, 2011) explains the circumstances of poor sanitation in India as a result of the middle-class monopoly in sanitation services. Due to insufficient pressure from low-income groups that suffer from poor sanitation, crisis interventions are the norm instead of disease prevention and wellbeing. Evidence exists that, with the visibility of SBM, existing sanitation NGOs have been empowered to demand services from the government (Raman, 2020). In cases of availability of political will for sanitation, the adoption of improved sanitation practices also depend on multi-scalar political will in both the governmental and non-governmental agencies, and the political ecology of related services at the local level including reliable water supply, monitoring mechanisms and land use (O'Reilly and Louiss', 2014). The political alignment and coordination of various levels of government at the national, state and city levels become necessary for prioritising scheme based activities (Martel, 2017).

Sanitation is referred as a governance problem in India repeatedly. Governance is a major issue in implementation and sustainability of various sanitation interventions (Davis et al., 2019; Narain, 2010; Reymond et al., 2020). Coordination between various departments that have an overlapping jurisdiction is identified as an issue (Narayan et al., 2020). A study of the implementation of SBM found that poor bureaucratic capacities and administrative incoherence were major barriers to coordinate sanitation efforts (Raman, 2020). Ethnographic studies found that frontline workers do not comply with the regulations of safe water and sanitation services (Hyun et al., 2018; Sharada Prasad and Ray, 2019). Sophisticated forms of rent seeking are pervasive across urban water and sanitation services in India, making traditional institutional reforms hard, but other measures such as information systems have helped reduce corruption (Davis, 2004).

3.3.2 Marginalisation

Sanitation remains inequitable in India, with various forms of marginalisation that includes gender, caste and socio-economic factors. Women, in particular, face health, safety and dignity issues (even physical and sexual violence) because of poor access to sanitation (Joy and Bhagat, 2016). This leads women to significantly change their sanitation habits, often at the cost of their health, to cope with the challenges of socially unsafe environments around toilets (Kulkarni et al., 2017). Further on-ground studies and advocacies in this regard have led to large scale adoption of female-friendly public toilets in major cities in India such as Hyderabad and Warangal (Reddy et al., 2019)

Caste issues are intertwined with sanitation in India. From the perspective of users, this affects adoption of sanitation – in some cases caste pressures to use or not use latrines, and requires targeted interventions (O'Reilly et al., 2016). From the perspective of sanitation workers, the problem is even bigger. The 2011 census data shows that there are close to 800,000 dry latrines in India, from which the excreta is manually handled often by Dalit women on a daily basis, making it a grave social crime (Shankar and Swaroop, 2021). Manual scavenging is not only a rural phenomenon, but also practised widely in dense urban settlements where sanitation workers are subjected to cleaning septic tanks and sewers leading to a loss of dignity, health and even life in many cases due to suffocation (Dubey and Murphy, 2020). Although the national government has outlawed manual scavenging twice through the Acts of 1993 and 2013, it still remains to be commonplace (Joy and Bhagat, 2016). The caste composition of sanitation workers also results in their low-priority for reforms among the key decision makers (Sharada Prasad and Ray, 2019).

3.3.3 Slums and Community Involvement

One in every six urban resident lives in a slum in India; of which 40% of them are connected to open drains (CSE, 2019). Although the legal basis for sanitation and national programmes are independent of tenure security, it is still a key predictor of sanitation demands in informal settlement, along with water access and proximity to existing sanitation facilities (Panchang, 2019). Community level latrines are identified to be successful solutions in several contexts, but require significant subsidies and affordability in the range of 2 dollars per household per month (Anantakrishnan and Srivastava, 2018; McFarlane, 2008). Sanitation has proven to catalyse change and even transform informal settlements into a low-income quarter with safely managed sanitation, using decentralised solutions in this case (Kazaglis and Kraemer, 2007).

Community based sanitation programmes have empowered the users in many contexts, not least the urban poor (Chaplin, 2011; Tomlinson, 2015). Treating sanitation as a public good and using social innovations have proved community based sanitation programmes to be successful in the long-term (McGranahan and Mitlin, 2016). But meaningful community involvement in sanitation can be tiresome, inequitable if not properly managed, and can easily explode in terms of complex interlinkages with other issues (Das, 2015). Co-production of knowledge and sanitation planning at a local level are methods to gain fine-grained diagnostics of the sanitation situation and foster community participation in the planning process (Narayanan et al., 2017).

In the following sections, the landscape of two particular sanitation typologies is summarised in the context of India - Faecal Sludge Management and Small-Scale Sanitation Systems.

3.4 Landscape of Faecal Sludge Management in India

Faecal Sludge Management is the storage, collection, transport, treatment, and safe end use or disposal of faecal sludge—what accumulates in onsite sanitation technologies and is not transported through a sewer (Strande et al., 2014). In India, the documents often refer to FSM with the explicit mention of sludge from septic tanks as septage, and therefore Faecal Sludge and Septage Management (FSSM).

3.4.1 Status of FSM in India

Only 40% of urban India is presently connected to sewer networks and about 1,200 Sewage Treatment Plants (STPs) are operational or under construction in India. The remaining 60% rely on on-site sanitation systems (OSS) (NITI-Aayog, 2021).

The National Government has recognised the gaps in sanitation coverage and embarked purposefully to address them, becoming one of the first countries to announce a national policy on FSSM in 2017 (GoI, 2017). SBM considers FSM to be central to achieving the vision of an 'Open Defaecation Free' India. It states that developing solutions to challenges of FSM therefore have an important place in the sanitation story of the country (Devaraj et al., 2021).

The launch of protocols for levels of Open Defaecation (ODF+ for toilets with proper maintenance and hygiene and ODF++ for toilets connected fully managed sanitation value chain), shows an emphasis on FSSM. The commitment is also seen through the prominence of FSSM in the national cleanliness survey

(Swachh Survekshan), as well as financial allocations for FSSM in the Atal Mission for Rejuvenation and Urban Transformation (AMRUT) and National Mission for Clean Ganga (NMCG) missions.

Currently, there is significant momentum for FSSM in India (NITI-Aayog, 2021):

- 20 States and Union Territories having adopted FSSM policies.
- 700+ Faecal Sludge Treatment Plants (FSTPs) have been commissioned, of which 220 are under construction and 150 are operational.

Further steps have been taken by various States towards FSSM incorporation and implementation through adoption of regulations and guidelines in respective states (Figure 3.2 and Table 3.1).

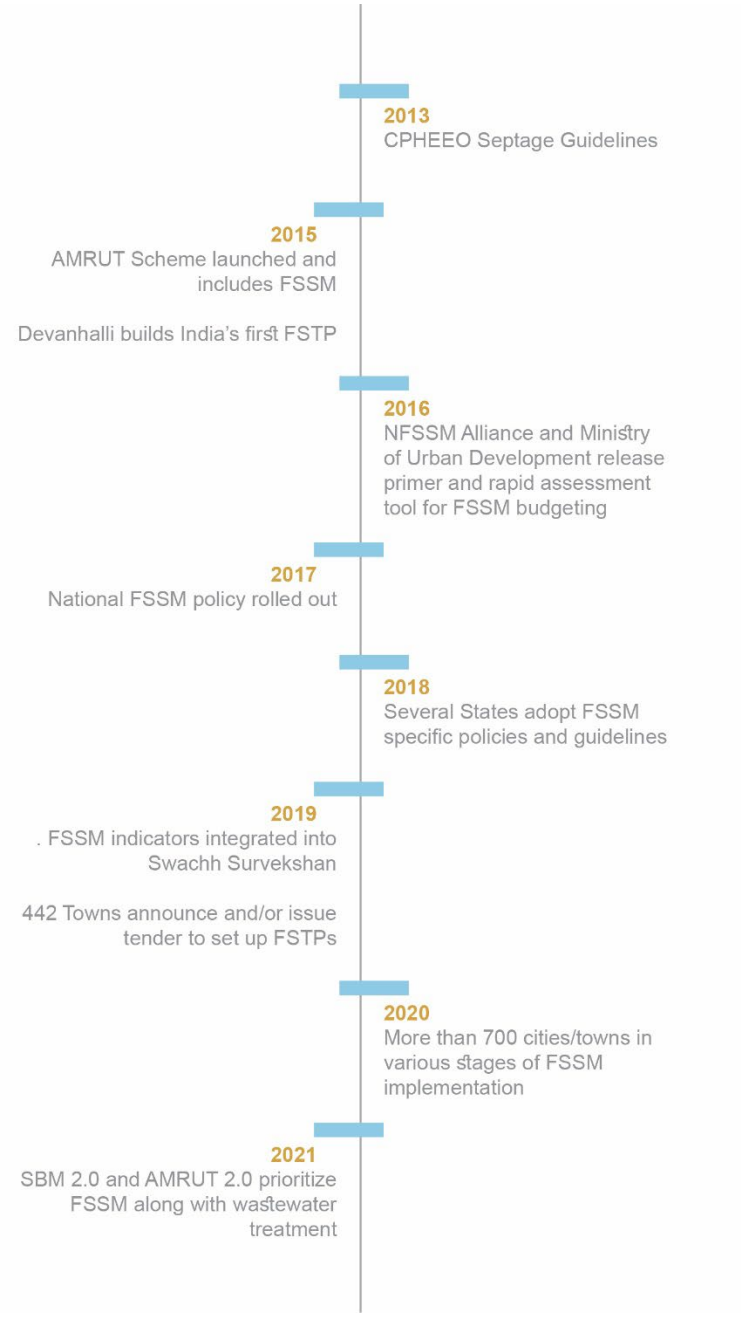


Figure 3.2: Milestones for FSSM in India

Table 3.1: State level regulatory guidelines and frameworks for FSSM

STATE	FSSM FRAMEWORKS
Andhra Pradesh	• Faecal Sludge and Septage Management: Policy and Operative Guidelines for Urban Local Bodies in Andhra Pradesh • Andhra Pradesh Government Order 134, March 2017
Maharashtra	• Maharashtra state FSSM strategy • Government resolution on co-treatment of faecal waste at STPs, 2018
Odisha	• Odisha Urban Sanitation Strategy • Odisha Urban Sanitation Policy (2016) & ULB's regulation (2018)
Rajasthan	• Draft Policy on FSSM, 2017 • State FSSM Guidelines for urban Rajasthan, 2018
Tamil Nadu	• Tamil Nadu Septage Management Operative Guidelines, 2014
Telangana	• The 2018 State Faecal Sludge and Septage Management (FSSM) Policy
Uttar Pradesh	• Guidelines for FSSM in Uttar Pradesh, 2018 • Draft State FSSM Policy, 2019

3.4.2 FSM Technologies widely used in India:

A literature review of various FSM case studies in India was conducted. Prominent types of technologies used for the treatment of faecal sludge include right from drying beds to wetlands. The appropriate technology is chosen based on a number of criteria including the budget, human resources available for operation and end use requirements. Few of these major faecal sludge treatment technologies used in India are shown in Table 3.2, along with their location, year of installation and capacities.

Table 3.2: Prominent Faecal Sludge Treatment Technologies in India

NO.	TECHNOLOGY USED	LOCATION	YEAR OF CONSTRUCTION	CAPACITY (M3/D)
1	Two settling-thickening tanks and eight unplanted drying beds. The leachate is treated in two parallel series of anaerobic baffle reactors, anaerobic filters, horizontal flow constructed wetlands and slow sand filters. The effluent is stored in a polishing pump equipped with an aeration pump. The dried sludge is stored in a storage shed.	Bhubaneshwar, Odisha	2018	75 + 75 (expansion option)
2	The treatment process consists of 20 unplanted drying beds, each 6.2x8 [m]. The leachate is treated in a horizontal flow constructed wetland followed by a maturation pond whereas the dried sludge is stored in a storage shed.	Karunguzhi, Tamil Nadu	2017	24
3	The treatment consists of two feeding tanks as a first dewatering step, followed by two parallel treatment lines for the settled sludge treatment: one composed of one bio-digester and stabilisation tank and the second composed of one bigger stabilisation tank. The stabilised sludge from both stabilisation tanks flows to unplanted drying beds. The effluent from the feeding tanks and stabilisation tanks flow to an anaerobic baffle reactor, anaerobic filter and horizontal flow constructed wetland. The final effluent and leachate infiltrate into the soak away pit. The dried sludge is co-composed with municipal solid waste.	Devanahalli, Karnataka	2015	6
4.	The treatment consists of one FSTP intake and four parallel settling-thickening tanks. The thickened sludge is then treated in two of the unplanted drying beds of the wastewater treatment plant. The effluent from the settling-thickening tanks and the leachate from the unplanted drying beds is pumped to the wastewater treatment plant inlet (capacity 15'000 [m3/d]). The dried sludge is used within the compound for gardening purposes.	Puri, Odisha	2017	50

3.5 Landscape of Small-Scale Sanitation Systems in India

Small-Scale Sanitation systems (SSS) are decentralised or non-grid systems that collect and treat sewage at or near its point of generation, using a small-scale sewerage network and a small-scale sewage treatment plant. It typically serves between 10 and 1,000 households, treating between 5-700 kiloliters per day (Reymond et al., 2020).

3.5.1 Status of SSS in India

SSS have had a history of at least 30 years in India, mainly commissioned in rural or poorer urban neighbourhoods by Research Institutes such as National Environmental Engineering Research Institute (NEERI), IIT Bombay, Shrishti Eco-Research Institute (SERI) and Non-Government organisations (NGOs) such as the Consortium for DEWATS Dissemination (CDD) Society, for research and community development purposes. Numerous successful case studies of small-scale wastewater treatment systems have been reported (CSE, 2014).

However, until recently, small-scale sanitation did not find a significant place in the policies of the national, state or local government. Although there is no dedicated legal framework around SSS, several new regulations on wastewater treatment have been introduced at various levels and this has led to an increase in the adoption of small-scale sewage treatment systems, especially in the urban and peri-urban areas of India.

The first major policy change was triggered by the then Ministry of Environment and Forests (MoEF) which introduced the Environmental Impact Assessment (EIA) in 2004 & an amendment in 2006, directing all new buildings with built up area over 20,000 m^2 to implement SSS. This triggered the installation of thousands of privately owned and operated SSS units, particularly in the peripheral areas of large cities where the biggest construction boom took place.

Few states in the southern part of India; Andhra Pradesh, Tamil Nadu, Karnataka, Kerala and Goa have taken the initiative to develop their individual SSS policies. Further, cities such as Bangalore, Chennai, Pune, Delhi and Hyderabad have their own mandates on SSS through the local municipal corporations, water supply and sewerage boards (Reymond et al., 2020). These become the final end of line agencies to support the SSS implementation (Bhullar, 2013).

3.5.2 Contexts in India

The design, technology choice and various other factors of SSS vary by contexts. The fundamental contexts for SSS are provided in Table 3.3. The motivation for uptake of SSS is also dependent on the context and could be due to legal and regulatory requirements, reuse opportunities, cost effectiveness, lack of existing sewer systems, temporary installations such as public toilets for gatherings, intermediary solutions until centralised infrastructures are put in place. From the 4S project database, 50% of the units are from middle and high-income Residential, 25% from commercial, 15% from institutional, and 10% from low-income residential (Klinger et al., 2020).

Table 3.3 Application contexts of Small-Scale Sanitation Systems in India (Klinger et al., 2020)

CONTEXT	EXPLANATION
Low-Income Residential	Comprising of both formal low-income sites as well as informal settlements, community and public toilets in a similar context, the sites of this context are usually not required by law to build their own wastewater plants due to a lower density of habitations. The project usually is implemented by government or by NGOs, but further on managed by the community.
Middle and High-Income Residential	This is the most represented category, with multi-storeyed buildings in a majority of cases. It is expected that more that financial constraints, management and operation aspects are more prone towards contributing to failure.
Institutions	Including public and non-public institutions such as schools or hospitals or offices, this category is assumed to have a good organisational entity and therefore an appropriate managerial body. However, important to note that, not all such sites have financial flexibility.
Commercial	The commercial-centres, as well as hotels/restaurants are included in this category. These are expected to have more financial fluidity than the institutional set ups and possibly strong organisational entities.

3.5.3 Technologies widely used in India

A wide variety of technologies exist in the sanitation sector and are available in the Indian wastewater market for various scales. Technologies vary from Activated Sludge Process (ASP) to Advanced Oxidation Processes. However, no comprehensive database has been found on the kinds of small-scale sewage treatment plants in India, or a list of all technological options available.

Technology providers have also come up with interesting variations of conventional processes and their own brand names to market themselves more effectively. For example, Deccan Water Treatment, a company based out of Puneprovides a version of sequencing batch reactor (SBR) called the Suspended Media Bio Reactor. EcoTech in Chennai, markets a variation of SBR called the KLARO, which is power optimised and automated specifically for small-scale applications. In addition, several providers also offer packaged/ready to install versions for the treatment.

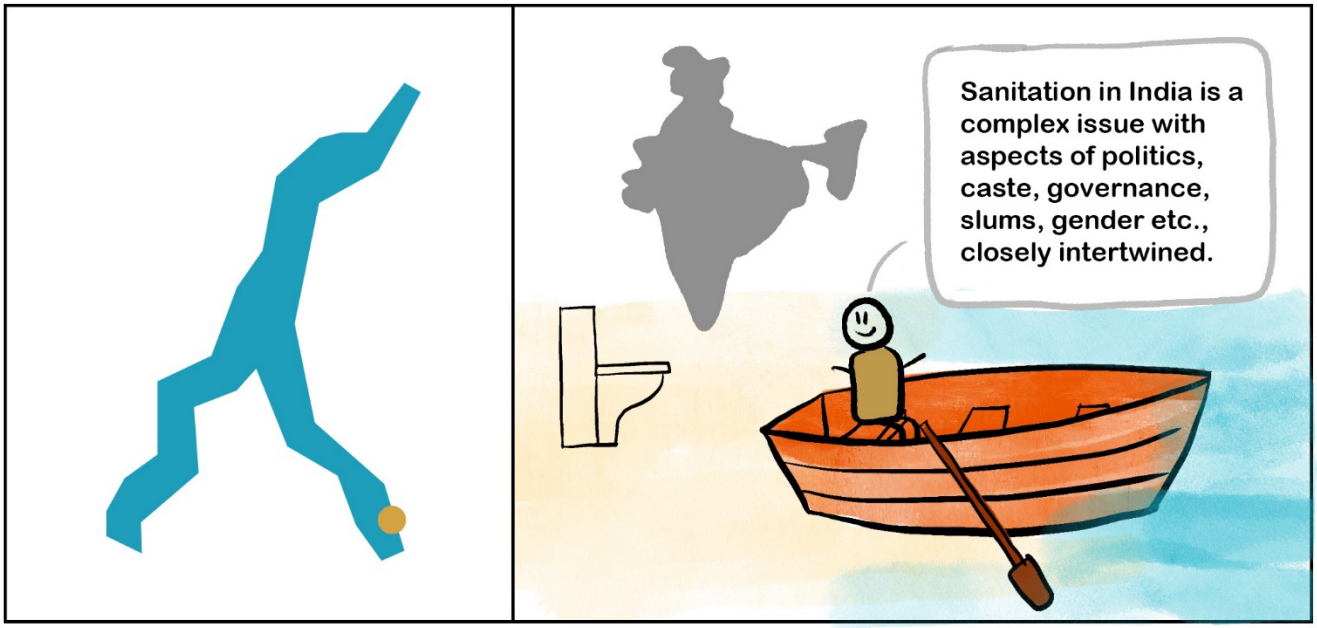
Given the wide range of technologies and their variations being present, listing the ones with fundamentally similar processes of treatment under a technology family is more comprehensible. Table 3.4 summarises the key SSS technology families.

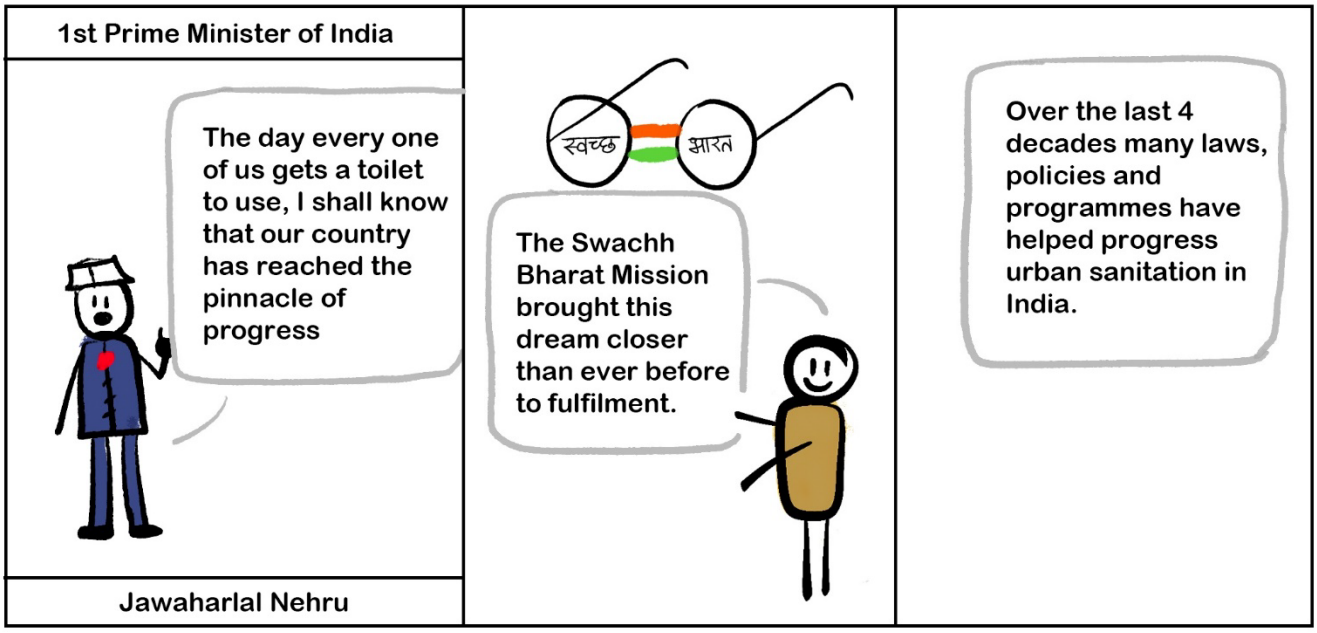
There is little or no knowledge that emphasises the importance of choosing the right technology for the right situation. In many cases, end users do not get adequate say in choosing technology. Consultants or high-level officials, who play a major role in choice of technology for various contexts, are not always unbiased given their selective knowledge or existing ties with companies, therein lacking transparency in decision making for sanitation systems. In cases of retrofitting solutions for

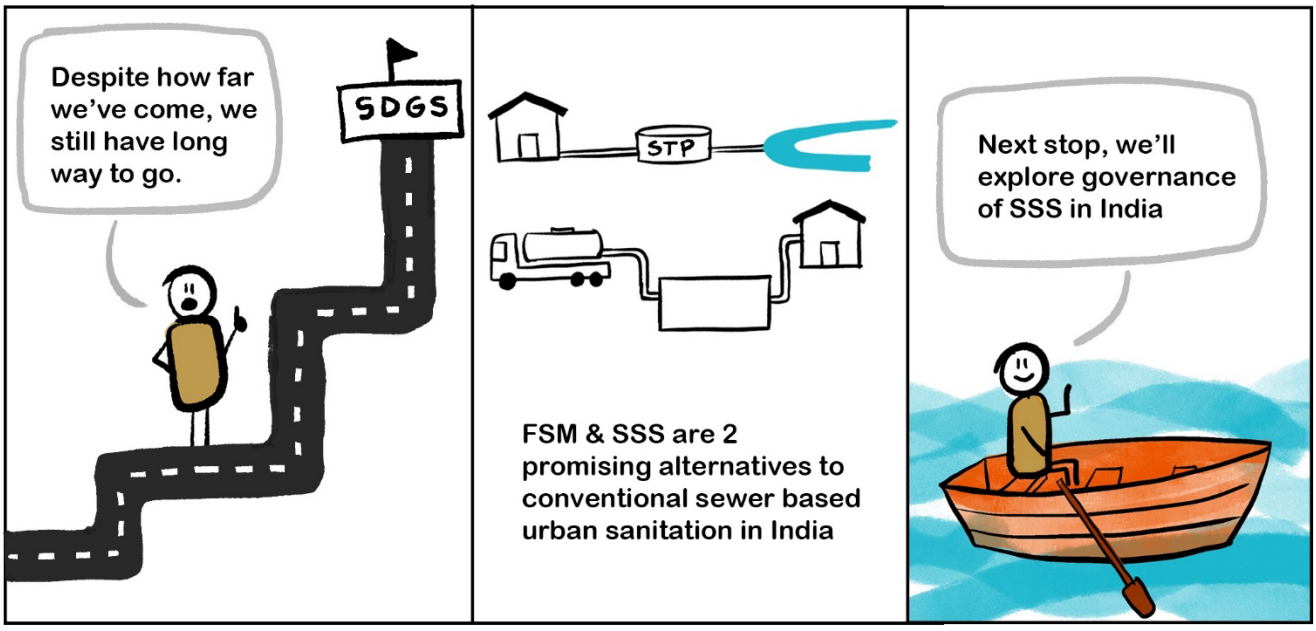
residential compounds, resident welfare associations are usually in place, which enables a user involved decision process. In any such case, a decision guide that considers holistically, the costs (both capital and operating), water quality, footprint, labour requirements, scale, prefabrication options, civil structures needed and other relevant factors is imperative.

Table 3.4 Classification of Technology families used in small-scale sanitation systems in India (Klinger et al., 2020)

TECHNOLOGY FAMILY	TECHNOLOGIES	ABBREVIATIONS
Activated Sludge (Suspended Growth) Processes	Conventional Activated Sludge Process	ASP
	Extended Aeration	EA
	Oxidation Ditch	OD
Sequencing Batch Reactor	Sequencing Batch Reactor	SBR
Membrane Bioreactor	Membrane Bioreactor	MBR
Attached Growth Processes	Moving Bed Biofilm Reactor	MBBR
	Submerged Aerated/Aerobic Fixed Film Reactor	SAFF
	Rotating Biological Contactor	RBC
	Trickling Filter	
Anaerobic Baffled Reactor (ABR) Based Systems	Combinations of ABR with Anaerobic Filter (AF), Planted Gravel Filters (PGF)/Constructed Wetlands, Biogas Settlers, Ponds and Vortex	ABR-Based Systems
Other Anaerobic Processes	Upflow Anaerobic Sludge Blanket Reactor	UASB
	DRDO Biodigester	DRDO
Constructed Wetlands and Soil Filtration Systems	(Continuous Advanced Multistage System using) Soil Biotechnology	CAMUS-SBT
	Solid Immobilised Bio-Filter	SIBF
	Single Phase Intermittent Sand Filter	SPISF
	Horizontal-Flow Constructed Wetland	HFCW
	Vertical-Flow Constructed Wetland	VFCW
	Hybrid Constructed Wetland	
POND SYSTEMS	Solar Evaporation	
	Waste Stabilisation Ponds	WSP
OTHER SYSTEMS (INCL. PHYSICO-CHEMICAL PROCESSES)	Chemo-Autotrophic Activated Carbon Oxidation / Fluidised Immobilised Cell Carbon Oxidation	CAACO / FICCO
	Electrolytically Activated Degenerative Oxidation	EADOx
	Advanced Oxidation Process	


Sanitation in India is a complex issue with aspects of politics, caste, governance, slums, gender etc., closely intertwined.


1st Prime Minister of India
The day every one of us gets a toilet to use, I shall know that our country has reached the pinnacle of progress
Jawaharlal Nehru
स्वच्छ
भारत
The Swachh Bharat Mission brought this dream closer than ever before to fulfilment.
Over the last 4 decades many laws, policies and programmes have helped progress urban sanitation in India.


Despite how far we've come, we still have long way to go.
SDGS
STP
FSM & SSS are 2 promising alternatives to conventional sewer based urban sanitation in India
Next stop, we'll explore governance of SSS in India

04

Analysing Sanitation Governance in India using Social Network Analysis

> **Sanitation in India is a governance problem**
>
> *– Depinder Kapur*

This Chapter has been previously published as: Narayan, A. S., Fischer, M., and Lüthi, C., (2020). Social Network Analysis for Water , Sanitation , and Hygiene (WASH): Application in Governance of Decentralized Wastewater Treatment in India Using a Novel Validation Methodology. Front. Environ. Sci. 7, 198. doi:10.3389/fenvs.2019.00198.

A.S.N., M.F. and C.L. jointly conceptualised this publication. A.S.N. wrote the original draft, managed the reviews and edits, software programming and created the visualisations. A.S.N. developed the validation methodology. M.F. and C.L. supervised the research. Investigation, data curation and analysis of the initial SNA upon which this publication was built on was supported by members of the 4S project i.e., Lukas Ulrich, Philippe Reymond, Harsh Patel and Tamara Kabir. A.S.N. handled the project administration and fieldwork for this research.

4.1 Abstract

Social network analysis (SNA) is a versatile and increasingly popular methodological tool to understand structures of relationships between actors involved in governance situations. Given the complexity of the set of stakeholders involved in the governance of Water, Sanitation and Hygiene (WASH) and the diversity of their interests, this article proposes SNA to the WASH sector. The use of SNA as an appropriate diagnostic tool for planning Citywide Inclusive Sanitation is explored. Missing data is a major problem for SNA in the studies of governance situations, especially in low- and middle-income countries. Therefore, a novel validation methodology for incomplete SNA data, relying on information from internal and external experts is proposed. SNA and the validation method is then applied to study the governance of decentralised wastewater treatment in four cities of India. The results corroborate key differences between mega and secondary cities in terms of institutions, community engagement and overall sanitation situation including aspects of decentralised wastewater treatment plants, based on the city types.

4.2 Introduction

Social Network Analysis (SNA) is a method of detecting and interpreting structures and patterns of connections between actors who may be individuals, collectives or institutions (Scott, 2017). SNA is a versatile tool for different applications due to its graphical representation, structural intuition and systematic data interpretation (Borgatti and Ofem, 2010; Freeman, 2004). It has been increasingly used in a variety of fields from political science (Fischer and Sciarini, 2016; Victor et al.), business marketing (Iacobucci, 1996), social psychology (Pearson and Michell, 2000) to public health (Valente et al., 2008), and environmental governance (Bodin, 2017; Bodin and Crona, 2009). More substantively, SNA is designed to deal with data on relations among entities, and thus data that describes interconnected phenomena, and consists of non-interdependent observations. Whenever a researcher believes that relations among entities are crucial for understanding a given phenomenon, SNA can provide important insights (see Table 4.1).

Table 4.1: Contextualised explanation of relevant SNA concepts for the WASH sector

SNA CONCEPT	RELEVANT INTERPRETATION IN SANITATION GOVERNANCE
Density	Indicates how closely actors within a network are connected to each other. Calculated as the number of observed network connections over the maximum number of network connections that could exist (if all actors are connected to all other actors). Useful mostly for comparing networks.
Centrality	Centrality indicates the degree to which an actor is embedded in the network. For example, high centrality refers to actors able to collect and transmit information and coordinate with other actors (Scott, 2017). Several centrality measures exist (Freeman, 1979); the most prominent ones are degree centrality (number of connections an actor has), closeness centrality (average path length to all other actors in the networks), and betweenness centrality (actor lying on shortest path between two other actors in the networks). Useful mostly to identify important or powerful actors in the network.

Core and Periphery	Indicates the degree to which a network has a core-periphery structure, and whether actors belong to one or the other. The core is defined as a set of densely interlinked actors, which is positioned in the centre of the whole network, whereas actors in the periphery are more loosely connected to the centre, and not among each other (Borgatti and Everett, 1999). Useful to identify a power structure in the network, and identify marginalised actors.
Centralisation	The degree to which centralities in the network are distributed equally or unequally among actors in the network (Freeman, 1979). High centralisation exists if there is one very central actor with all other actors being much less central. Useful to identify power structure and hierarchies.
Cliques	Subgroup of actors within the network that is densely connected. Useful to identify fragmentation of the network, or coalitions of actors, etc. (Bron and Kerbosch, 1973)

Governance in water, sanitation and hygiene (WASH) for development, especially in urban sanitation, is complex and commonly involves a number of stakeholders interacting across administrative levels, sectors and demographics (Strande et al., 2014). For instance, political economy studies of WASH and related urban services in Asian low- and middle-income countries, have revealed that the complexity of governance combined with weak institutions are a detriment to urban service delivery (Boex et al., 2020). In such a context, SNA can be used to describe and analyse the polycentricity of governance and institutions relevant for economic development. Furthermore, SNA has been related to Ostrom's (e.g., 2009) crucial concepts of polycentric governance (by assessing the complex patterns of different actors participating in a diversity of parallel decision-making bodies, e.g., Lubell, 2013), and social-ecological systems (by assessing how governance networks of actors are related to underlying ecological networks, e.g., Bodin 2017). The use of SNA for such contexts can thus take into account, the potentially important structure of relations among different actors, and could offer a different and possibly more appropriate perspective as compared to more conventional stakeholder analysis methods, which are often employed in WASH research and practice. The importance of SNA in understanding the complex adaptive systems existent in WASH for development has been indicated by Neely (2013) to answer the questions of *why* and *how* to ensure sustainability of community WASH interventions.

More specifically, SNA has several key advantages for the analysis of complex governance situations. First, SNA can help in identifying and interpreting specific roles of given actors in the governance network including gatekeeper or broker roles (Bodin and Crona, 2009; Ingold, 2014; Ingold and Varone, 2012). These actors can be crucial for the diffusion of information and best practices, or for the elaboration of compromise solutions in governance networks. Second, a graphical representation of the SNA, a network graph (or sociogram) provides intuitive visual insights of the interactions between actors and allows for identification of key and marginalised players, and therefore could facilitate more equitable stakeholder involvement. Such information could pave the way for effective stakeholder engagement, taking into account formal and informal networks, and reveal possibilities to build on existing social structures and points of interventions that improve success in WASH governance. For example, using SNA for identifying collaborative social networks for better water resource governance in the *Mkindo* catchment, Tanzania (Stein et al., 2011). A deeper understanding of stakeholder relations can increase the likelihood of collective action resulting in higher success of interventions (Prell et al., 2009). The use of SNA for identifying key characteristics of stakeholder networks that support institutional development has been shown in the service delivery of rural water supply in several low- and middle-income countries (McNicholl et al., 2017). Third, the very process of SNA data gathering has positive effects on the participation of stakeholders and the building of relationships

with them (Jami and Walsh, 2014), while also increasing their awareness of other actors in the network. This is particularly useful in planning for the paradigm shift in urban sanitation that is Citywide Inclusive Sanitation (CWIS), which is based on equity in sanitation service delivery, combined use of diverse sanitation systems, and safe management of faecal waste along the entire sanitation value chain (Lüthi and Narayan, 2018).

Despite the potential benefits of SNA for research in the WASH sector, there has been a preference for stakeholder analysis over SNA, especially in urban sanitation studies (Lüthi et al., 2011b; Myers, 2016; Reed et al., 2009; Reymond, 2014). Stakeholder analysis has been criticised for lack of consistency, halved perspectives, and for being in want of accounting informal relations (Hermans, 2005; Reed et al., 2009). Stakeholder analysis is purely qualitative and relies solely on interviews, focus group discussions, and snowball sampling to identify stakeholder interest and influence (Reed et al. 2009). SNA, on the other hand, can be both quantitative or qualitative, and allows for a mixed methods approach (Edwards, 2010). Studies advocate combining SNA and stakeholder analysis to produce fine-grained insights in water infrastructure planning, because this would improve rigour and offer complimentary perspectives that would help create a more complete situational diagnosis of stakeholder interest and interactions (Lienert et al., 2013). Other studies have promoted this view in natural resource governance and participatory planning (Paletto et al., 2015; Yamaki, 2017).

One important disadvantage of conventional SNA methodology and related data gathering through surveys or interviews (Wasserman and Faust, 1994) is the problems in data collection similar to most other key informant methodologies. SNA requires reliable data to draw strong inferences from the analysis of the networks. This presents the need for a systematic validation procedure, which could mitigate the issues that arise with unreliable data, especially from research in low- and middle-income countries, where data quality and availability is a consistent issue (Becker et al., 2012). Since most WASH research is carried out in similar settings, an appropriate validation procedure is even more relevant.

Decentralised wastewater treatment systems in India have witnessed an exponential increase in their uptake across the country in the last decade. This was prompted by a 2006 amendment to the environmental clearance laws that mandated large buildings (built up area above 20,000 m^2) to treat sewage in situ. An estimated 20,000 small-scale Sewage Treatment Plants (STP), serving between 10 and 1,000 households, are currently in operation using various technologies (Ulrich et al., 2019). A majority of them are found in cities, both mega and secondary. However, due to the lack of a clear policy framework and jurisdictional overlap between governing agencies at various levels, the performance and sustainability of such small-scale sanitation systems (SSS) are affected (Chandragiri et al., 2019). Sustainable long-term operation of such SSS require effective governance (Ross et al., 2014). Understanding the governance of SSS can also help inform future policies for their planning, implementation and long-term monitoring. Such a study can also help the understanding of the nuanced differences between mega and secondary cities in India, which have inherent differences in institutional set up, urbanisation, citizen engagement, decentralised wastewater treatment, and sanitation at large.

Therefore, the combined aim of this paper is to: i) propose SNA as a useful tool for WASH research and practice, ii) introduce a novel validation methodology for SNA, and iii) explore the differences in sanitation governance between mega and secondary cities in India, using SNA as a tool. In doing so, this paper presents the first research carrying out social network analysis research for urban sanitation settings.

4.3 Methods

4.3.1 Social Network Analysis and Low Response Rates

The goal in the first stage was to gather SNA data on the governance networks in four Indian cities based on interviews and surveys. This type of data gathering in the field is well established for SNA and has been previously used as a systematic method to describe and analyse the governance network between multiple stakeholders in areas such as the water sector (Angst, 2018; Lienert et al., 2013), natural resources governance (Bodin and Crona, 2009), climate governance (Ingold and Fischer, 2014), energy governance (Fischer, 2015), policies for reducing emissions (Brockhaus et al., 2014), and planning (Dempwolf and Lyles, 2012; Gerber et al. 2013). In this initial attempt, the relevant actors responsible for the SSS present in the four Indian cities (Chennai, Bangalore, Mysore and Coimbatore) were identified through informal expert contacts and document analysis (a set of about 15-20 actors per case, e.g., national, state and city level public administrations, international organisations, relevant boards and associations, etc. An overview of actors appears in Table 4.2). Individual representatives of the relevant organisations were then contacted by email and phone in order to interview them or have them fill out a written survey with the same content. For example, in order to assess the relevant network relations among actors, the survey / interview protocol asked actor A to "check, on a pre-defined list of all relevant actors – all those actors with which actor A regularly exchanged technical information on sanitation issues within the last 10 years."

A common problem with gathering network data directly from the stakeholders themselves is low response rates, as with any other interview and survey data gathering. In the present case, the interview and survey response rates on average were less than 40% (with a maximum of 50% in Bangalore and a minimum of 27% in Coimbatore). Common reasons for non-response are that individuals do not feel competent to answer the questions, are not interested in filling surveys, do not have time, do not want information about their organisation to appear in studies, etc. These reasons were mentioned by actors in this specific case, but they correspond to common reasons for non-response in survey and interview-based research. Overall, while low response rates is a common problem specific to social science research in low- and middle-income countries such as India, it is also an issue in many studies of this nature elsewhere, including SNA research in the United States, for example (Lubell et al., 2017).

Low response rates lead to incomplete data. Data can be incomplete with respect to actors that are missing, or, more frequently, with respect to relations between the actors that are missing. Concerning the latter, survey and interview data gathering in the context of SNA always has two potential sources of information for the relations between two actors, that is, from one or the other actor. While this can mitigate issues of low response rates (if actor A indicates a relation to actor B, but information from actor B is missing, the researcher still has partial information on that relation), missing data in SNA can still be problematic for several reasons. Most importantly, incomplete network data can lead to unreliable estimates of network-level statistics, given that network-level statistics are based on the structure of the entire network (Burt, 1987). For example, centrality is a popular network measure used to identify the most important actors in a governance network (Table 4.1). Centrality measures can be incorrect due to missing data, or if parts of the networks are missing or disconnected from each other (Costenbader and Valente, 2003). More substantively, the analysis of incomplete network data might lead to the erroneous identification of important actors through wrong or unstable centrality indices. It can further lead to inaccurate density measures (see Table 4.1), if the percentage of missing data differs between the networks to be compared.

Table 4.2: List of actors identified in the first step for Karnataka & Tamil Nadu. See Figure 4.1

LEVEL	ORGANISATION	ABBREVIATION
National	Bureau of Indian standards	BIS
	Central Pollution Control Board	CPCB
	Central Public Health and Environmental Engineering Organisation	CPHEEO
	Ministry of Skill Development and Entrepreneurship	MSDE
	Ministry of Water Resources, River Development and Ganga Rejuvenation	MWR
State	City Managers' Association	CMA
	Directorate/ Commissionerate of Municipal Administration	DCMA
	Department of Environment and Forest	DoEF
	Lake Development Authority	LDA
	State Environmental Impact Assessment Authority	SEIAA
	State Housing Board	SHB
	State Pollution Control Board	SPCB
	State Urban Development Department	SUDD
	State Urban Infrastructure Development & Finance Corporation	SUIDFC
	State Water Supply & Sewerage Board	SWSSB
City	City Municipal Corporation	
	City Water Supply & Drainage Board	CWSDB
	Divisional Pollution Control Board	DPCB
	Urban Development Authority	
International Development Organisations /NGOs	Asian Development Bank	ADB
	Centre for Policy Research	CPR
	German International Cooperation	GIZ
	Indian Green Building Council	IGBC
	National Institute of Urban Affairs	NIUA
	World Bank	
Private Players	Architects	
	Buyers of treated wastewater	
	Consultants	
	MEP Consultants	
	STP Designers/Manufacturers	
	O&M service providers	

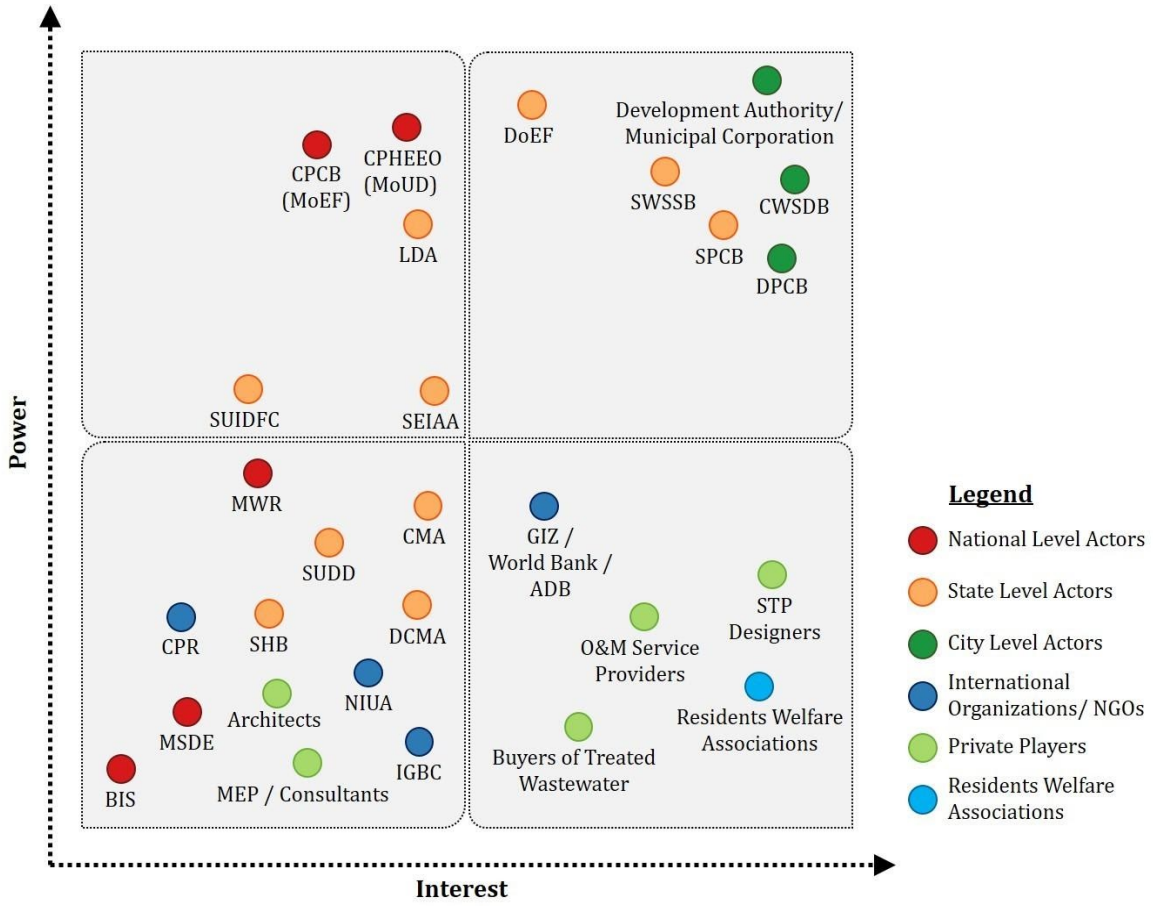


Figure 4.1: Power-interest matrix of potential stakeholders involved in small-scale sanitation governance at the local level. Refer to Table 4.2 for abbreviations. Colour coding is followed in all other network graphs presented below.

4.3.2 Validation Methodology

In order to increase the validity of the data gathered on the four cities in India, a validation methodology was developed. The objective of the process was to validate an existing, incomplete network, using available expertise from informants who have high knowledge of the case and the relationships the actors share within the network. This process of eliciting expert judgements has been previously used for WASH studies in low- and middle-income countries where data is often not readily available and knowledge from experts was found to be invaluable (Montangero and Belevi, 2007). Similar practices have been employed, albeit scarcely, to elicit network data for social network analysis. Carley and Krackhardt (1996) involved a third person within the network to comment on connections between dyadic relations, the equivalent of an 'insider'. Here, the cognitive inconsistency between non-symmetric and non-reciprocated relations between actors were studied, using such insiders. Orenstein and Phillips (1978) used press reporters to give information about political actors' relations, a case which used members completely outside of the network, an 'outsider'. As mentioned by Doreian et al. (1989), it is important for these outsiders to be in the margins of the study group and yet remain knowledgeable.

Insiders bring in detailed information about relations between actors based on their direct experience and a perspective only available to them. Similarly, outsiders are beneficial due to their ability to view the entire network without direct involvement and, therefore, without egocentric biases (Doreian et al. 1989). Using these two established types of informants, insiders and outsiders, simultaneously,

allows for an additional level of confirmation to be obtained regarding network data between actors, while also reducing any possible perception biases.

In order to improve data reliability, a seven-step validation procedure has been proposed below. This procedure is based on network graphs that are visualisations of the social network. Most importantly, these visualisations include nodes (also called vertices) to represent the actors in the governance networks and ties (also called links or edges) to represent relations between the actors. Colours and sizes of nodes and ties can be used to represent attributes of these elements. For example, different colours can be used to represent different types of actors, and tie size can be used to represent the intensity of a relation. The steps of the validation procedure are grouped as desk-based steps (1-3), field-based steps (4-6) and reconciliation steps (7).

1. Usage of existing incomplete or desk-based network graph

   The initial network graph stems from an incomplete social network analysis, with either missing actors or missing information on relations between actors. The incompleteness can be either due to low response rates in interviews or surveys, or to the fact that it was a purely desk-based study, which needs validation from the field to bring it closer to the reality of the different types of relations among actors.

2. Expert identification

   This could either be carried out from a Power-Interest matrix, choosing actors with high interest (Quadrant-1 & 4 in Figure 4.1) or who could be chosen from case knowledge. Between 10-20 % percent of the number of actors in the entire network graph, depending on its size, could feature as experts. It is preferable to keep this percentage low, otherwise there is a risk of carrying out an elaborate conventional SNA procedure of interviewing most actors, again with problems of missing responses. It also helps target the most valuable experts and ease the reconciliation (step 7).

3. Insider – Outsider selection

   An equal number of insiders and outsiders (defined as above) have to be selected from the experts. Those actors positioned in the core of the network graph with high centrality are classified as insiders and those actors who are either in the periphery of the previous network graph or who do not feature as an actor at all, and yet have high interest and/or knowledge about the context of the social network, will be classified as expert outsiders.

4. Discussion based on a simplified unconnected version

   A simple version of the network graph, where actors are arranged randomly with equal sizes and without colour codes or connections between them, is presented to each expert (insider and outsider). This ensures that there is only basic inference on the part of the actors, possible from the representation, and does not create any biases. In order to deal with the first basic issue, concerning missing data in the SNA (missing actors), it is verified that all important actors are featured, and that no non-important actor is included. If not, the suggested actors are added or deleted (for example: Divisional PCB is removed as mentioned in Figure 4.2).

5. Simplified version to make connections

Post the actor verification on step 4, the perceived relations between them are requested from the expert in order to deal with the second missing data issue in the SNA, that is, missing relations among actors. Types of connections vary by case; in governance, typical connections include information exchange (technical and administrative), collaboration, line reporting, etc. (Victor et al.)*. These connections could be formal only, or informal only, or both - as required by the network graph. Initially, the obvious connections are marked, and then the less visible connections, such as informal or inter-sector connections are made (for example: International Organisations and Private Companies in Figure 4.2). This exercise might take some time, and often requires prompt questions.*

6. Existing network graph for representation questions

Post the unbiased version, the original non-validated network graph is presented to the expert, and representative questions are discussed. The expert is then invited to verify which actors are central or peripheral actors, which connections are present or not, and whether the size and positions of all actors are right according to his view (note that the position of the actor usually represents its centrality, and the size can represent different types of information, in this case Eigenvector centrality). Additionally, any weak, non-existent or irrelevant connections are marked to be removed (for example: a weak connection between the Central Pollution Control Board and International Organisations was marked for removal in Figure 4.3. Similarly, connections between urban development authority and divisional pollution control board, and state funding corporation and pollution control board were also suggested to be removed).

7. Data reconciliation

Based on all the data collected from the above steps 1-6, the corresponding binary adjacency matrix is filled as 1 or 0 – the pair of actors being connected or not connected, respectively. When there are conflicting responses for the same connection from various sources, the reconciliation for the relation is carried out based on the following (see example in text further below):

i. Data from the previous network graph

ii. Weightage of expertise of insiders and outsiders

iii. Documental evidence found

iv. Justification provided during the interview

v. Substantial case knowledge

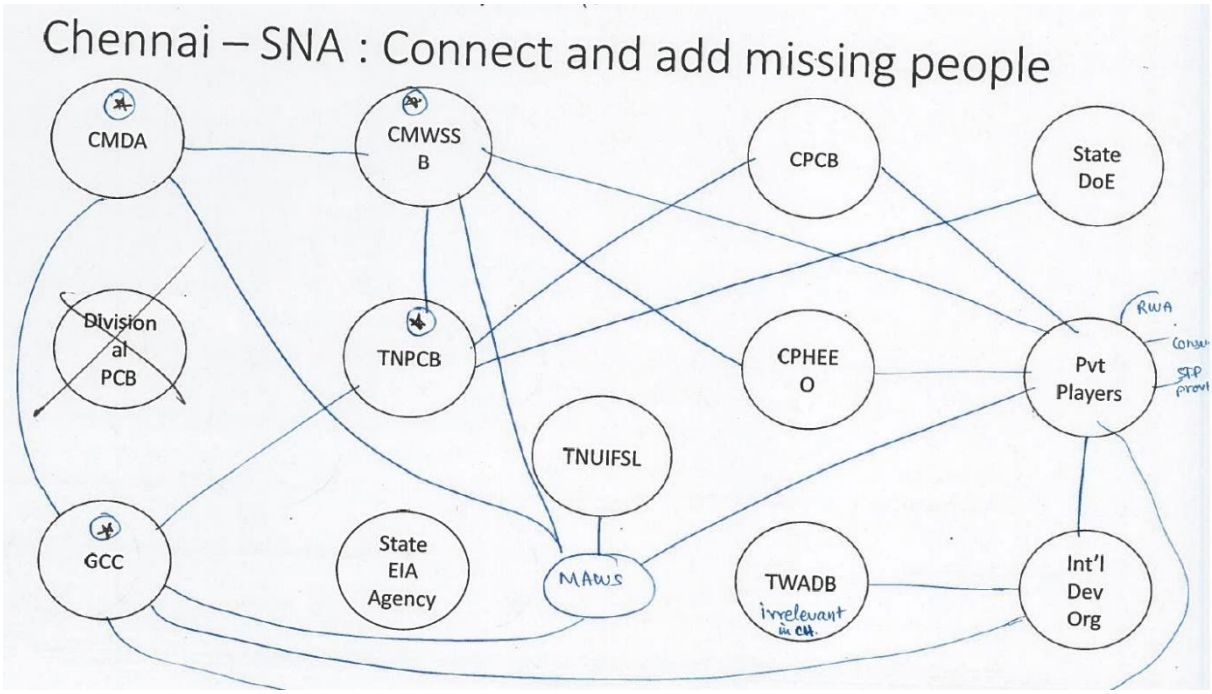


Figure 4.2: Representation of the discussion based on the unbiased version mentioned in Step 4 and 5 of the validation procedure.

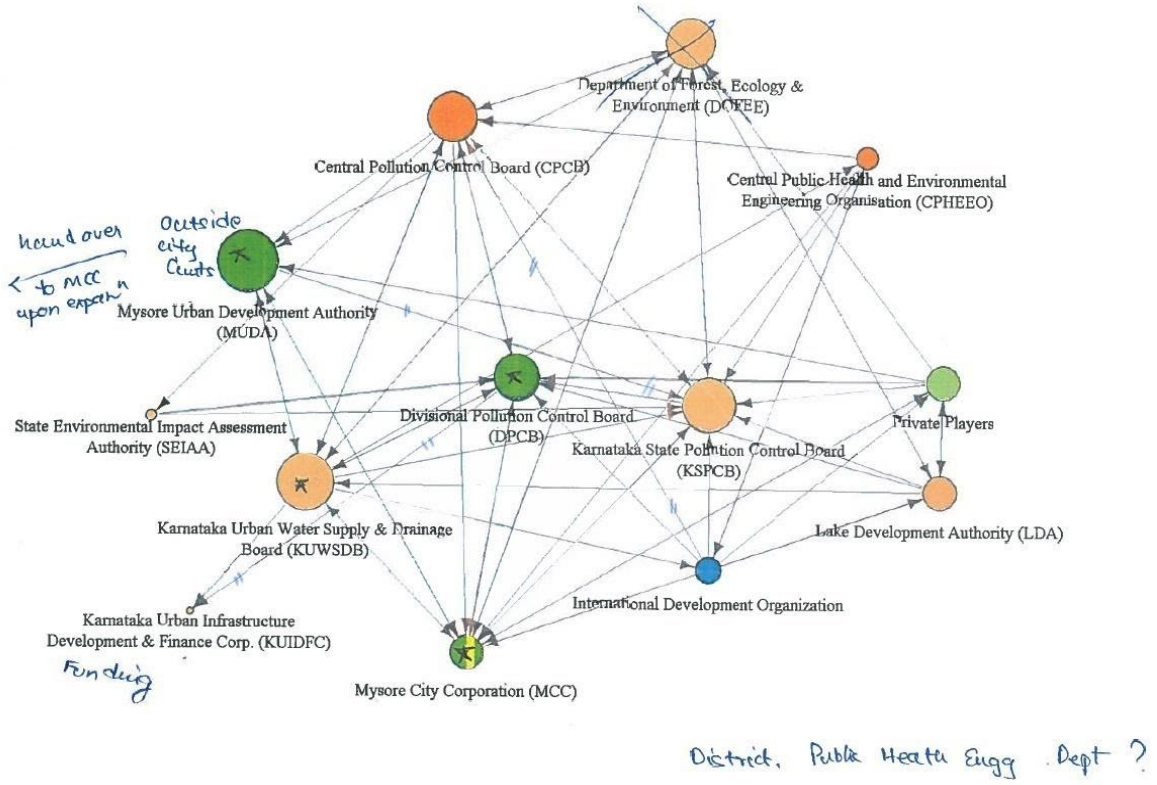


Figure 4.3: Representation of the discussion based on the initial version of the network graph mentioned in Step 6 of the validation procedure.

4.3.3 Validation of the network graph

For the validation procedure proposed in this paper, four key stakeholders were chosen for each of the four cities and a total of 16 validation interviews were carried out (Table 4.3). For reasons of potential research fatigue (Clark, 2008), all the stakeholders chosen were new and had not been interviewed for the previous social network analysis. This was possible since these actors were not part of the earlier SNA interviews (due to poor selection, unavailability or inaccessibility at that point of time), which resulted in analysis being incomplete in the first place. In addition, certain experts, who were retired or switched careers, and still had significant knowledge were included in the validation study.

4.3.4 Discussion on Validation Methodology

While such a validation method allows for the gathering of additional data to complement incomplete networks and thus provides an improvement over incomplete survey or desk-based studies, there are obviously some challenges as well. Four such challenges and their mitigation are discussed below.

Firstly, knowledge biases, exercise preferences and effective priming are concerns for the format of the validation methodology. The order of steps 5 and 6 were found to be critical in drawing out major connections in the expert's opinions without biasing. This sequence also ensured that the actors are primed for a more visually complex, information dense and influential network graph. Through the combined usage of time-consuming step 5 and visually intimidating step 6, experts who had a preference for one step over the other were also catered to. Experts are often senior and time pressed; therefore, the process had to be time effective and flexible. Therefore, this two-pronged approach reduces the amount of information lost due to temporal and methodological leaks.

Secondly, clarity in criteria for connections is important to be established at the beginning. Interpretation of the requirements of an existent connection varies depending on experts, and has to explicitly clarified. These assumptions could result in inaccurate connections (for example: are solely funding agencies of decentralised STP projects involved in governance, even if they have no responsibility apart from their financial contributions?). There is a possibility that large biases could emerge from the experts as well (for example: private sector experts tend to focus on their importance, while government players tend to downplay the former's importance. (see Fischer and Sciarini, 2015). Both aforementioned concerns, could be mitigated by objectively administering the interview with clarity on the relational requirements and minimising information spill to prevent biases.

Thirdly, prompting is frequently employed in order to maximise the information elicited from the experts, especially in circumstances where inherent knowledge or previous connections are to be challenged. This could potentially lead to interview frustration or bias (Bowling, 2005). At a certain point when all major connections are explored, to bring out inconspicuous connections, prompting is found to be necessary. The researchers must have a considerable amount of prior case in order to carefully prompt when required. For example in step 5, the connection between private company and the pollution control board required prompting in several cases, to be considered for either connecting or not.

Finally, conflicting information leads to difficulties in reconciliation. Since the validation methodology relies on fewer respondents, albeit experts, it requires care to bring in diverse perspectives. Otherwise, the SNA could risk becoming skewed through purposeful sampling (Patton, 1990). The validation procedure finally rests on the systematic reconciliation of conflicting data points. This is carried out qualitatively and involves the judgement of the researcher, which, yet again, places the requisite of prior substantive case knowledge on the researcher. Since the method itself is a mix of qualitative data collection and quantitative data analysis, these limitations are inherent and require careful consideration while selecting experts and being systematic during the reconciliation. However, such

limitations are prevalent in most qualitative methods (Taylor et al., 2015), including conventional social network analysis (Scott, 2017). The reconciliation procedure becomes crucial when the experts give varying and frequently conflicting network data. Therefore, systematic assessment of the data needs to be carried out, based on expertise weightage, documental evidence, substantive case knowledge, and justification provided during the interviews. For example, when C3 and C4 (Table 4.3) had conflicting views on one specific connection between the city corporation and state pollution control board, C4's view was withstanding since C4 earlier held the positions at both city and state levels. Additionally, C4's justification proved to be more convincing with references to policy documents.

In the results section, we present and compare the governance of decentralised wastewater treatment in four cities based on the data received from the different steps of the data collection, including the validation procedure. Since the goal is to describe governance networks and compare different cases, SNA as a standalone method lacks context to interpret the network graphs and needs to be used in conjunction with other research methods, especially qualitative methods to gain deeper understanding of the situation and prevent simplistic conclusions on the stakeholder interactions (Edwards, 2010; Prell et al., 2006). Therefore, this validated network data was used in complement with two workshops and 76 in-depth qualitative key informant interviews, which provided the background and context on urban wastewater management in India, for the selected mega and secondary cities, and the differences between them were explored (see Results section). In addition, the institutional and performance analysis of the specific small-scale sanitation systems in the four cities was available to provide additional perspectives relevant to this analysis (Ulrich et al., 2019). The validated data was processed using the user friendly SNA specific open source software *Gephi* (Bastian et al., 2009), and represented using *Force Atlas* configuration without any manual manipulation.

Table 4.3: Key Informants interviewed for validation with their expertise levels and interview codes

Code	Affiliation	Actor	Expertise	City
C1	Academia	Outsider	High	Chennai
C2	NGO	Outsider	Low	Chennai
C3	City Government	Insider	Intermediate	Chennai
C4	State Government	Insider	High	Chennai
B1	NGO	Outsider	High	Bangalore
B2	Private Company	Insider	Intermediate	Bangalore
B3	Utility	Insider	Intermediate	Bangalore
B4	Academia	Outsider	Low	Bangalore
K1	Private Player	Outsider	High	Coimbatore
K2	Academia	Outsider	Low	Coimbatore
K3	State Government	Insider	High	Coimbatore
K4	City Government	Insider	High	Coimbatore
M1	Academia	Outsider	Intermediate	Mysore
M2	City Government	Insider	High	Mysore
M3	State Government	Insider	High	Mysore
M4	NGO	Outsider	Intermediate	Mysore

4.4 Results

In this section, four main results regarding the use of SNA for our case study are presented. Firstly, the comparison of the pre-validated SNA with the validated SNA, and the major modifications made from the validation exercise are given. Secondly, a detailed illustration of using SNA to understand governance of decentralised wastewater treatment in one particular city – Chennai, is made. Thirdly, the differences between mega and secondary cities in terms of sanitation are presented, and then SNA results are discussed in relation to few of these key differences.

4.4.1 Comparing Pre-Validated SNA with Validated SNA

The initial procedure yielded an incomplete network, based on which pre-validated network graphs were created for the four cities of Chennai, Bangalore, Mysore and Coimbatore (Figures 4.4a-d). Similarly, network graphs were created using the validated network data for the same cities (Figures 4.5a-d). Five major differences that are clearly visible are discussed below – actor influence, removal of irrelevant actors, addition of important actors, centralities of actors and densities of overall network.

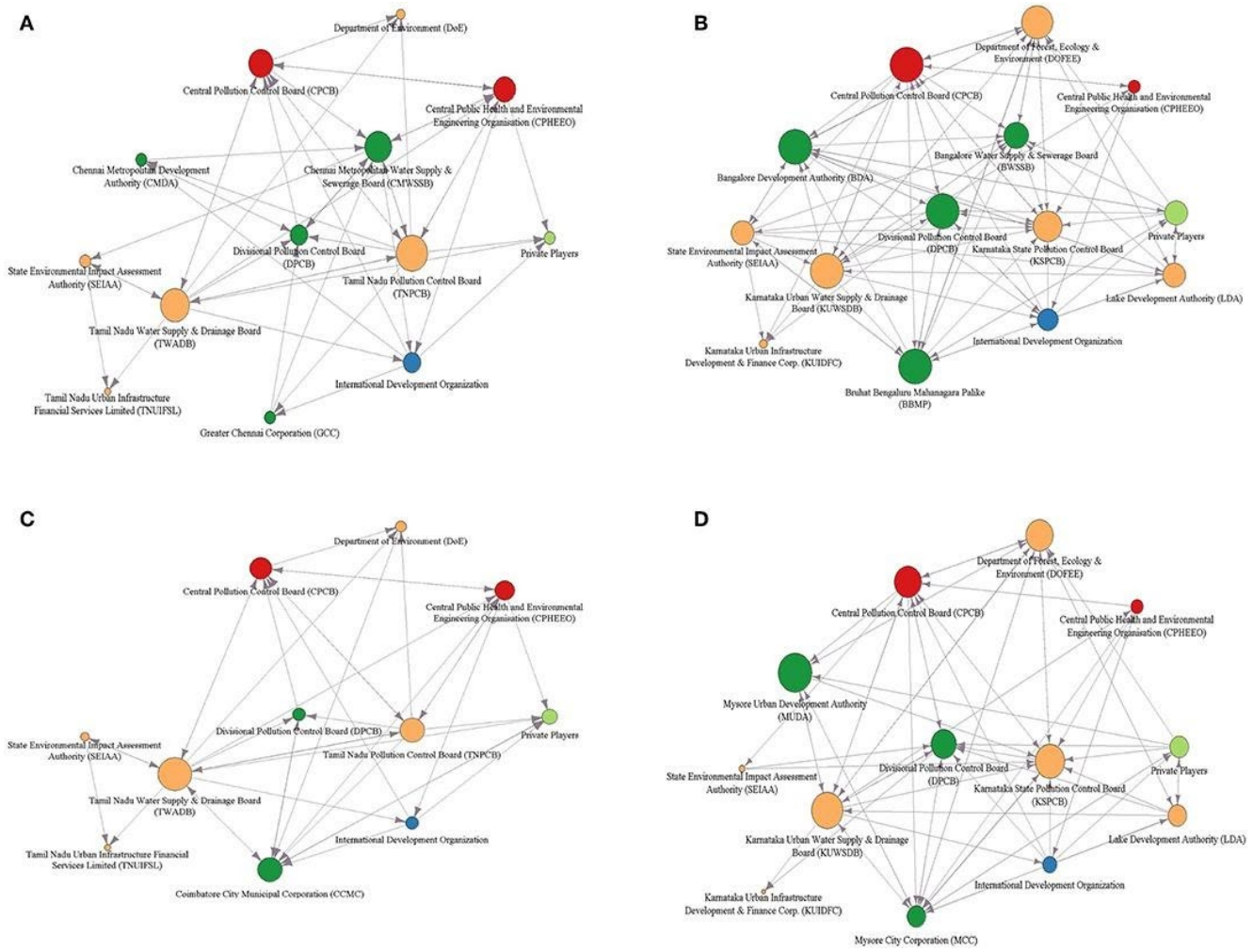


Figure 4.4: Pre-validated network graph of actors present in a) Chennai b) Bangalore c) Coimbatore d) Mysore.

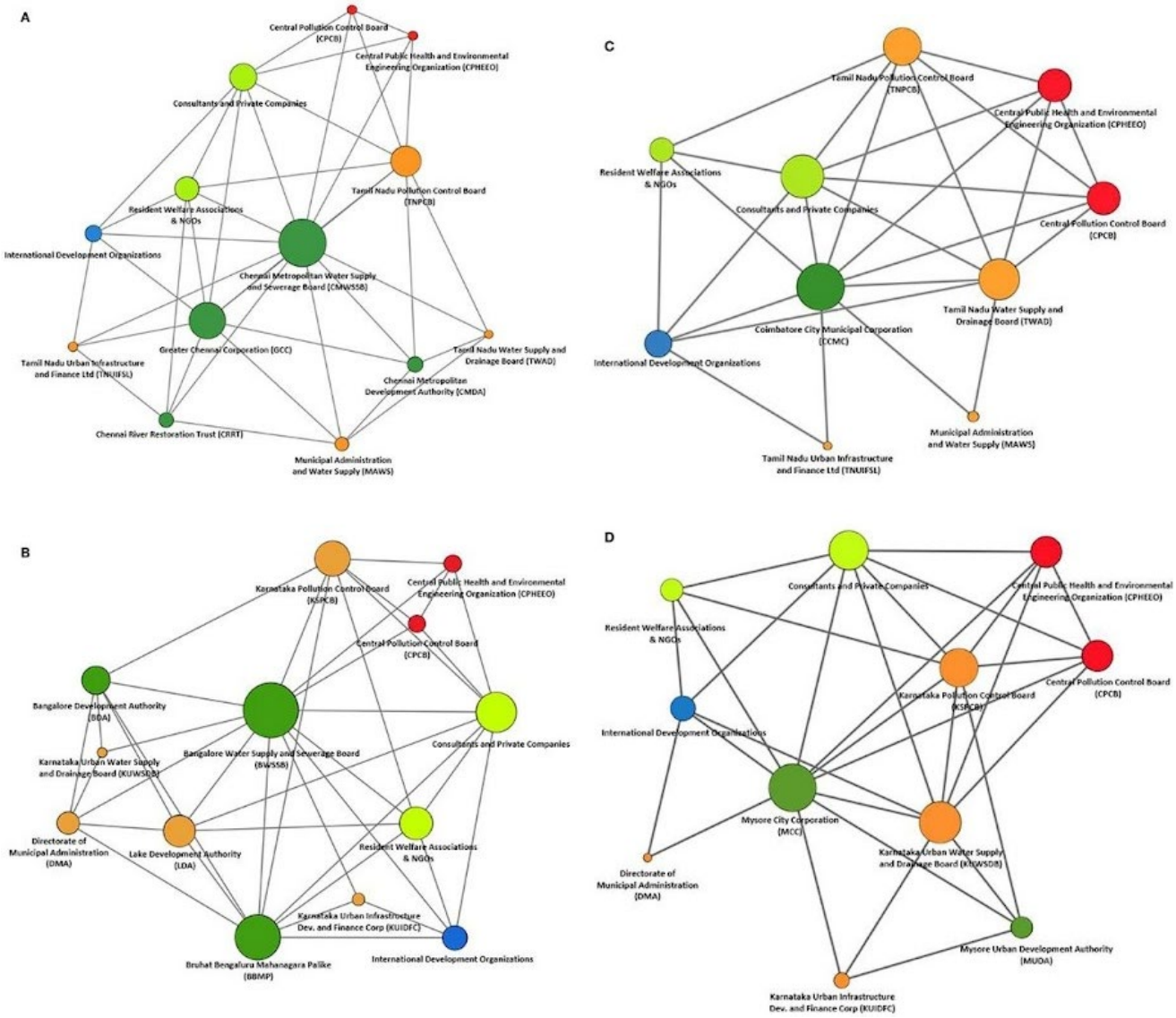


Figure 4.5: Validated network graph of actors present in a) Chennai b) Bangalore c) Coimbatore d) Mysore.

In the interviews, it was unanimously stated that certain actors had a much bigger role in implementation than others who only had soft powers to influence policies. Actors were then broadly classified as implementing actors and influencing actors. For example, comparing Figures 4.4b and 4.5b, the Central Pollution Control Board (CPCB) and the Central Public Health and Environmental Engineering Organisation (CPHEEO) are influencing actors, while Bangalore's Water Utility (BWSSB) and Resident Welfare Associations (RWAs) are implementing actors. It is important to note that the aforementioned influencing actors are at the national level, while implementing actors are at local level. CPCB sets effluent standards while CPHEEO develops engineering manuals, and both are strong influencers in designing SSS for all contexts. Whereas, BWSSB and RWAs are actors that are directly involved in the building, operation and maintenance of SSS. Although these influencing and implementing actors could have been visually marked differently in their node characteristics, the

validated network graph clearly makes the distinction through their position in the core or periphery (Table 4.1), and their node sizes that represent their centrality measures.

Through step 4, the most relevant actors were identified, and unimportant actors were removed. This resulted in changes in the actors present in the network. The main actors removed were the State Environmental Impact Assessment Agency (SEIAA), the Divisional PCB (DPCB), and the Department of Environment (DoE), due to their relative insignificance in the governance of SSS. SEIAA was removed due to the fact that the Impact Assessment Certifications for construction and operation of STPs are within the purview of the respective state pollution control boards (CPCB, 2016). DPCB is a department within the state PCB and, therefore, does not require explicit mention. DoE as a department does not directly play any role apart from being the state level agency that the PCB reports to.

Additions were made to the social network as certain actors were found to play a directly influencing or implementing role in SSS for these cities. In Figure 4.5a, Chennai River Restoration Trust (CRRT), a special purpose vehicle (an independent legal entity with a specific goal, which in this case has the mandate of the rejuvenation of urban water bodies in Chennai) was found to be engaged in the setting up of SSS and also in coordinating with other actors for SSS's wider establishment, and was therefore, added. Similarly, the node Private Players (Figures 4.4a-d), was meant to represent RWAs, NGOs, private STP companies, and consultants. Since the adjacency matrix of their relationship with other actors varied greatly, they were split into two groups (Figures 4.5a-d). Further, the main agency that directed all municipal governance including water and sanitation was the Municipal Administration and Water Supply (MAWS) in the state of Tamil Nadu, and the Directorate of Municipal Administration (DMA) in the state of Karnataka. These agencies were found to play a bigger role in the smaller cities with respect to SSS.

Overall, the centralities of actors changed with modification in the network data. The most central agency is no longer the PCB, but the utility (CMWSSB/BWSSB) in the mega cities of Chennai and Bangalore while the municipal corporation (CMC/MCC) became the most central actor in the secondary cities of Coimbatore and Mysore, with the parastatal water supply and drainage board (TWAD/KUWSDB) playing a bigger role in the latter two.

The densities of the networks of the four cities have also changed to reflect a more uniform network density across the four cases (Table 4.4). This is a result of the changes in the overall number of actors and the changes in the individual relations of each actor. The higher values are due to the elimination of irrelevant actors who earlier had minimum connections, thereby increasing the overall network density.

Table 4.4: Network densities for the respective cities before and after validation

City	Density from initial SNA	Density in validated SNA
Chennai	0.28	0.50
Bangalore	0.36	0.52
Coimbatore	0.30	0.58
Mysore	0.41	0.55

4.4.2 Using SNA to Understand Governance of Decentralised Wastewater Treatment

In order to illustrate the usage of SNA for insights into the governance of decentralised wastewater treatment, the case of Chennai is taken as an example (Figure 4.5a). There are a total of 13 key actors involved in the city's SSS. The network overview characteristics, such as network density and average path length provide basic insight into the network graph. A density of 0.50 indicates quite strong connections, as half of the actors are directly connected with each other. The network diameter of 2 shows that the longest distance between two nodes positioned afar is 2, and for them to have contact there is one actor in between. The average path length of 1.5 corroborates this by suggesting that on an average, any two actors are connected through one and a half other actors. These network characteristics are particularly useful when comparing networks, but are more difficult to interpret by themselves. For example, we can state that a network in one city is denser than in another city, but it is hard to judge whether the network is dense, per se, as this depends very much on the type of network (type of context, types of nodes, types of ties, etc.).

All actors either perform the roles of implementing or influencing agencies and, as mentioned before, this is not explicitly labelled, but the size of the nodes and their positions form a core and periphery structure (Table 4.1) which indicates whether the actors are implementing or influencing. In the case of Chennai, the Utility (CMWSSB), the municipal corporation (GCC), State PCB (TNPCB), Consultants & Private Companies, and RWAs & NGOs are directly involved in the process of commissioning, licensing, building, operating, and maintaining SSS. Therefore, they are clearly seen to be implementing agencies, while all the others remain only as influencing agencies since they only have indirect involvement in the process, such as financing, setting standards for discharge and performance, providing expertise, advocating or simply approving SSS projects.

The centralities of these actors offer more detail in terms of how much power they have within the network. This also translates to how much influence they have in governance within this context. Among the many different centralities (Table 4.1), degree centrality and betweenness centrality are the most relevant in the present case, as they offer simple measures of an actor's influence within the network. Together, they offer a complementary set of perspectives i.e., degree centrality represents the simple number of connections an actor has – and thus the actor's potential to serve as a hub. Whereas, betweenness centrality represents the extent to which an actor is placed on a path between other actors. The latter shows the power an actor has in controlling information exchange between other actors, and how the network will get disrupted if that actor is removed. Table 4.5 provides the values of centralities for all actors involved in SSS governance in Chennai. For example, CMWSSB as the most central actor has connections to all other 12 actors, whereas four actors are connected to only a third of the network (degree centralities of 4). The betweenness centralities are more complicated to interpret directly from the measure, but suggest a clear hierarchy in terms of the actors' abilities to connect with other actors within the network. While both centrality measures offer theoretically informed complementary perspectives, they are also highly correlated, suggesting that actors cumulate different aspects of centralities and related potential for influence, etc.

Based on the centralities, actors and their most suitable functions can be identified. For information diffusion, the actor with the highest centrality measures (both degree and betweenness) is CMWSSB. They are best placed to inform all actors of policy changes, standard settings, and best practices. For, the role of monitoring, a governmental agency requires a high centrality and to be within the core of the network, yet independent enough that it is not easily influenced by virtue of its connections to other actors. In this case, CMWSSB, GCC and TNPCB are relevant agencies for monitoring the performance of SSS in Chennai. TNPCB has already been constitutionally mandated to monitor all sewage treatment discharges, according to the Water Act of 1974. A recent notification from the National Ministry of Forests,Environment and Climate Change (MoEFCC)has delegated the power of ensuring compliance with environmental standards to the urban local bodies such as GCC (Chandragiri et al., 2019). In reality, there is little clarity on these institutional mandates for the long-term

monitoring of SSS and each of these agencies have their own limitations in terms of jurisdictional reach and capacity (Chandragiri et al., 2019). Therefore, purely looking at the SNA, CMWSSB is the most central actor with the highest betweenness centrality by far; it has access to most of the other actors involved in SSS. In addition, CMWSSB is an independent agency and works towards overall sanitation provision for the city; it is best suited to perform the role of monitoring individual SSS. Further, since CMWSSB themselves are required to report to TNPCB about their own treatment performance, TNPCB could be the ultimate custodian of the monitoring database and capable of performing the final verification audits of SSS performances. This function is suitable to their limited organisational capacity.

In the planning process of CWIS projects, it is important to involve all stakeholders present (Narayan and Luthi, 2019). In this particular case of governance of SSS, actors such as CRRT, who advocate for SSS and for the restoration of urban water bodies in the city, are often not included in the planning. Similarly, CMDA who is responsible for zoning and approval of all construction plans including those of SSS, does not even feature in conventional stakeholder analysis for the same reason. This is also evident from the lack of connections between international organisations involved in SSS projects and CRRT/CMDA. Such agencies can be powerful allies when forming coalitions to create policy shifts or simply to help support the planning of SSS in CWIS projects.

SNA can also inform about many other aspects of WASH research and practice, such as the important role of consultants and private companies in setting up SSS as seen by their betweenness centrality, or the limited connections international organisations have with state and national level actors in SSS governance (visible in the network graphs in figures 4.5a-d). These all have a direct effect on the governance of this sector. These are all deeper insights which other methods such as stakeholder analysis, often fall short in bringing to light.

Table 4.5: Centrality measures of different actors in Chennai

Actor	Degree Centrality	Betweenness Centrality
CMWSSB	12	20.25
GCC	9	6.17
TNPCB	8	5.25
CONSULTANTS & PRIVATE COMPANIES	7	2.58
RESIDENT WELFARE ASSOCIATIONS & NGOS	6	1.17
MAWS	5	1.08
CMDA	5	0.5
CRRT	5	0.92
INTERNATIONAL DEVELOPMENT ORGANISATIONS	5	0.58
CPCB	4	0
CPHEEO	4	0
TWADB	4	0.25
TNUIFSL	4	0.25

4.4.3 Comparing Small Scale Sanitation in Mega and Secondary Cities

Although there is no standardised definition for the boundary of a city, the administrative jurisdiction, built up area and degree of economic and social interconnectedness together provide a delineation of what is a city. Mega cities are, however, clearly defined as urban agglomerations with a population more than ten million (UN DESA, 2016). Secondary cities are more complicated to describe, as they are contextually defined in terms of population, functionality, connectivity and hierarchy. However, at large, these are cities with a population that is between 10 and 50% of the largest city in the country, and contribute significantly to the regional and subnational economies (Roberts, 2014).

In India, cities are classified under several systems by the revenue departments, census agencies, central ministry of urban development and individual state governments (Nandi and Gamkhar, 2013). At the national level, the Class system and Tier system are popular and they classify cities by population and economic contribution. They are however, inconsistent with international terminology and vary even between each other. Therefore, in our analysis henceforth, international definitions are followed. Mega cities are ten million above in population and secondary cities are ones with a population of at least one million, and feature among the top five in the economic hierarchy of the state.

Therefore, Chennai and Bangalore with populations of 10-11 million each feature as mega cities, whereas Coimbatore and Mysore with populations of 1-3 million each (UN DESA, 2016) and by virtue of their positions in the respective state hierarchy, feature as secondary cities. The reason for choosing to study these four cities is multi-fold. Among the five mega cities in India, Chennai and Bangalore were most comparable by size and demography. The states of Tamil Nadu and Karnataka to which they belong respectively, have dedicated and progressive sanitation policies. Hence, within the two states, the respective secondary cities of Coimbatore and Mysore were chosen due to high data availability from past projects. Therefore, by reducing inherent variability, the key differences with respect to sanitation could be better focussed.

In the sanitation sector, especially within India, the differences between rural and urban contexts (Chaudhuri and Roy, 2017; O'Reilly and Louiss', 2014) and the characteristics of small towns have been previously explored (Singh et al., 2015; Sundaravadivel and Vigneswaran, 2001). However, there has been no study, to date, on the differences between mega and secondary cities in the WASH context. There are considerable differences in their institutional set up, funding availability, community engagement, urbanisation and presence of SSS (Table 4.6) that are worth exploring. These differences are important in planning for CWIS, which aims to contextually determine sustainable sanitation interventions (Lüthi and Narayan, 2018). Since the governance landscape, business ecosystem, stakeholder involvement and local knowledge vary significantly between these two types of cities, accounting for these differences in the planning and design stage of sanitation systems, especially in SSS, augers well for their success and sustainability.

Table 4.6: Key differences between Mega Cities and Secondary Cities of India in overall sanitation as summarised from qualitative interviews and workshops

Aspect	Mega Cities	Secondary Cities
INSTITUTIONAL SET UP	• Dedicated Utilities for Water and Sanitation. • No role for parastatal Water agency (TWADB/KUWSDB) • Little role for municipal corporation	• No dedicated Utility • Subset of Municipal Corporation • Major role for parastatal agency in planning and designing sanitation systems
FUNDING AVAILABILITY & CYCLES	• High municipal fund generation • Higher state budget allocation • Relatively fast funding cycle due to proximity to decision makers; but slowed down due to interdepartmental coordination requirements	• Low municipal fund generation • Relatively low state budget allocation • Slow funding cycle due to distance from the power centre. But less agencies to coordinate with
COMMUNITY ENGAGEMENT	• High number of RWAs and NGOs • Low direct engagement with citizens • Fact attributed due to higher migrated population	• Lower number of RWAs and NGOs • Better engagement with citizens • Fact attributed due to closer relationship between people and local government
DECENTRALISATION OF STPS	• Higher number of SSS • Stricter city by-laws present • More number of large buildings required to treat sewage in situ • Pockets of unsewered areas needing SSS on site • More SSS private companies present • More water reuse incentive	• Low number of SSS • Fewer large-scale complexes • Sewer aspirational, so SSS not considered a long-term option • Fewer SSS private companies • Lower water reuse incentive
OVERALL SANITATION SITUATION	• Lower overall safe management of faecal waste Based on Shit Flow Diagrams - 50-60% (Eawag 2019b) • Lower national ranking in cleanliness survey: Swachh Survekshan 2019. Chennai -61, Bangalore 194.	• Higher overall safe management of faecal waste Based on Shit Flow Diagrams - 70-80% (Eawag 2019b) • Higher national ranking in cleanliness survey: Swachh Survekshan 2019. Mysore - 3, Coimbatore- 40.

4.4.4 Relating SNA Measures to the Differences Identified

The network graphs (Figure 4.5a-d) and their related measures (Table 4.1) that result from the SNA can be usefully related to some of the differences between mega and secondary cities with respect to sanitation, particularly SSS (Table 4.6). Other differences however, are beyond the scope of SNA. The discussion below focuses on three key differences that relate to SNA.

Firstly, the differences in the institutional set up are visibly seen, as the number of actors involved, and their respective positions in the network graph vary. Sanitation in mega cities is governed by a dedicated utility, while sanitation in secondary cities is often governed within the municipal corporation itself. This is clearly seen through the central actors in the network graphs (Figures 4.5a-d), where the utilities of Chennai and Bangalore (CMWSSB/BWSSB) assume the central positions, whereas in Mysore and Coimbatore, they are replaced by the municipal corporations (MCC/CMC), along with a larger role for the parastatal agencies (TWAD/KUWSDB). Similarly, due to the limited capacity available for SSS planning in secondary cities (Chandragiri et al., 2019), consultants and private companies end up playing a larger role (see Figure 4.8c).

Secondly, community engagement is another key difference between mega and secondary cities. In the former, there are a higher number of non-governmental organisations (NGOs) and resident welfare associations (RWAs) reported; yet, the quality of engagement with the citizens is relatively lower when compared to the secondary cities. One plausible explanation from experts for this is the higher number of migrants venturing into mega cities for job opportunities, who have a significantly lesser connection with the governance of the cities, when compared to the residents who have spent a majority of their lives in secondary cities, and the latter have a greater motivation for better governance and infrastructure. Studies have suggested that the sense of belongingness among migrants towards a new city, their past experiences, and the broader narrative in place, affect their involvement in urban governance (McDuie-Ra, 2012; Scholten et al., 2017; Wessendorf, 2017). This aspect is not clearly deductible from the present network graphs, since the quality of the relations were not accounted for in this analysis. Nevertheless, SNA as a tool has the scope to do such an analysis and can represent the quality of relations though the thickness or shades of colour in the connections.

Thirdly, the overall sanitation situation in the two secondary cities have been found to be considerably better than that of the two mega cities, as seen in the results of the 'Faecal Waste Flow Diagram' (also called 'SFD') assessments (Eawag, 2019). The national level survey on cleanliness, which includes faecal waste and solid waste management, have placed Mysore and Coimbatore in the top 50, whereas, Chennai and Bangalore are 61 and 194 (MoHUA, 2019). However, Chennai, along with Bangalore, consistently ranked above 100 in the past editions. The SNA for these four cities can contribute to the explanation of this diagnostic. Mega cities have issues regarding coordination and overlapping jurisdictions, which the network graphs have visually revealed, with multiple actors (Utility, Municipal Corporation, Pollution Control Board and City Development Authority) involved in SSS governance and implementation, and yet having limited connections between them. This causes issues in sanitation governance and leads to slower funding cycles even though the proximity to power centres is closer in mega cities. The overall graph density further gives an insight into relatively poorly connected actors in mega cites compared to marginally better secondary cites (Table 4.4).

4.5 Discussion

The above results indicate that SNA could bring out useful information and new perspectives for WASH governance that other methods miss out. SNA can also corroborate key qualitative evidence, while allowing for a systematic comparison of the governance networks in different cities.

The validation method itself goes beyond the WASH sector and can be applied in any situation where the reliability of network data is low. The validation methodology proposed in this paper is particularly useful when data reliability is low due to poor response rates; it helps validate incomplete and desk-based SNAs, which was found to be the case in the initial attempt of carrying out a conventional SNA.

The results also reveal that a simple SNA, such as the present case, has limitations in terms of the differentiating factors that could be analysed between mega and secondary cities. However, this limitation can be significantly overcome. There is scope for SNA as a tool to get more complex, and to account for the quality, strength and formality of connections by weighing the relationship and representing them using thickness, patterns and colour shades of edges connecting nodes (e.g., Brandes and Wagner, 2004).

The reconciliation procedure in the validation methodology relies on the researcher having inherent case knowledge and places emphasis on their judgement. Albeit systematic, the replicability of results is uncertain, as in any other qualitative method. Since the reconciled data is a binary matrix of relations, there is high risk of low replicability. This can be mitigated if the reconciliation is based on statistical measures of centrality or simply Bayesian, which then could be represented as weighted edges. The size of nodes, which currently represents centrality, could also be altered to represent other factors, such as perceived importance, size of organisation, power, interest, or any other factors the research would benefit in representing.

It is important to use SNA in tandem with other methods to derive relevant conclusions that are complementary. SNA as a standalone method, risks being simplistic with little context sensitivity. Depending on the research question, SNA in complement with stakeholder analysis, qualitative interviews, focus group discussions, stakeholder workshops, discourse analysis, etc., could deliver deeper insights. This has been shown throughout the results, which uses contextual information from qualitative interviews and document analysis to strengthen various arguments, such as the larger role of the private sector in driving SSS in secondary cities. Furthermore, additional useful questions could be asked based on the network data, and involving more advanced statistical tools. For example, Exponential Random Graph Models (ERGMs) (Cranmer et al., 2016; Fischer and Sciarini, 2016) and similar models allow for inferences on the factors associated with network ties between two actors. Relying on such methods could, for example, reveal whether actors exchange information mainly due to their ideological similarity, or due to being part of the same institutional arena. Based on such results, concrete measure could be taken to strengthen network relations among a given set of actors in the entire network.

Therefore, SNA has the potential to be a powerful tool in the WASH sector, especially when planning for Citywide Inclusive Sanitation (CWIS), which involves participation of all stakeholders, in order to provide equitable and context appropriate solutions. Therefore, the results of an SNA along with a stakeholder analysis adds value to the initial step of planning - a diagnostic study of sanitation governance in the select city. SNA as a process is just as valuable as the results, since it allows for the identification of marginalised stakeholders who are part of the sanitation governance, by not just the researcher, but also the survey participants themselves (Hauck et al., 2016; Valente et al., 2015). SNA as a process, proposed in this paper, is enriching for the participants as well since it uses techniques of knowledge co-production which engages the local actors in social learning (see Schröter et al., 2018). Such a tool is important in the urban WASH sector, especially in low and middle-income countries, such as India, where the complexity of stakeholders involved is immense. This could help the planning for CWIS become inclusive even at the local level closest to implementation. It could identify actors who

could potentially act as policy entrepreneurs or form advocacy coalitions to bring about policy shifts (Ingold, 2011).

The differences in mega and secondary cities that are presented also significantly help in planning for SSS in particular. Lack of monitoring leads to poor operation and maintenance, which then leads to poor performance of systems, and ultimately results in failure of SSS, as proved in India (Davis et al., 2019; Ulrich et al., 2019). The present SNA has been shown to identify the actors who are best suited to carry out the long-term monitoring of SSS. Although WASH governance is not rigid and can be adaptable (Chandragiri et al., 2019; Rosenqvist, 2018), based on an actor's position and connections, their functional potential could be explored to identify which actors are best placed to perform certain functions – central actors for information diffusion and overall influence, and peripheral actors for support functions, presence of cliques for collaboration etc. Such nuanced and visual information will be a useful addition, when seeking to strengthen governance, by using stakeholder participation tools in local scale systems such as *The Governance Spectrum* and *Role play Scenarios* (Mitchell and Ross, 2016) or form the basis for action research using participatory design games as used in the study of governance of community-managed sanitation services in Indonesia (Rosenqvist, 2018).

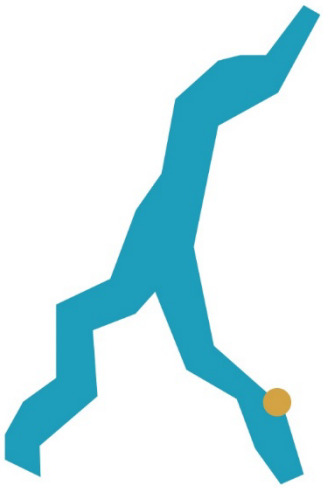
Further research is necessary to understand the limits of using SNA for the WASH sector, and of the validation methodology presented. The proof of concept tested in this article has less than 15 actors in each of the four cities. The feasibility of the usage and validation could be tested for larger networks, where the nodes are not institutional actors but individual actors, in cases directly involving implementation of CWIS interventions.

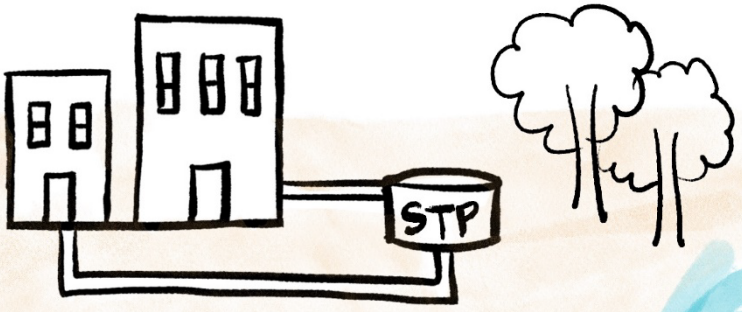
4.6 Conclusion

The paper proposes SNA as a useful tool for the WASH sector, especially in planning for CWIS. It provides deeper insight into the stakeholders involved in governance situations, such as decentralised wastewater treatment. Apart from visually representing the actors and the exchange of information between the connections, SNA has been shown to be used for comparing contextual differences between different cases, such as SSS governance in mega and secondary cities.

The validation procedure helps to overcome the problem of low response rates in the gathering of network data, which results in incomplete SNA and leads to unreliable network graphs and centralities. The problem of incomplete or desk-based SNA, which is frequently present in research in the WASH sector of low- and middle-income countries can be overcome through the use of the proposed validation methodology. The novel use of the combination of insiders and outsiders with expert knowledge, balances the biases and widens the perspective of the SNA.

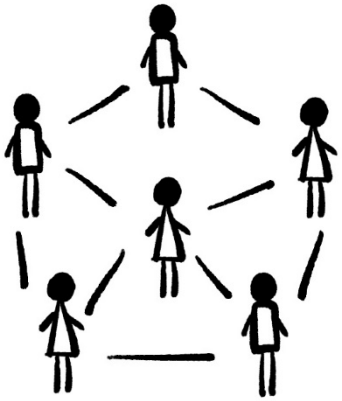
The proof of this concept is tested in four mega and secondary cities in India – Chennai, Bangalore, Coimbatore and Mysore, for the context of the governance of decentralised wastewater treatment. Using Chennai as an example, the use of SNA to show fine grained insights, such as overall network densities, actor centralities, and functional suitability of actors to perform monitoring has been illustrated. This, combined with the inferences from qualitative analyses, shows that the SNA can corroborate few key differences between mega and secondary cities with respect to sanitation governance, their institutions, community engagement, funding availability and the overall sanitation situation. These differences are important considerations to be discussed when planning and designing CWIS projects for such cities.

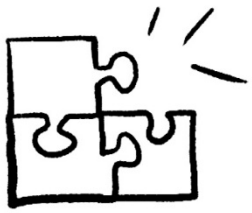




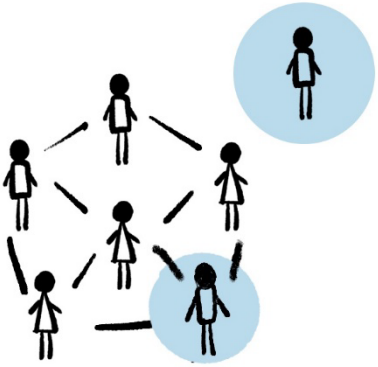
Small Scale Sanitation or SSS has had a rapid rise in India. But its governance has been poorly studied.

Social Network Analysis or SNA is a method to see how different actiors interact in a governance situation.



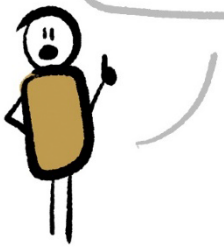


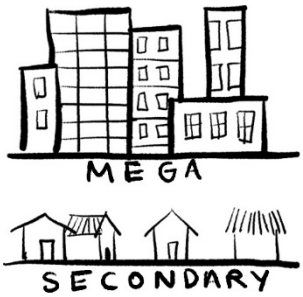
But often such SNA data is incomplete or unreliable.



So a new validation process uses insiders and outsiders to fill in the data gaps.

This was tested and we saw how certain actors are better to play certain roles based on their position in the social network.





Using this we also saw the difference in sanitation governance between Mega and Secondary cities in India.

05

Sanitation Planning in India

> **Sanitation Planning in India is an enigma. No one can fully understand it.**
>
> ***– Deepa Karthykeyan***

This Chapter has been previously in part in: Narayan, A. S., Maurer, M., and Luthi, C. (2021b). The Clean Plan - Analysing sanitation planning in India using the CWIS Planning Framework. J. Water Sanit. Hyg. Dev. doi.org/10.2166/washdev.2021.130. The sections specific to sanitation planning practice in India have been presented here.

A.S.N., M.M. and C.L., jointly conceptualised this publication. A.S.N. wrote the original draft, managed formal analysis, reviews and editing, software programming and created the visualisations. M.M. and C.L. supervised the research. Neha Gupta, Nirdesh Joshi, Kripa Ramachandran (Eawag interns), Rohini Pradeep (CDD), Rahul Sharma, Harsh Yadava, Ravi Kumar, Venugopal (GIZ) provided assistance in data curation, analysis and visualization for the SFDs of four cities. A.S.N. handled the project administration and fieldwork for this research.

5.1 Abstract

Sanitation in India has received national attention for over a decade, especially with the Swachh Bharat Mission (SBM) making it a political priority. However, due to the lack of appropriate sanitation planning practices, little long-term gains have been made in urban sanitation beyond the ending of open defaecation. In this chapter, we analyse the key barriers to sanitation planning in India, in the context of the emerging paradigm of Citywide Inclusive Sanitation (CWIS). A mixed method approach of shit flow diagrams, social network analysis, policy analysis, interviews and workshops at the national, state (2) and city (4) levels were conducted. Eight factors were identified as important barriers for planning including inadequate planning capacities, lack of ownership of city sanitation plans among city governments, poor community involvement, absence of a uniform planning framework, unreliable political and financial support, overlapping jurisdictions, and scheme-based funding.

5.2 Introduction

Over the last decade, the sanitation landscape of India has been rapidly changing, with progressive laws, programmes and policies (TERI University, 2017; Wankhade, 2015). The most notable among them is the Swachh Bharat Abhiyan (SBM) or Clean India Mission, which helped the country declare itself open defaecation free in 2019. The success of this mission, as the world's largest sanitation campaign has prompted it to be replicated in other countries, for example the Clean Nigeria Campaign (GoN, 2019). However, the plans of SBM did not go beyond the latrine, leaving the rest of sanitation service chain unattended and the sustainability of the outcomes in significant uncertainty (Gupta et al., 2019; Kumar, 2017).

In India, 32% of the urban households are connected to sewers, of which only 30% of the sewage generated is treated, leaving over 43,000 million litres of untreated sewage into the environment every day and 30 million households (not including the newly added latrines of the SBM) relying on septic tanks with no proper disposal strategy (WaterAid, 2016). The aspirational centralised sewer based sanitation systems are resource and time intensive (Gambrill et al., 2020; GoI, 2008). This prompted the National Government to embrace non-conventional solutions such as Faecal Sludge Management (FSM) by introducing specific funding schemes and polices to meet the rising sustainable sanitation demands (GoI, 2017). Similarly, small-scale sanitation (SSS) systems are steadily gaining prominence in complementing centralised treatment plants in large Indian cities (Klinger et al., 2020; Narayan et al., 2020). However, the systematic uptake of both these alternative non-sewered sanitation systems (FSM and SSS) in India has been challenging and their implementation, an operational and governance struggle (Devaraj et al., 2021; Reymond et al., 2020).

This struggle to provide safe sanitation can also be observed in other cities globally due to the complexity of population density, migration, urbanisation, slum expansion, settlement heterogeneity, tenure security and sheer urban poverty (Chaplin, 1999; Scott et al., 2015). Despite the overall sanitation service levels being higher in cities than in rural areas, its implementation progress has been slower; between 2000 and 2017, the access to improved sanitation in rural areas has increased by 23%, while in urban contexts the increase has been a meagre 6% (UNICEF and WHO, 2019).

One of the key reasons for failure in provision of sustainable sanitation, especially in complex settings such as cities in low- and middle-income countries (LMICs), is the lack of adequate sanitation planning (Kennedy-Walker et al., 2015). While the technologies and policies for sanitation, especially in India,

have advanced to accommodate contextual needs, planning practices have largely remained conventional and dominated by expert driven rational-comprehensive approaches, in places where they are not most appropriate (McConville et al., 2011). Although top-down technocratic planning has been successful in the Global North, these planning approaches struggle to handle the complexity of sanitation provision in the Global South where the urban demographics, socio-cultural factors and equity criteria vary significantly (Hawkins et al., 2013b). This complexity of urban sanitation in LMICs demands borrowing solutions from all different technical and non-technical sources (Schertenleib et al., 2021).

Good sanitation planning practices allow for a systematic evaluation of solutions based on a holistic understanding of contextual demands that lead to community acceptance, long-term sustenance and leveraging synergies with other urban development goals (McGranahan and Mitlin, 2016; Narayan et al., 2021a). Benjamin Franklin's words "failing to plan is planning to fail" are relevant in the case of India, where sanitation is often an ad-hoc activity and city governments do not adequately spend time and effort in planning sanitation. This results in poorly managed urban sanitation and even visible pollution of urban water bodies (Sharada Prasad and Ray, 2019; TERI University, 2017). The existing capacities and attitudes of local planners, consultants and decision makers in most city governments across LMICs including India, still follow a one-size-fits-all top-down approach and are therefore yet to meet the standards of the emerging concept of Citywide Inclusive Sanitation (CWIS).

CWIS is a paradigm shift from the conventional approach to urban sanitation that can be characterised as technocratic, infrastructure focused, sewer aspirational and context insensitive (Schrecongost et al., 2020). Instead, CWIS places equity and service-based safe management of entire sanitation value chain at the forefront, while encouraging a mix of technological solutions and business models (Narayan and Luthi, 2020). It brings multi-sectoral and multi-level stakeholders involved in sanitation provision together, an action often neglected in past planning practices. CWIS is gaining traction across international development agencies, governments, academia and NGOs (Gambrill et al., 2020), and even in India, it is being piloted across eight cities.

5.3 Research Design and Methods

This research followed a case study approach and used a mix of qualitative and quantitative research methods. The fieldwork and data collection spanned a total of six months between 2018 and 2020. The methods used include key informant interviews, participant observations, expert workshops, social network analysis, shit flow diagrams (SFDs), policy and document analyses (Bryman, 2012).

The initial sampling for experts was purposeful through stakeholder mapping and was then complemented with snowball sampling and networking at major sector conferences. The use of the innovative social network analysis (Narayan et al., 2020) allowed for the identification of key actors within the sanitation landscape[11]. Eighty-four repeated in-depth interviews were conducted with sixty experts for an average of forty-five minutes, while some extended up to three hours. The interviews were mostly in English, however, around twenty percent of the interviews were in the local languages of Tamil and Hindi.

[11] See Chapter 4 for the Social Network Analysis components. This chapterbuilds on the previously published work exploring aspects of sanitation governance in the same case studies.

Furthermore, four workshops were organised with national and international sanitation experts from international development agencies, NGOs, academia, and public sector to analyse sanitation planning practices and past implementation experiences in India (Table 5.1). These workshops often happened in conference and training settings, such as the World Toilet Summit, Mumbai in 2018 and Eawag-ConCaD Training Bangalore in 2019, which provided easy access to expert participants.

Participant observations of sanitation service provision, policy interpretation, infrastructure decision-making, and stakeholder engagement, was carried out wherever possible at the national and city levels. Document analysis through procurement of publicly listed and unlisted or undisclosed documents helped triangulate data through additional independent sources.

Qualitative data was mostly analysed through thematic content analysis coded in nVivo software following standard case study research protocols (Bryman, 2012). Further in-depth information including interview and workshop guides, anonymised interviewee list and thematic analyses codes are provided in the supplementary material (provided in Appendix II) to make this research as reproducible as possible. There may be inherent research biases in data interpretation during the analysis, but preventive steps were undertaken such as, a multi-perspective approach, corroboration and triangulation. According to Eawag Ethical Review of Projects involving human subjects (PD-16-09), this was deemed minimal risk. All participatory data was obtained after verbal consent and fully anonymised[12].

Table 5.1: Type of key informants participated in interviews and workshops. (There is a 50% overlap between the experts interviewed and experts who participated in the workshops. Disaggregated information on this provided in supplementary material.)

Type of stakeholder	Number of stakeholders interviewed	Total number of workshop participants in 4 workshops
National Government (NGV)	5	3
State / City Government (SGV)	13	7
Academia (ACD)	15	9
Private Sector (PVT)	8	4
NGOs and Resident Welfare Organisations (NRW)	11	10
International Development Agencies (IDA)	8	9
Total	**60**	**42**

[12] The stakeholders are referred using codes given in Table 5.1 and the anonymised interview list in the supplementary material.

5.4 Study Location

The spotlight on India's sanitation sector in the last decade, right from adopting one of the most comprehensive sanitation planning policies (GoI, 2008) to solving the world's largest open defaecation challenge (even having dedicated Bollywood movies on it), makes it a worthwhile case to explore how urban sanitation is being planned. This has to be done at the national, state and city levels, to unpack the intricacies of policies, mandates, planning and implementation.

The primary study sites for the study were located in two comparable Southern states of Tamil Nadu and Karnataka, which have two of the most progressive sanitation policies. The four cities within these states were Chennai, Coimbatore, Bangalore and Mysore. While the site selection was partly based on purposive sampling technique due to availability and accessibility of data, it was also due to their comparable size, demography and sanitation statuses. Chennai and Bangalore are capital and mega cities in the respective states, while Coimbatore and Mysore are secondary cities with populations of approximately 1.5 million. They are also the cleanest cities in their respective states according to the Swachh Survekshan national sanitation survey (MoHUA, 2019). Table 2 summarises key information about the cities based on the individual SFDs and their accompanying reports prepared as part of this research (See supplementary material for SFD graphics)[13].

It is useful to note that these cities are representative of 'Class IA with population over one million', which account for a third of the urban population in India. However, there are several cities and small towns in India that are smaller than these four cities, in terms of area and population, where certain aspects of the CWIS approach would still be applicable depending on their specific contexts. The four cities chosen here, provide a wider scope to explore various aspects of CWIS, such as the co-existence of a mix of technologies and service models, due to their size and history.

Table 5.1: Key facts regarding the case study locations and their sanitation status.

City	State	Population (in millions)	Swachh survekshan rank 2019	% of population using safely managed sanitation	% of population using sewered sanitation	No. Of interviewees
Chennai	Tamil Nadu	10.5	61	62	42	14
Coimbatore	Tamil Nadu	1.6	40	76	34	12
Bangalore	Karnataka	12	194	52	84	10
Mysore	Karnataka	1.5	3	72	82	8

[13] The expert reviewed SFD reports for the cities are available for free in the SFD portal at www.sfd.susana.org

Historically, the four cities had their sanitation planning needs covered by their utilities, in case of the mega cities and the corresponding parastatal agencies in case of the secondary cities (See Chapter 4 for the SNA showing the differences in the institutions involved in the mega and secondary cities). The utilities of Chennai and Bangalore have dedicated planning and design wings that prepare detailed project reports (DPRs) for sanitation which are often sewer master plans. On the other hand, the more recent city sanitation plans that are tied to national schemes are developed by the municipal corporations of these mega cities (GIZ, 2016). Bangalore's utility (BWSSB) has created a strategic vision document for 2050 that includes detailed plans for water supply, sewerage and designs of centralised treatment and reuse opportunities[14].

In Chennai and Bangalore, apart from their utilities and municipal corporations, the respective urban development authorities create city master plans once every two to three decades, which features the overview of water supply and sanitation under the social infrastructure section (for example see CMDA, 2008). Furthermore, in cases of major development projects led by the state housing boards or the slum clearance boards, the utilities provide bilateral sanitation planning services.

The secondary cities have historically depended on the parastatal agencies for major infrastructural planning and designing, due to the limited capacities available at the local municipal corporations. In the case of Tamil Nadu, Chennai's utility is providing additional support to development of sewerage plans for Coimbatore. Similar to the mega cities, their city sanitation plans required for national funding schemes are made by the municipal corporations themselves or through external consultancies (Eawag, 2019).

5.5 Results and Discussion

5.5.1 Analysis of current sanitation planning practices[15]

Urban sanitation planning in India has largely gained prominence only since the introduction of the National Urban Sanitation Policy (NUSP) in 2008, which specifically highlighted the use of the City Sanitation Plan (CSP) process (GoI, 2008). This CSP process is a comprehensive planning approach that is cross-sectoral and aims to be a key document for city managers in all aspects covering environmental sanitation (including water supply, solid waste and storm water drainage) (GIZ, 2016). In many ways, the NUSP and the CSP have been forward-looking and are well aligned with most of the CWIS principles (Workshop 4). Despite this, over 80% of the interviewees agree that the policy has fallen short in delivering the impact it promised.

Based on the responses mentioned by the interviewees and workshop participants, the major themes were grouped, and the top eight are highlighted in Figure 5.1 and described below. See supplementary material for all the 27 identified themes with their detailed meaning. These themes are highly interrelated and have direct influences on each other. For example, lack of political and financial support are critical reasons for poor planning capacity and dependency on sanitation related schemes. Similarly, the lack of coordination and community involvement could have a significant effect on ownership.

[14] This strategic document was prepared by BWSSB and Jacobs Engineering Group in 2019. It is not publicly available yet. See bwssb.karnataka.gov.in for the press release and summary document.

[15] All results obtained from interviews, workshops, document analysis and scholarly literature are clearly cited as such. The results from interviews are corroborated in at least three instances before being picked or come from highly reliable sources. Those results that are not cited, are to be seen as inferences from the aforementioned sources.

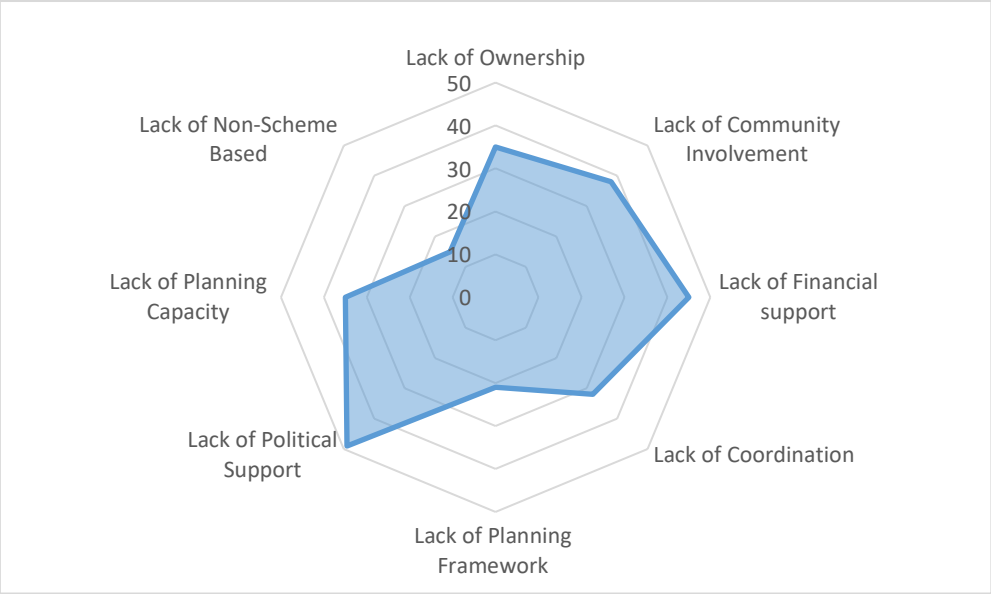


Figure 5.1: Key barriers to sanitation planning in India as stated in interviews are depicted in no particular order. The radial axis indicates the number of experts who mentioned the respective factors in the interviews.

Lack of Planning Capacity (35 respondents)

"Most cities in India have limited capacities to plan for safe sanitation" is a statement that was often heard throughout most interviews (ACD14, NGV06, SGV17, NRW05, IDA05). Since city governments do not have the adequate human capacity themselves to systematically plan sanitation, this work is outsourced to external consultants. Often, these consultants themselves lack technical capacities for comprehensive CWIS planning, which not only includes engineering skills including estimating quantities and qualities of faecal sludge to design collection systems and treatment plants, but also social science skills such as community engagement and gender sensitive planning (NRW11, PVT04). The consultants to whom the entire mandate is shifted onto, are given little time and resources to understand the context, which leads them reproduce 'template solutions' from other cities (IDA05, Workshop 4). New capacity building initiatives geared towards CWIS have started with national and international support (Dash and Kapur, 2021).

Lack of Non-Scheme Based Approach (15 respondents)

"CSPs were scheme based; with the introduction of new national urban schemes (called 'AMRUT' and 'Smart Cities Mission'), we moved to a different template" (SGV13). Sanitation is tied closely to the interests of the national schemes which are pegged onto changing political priorities, rather than the actual needs of the cities (ACD12, Chaplin, 1999; Jain et al., 2020). With the advent of the SBM and AMRUT schemes, the planning format was changed from CSPs to detailed project reports of sanitation infrastructure (GoTN, 2017). This meant that key aspects of CWIS and the NUSP were diluted with the omission of equity, sustainability and accountability factors. The funding tied to other urban development schemes including the Smart Cities Mission, did not request submission of the old format CSPs (Workshop 4).

Lack of Planning Framework (21 respondents)

"There is no uniform framework to plan sanitation in India" (NGV02). Although there was international support for the creation of the CSP process which led to the development of toolkits and guidance material (GIZ, 2016), its uptake at the local level has been poor (Workshop 4). Different cities follow

different sanitation planning methodologies or the lack thereof, which results in ineffective implementation and misinterpretation of sanitation targets set by the NUSP (ACD13, PVT06). Two-thirds of all national level interviewees and eighty percent of all international development representatives agreed that this was of high importance. The lack of a targeted planning framework potentially has spill over effects on other aspects such as ownership, coordination, and community involvement (Workshop 4).

Lack of Ownership (35 respondents)

"How do you expect municipalities to have ownership of a checklist document that they did not prepare by themselves?" (NRW05). Respondents mentioned that CSPs were widely regarded merely as checklist document, that city governments are required to submit in order to apply for national funding schemes. Furthermore, CSPs were mandated as part of the NUSP by the national government, and did not have the complete buy-in from cities and states (ACD13, IDA02). Constitutionally sanitation is a state subject (Cullet and Bhullar, 2015), but the national government provides the majority of funding, announces sanitation schemes, drafts policies, sets standards and regulations, and controls the narrative, thereby preventing states to freely execute their own governance mechanisms (Workshop 1)[16]. This disconnect between national agenda, state's mandate and the implementation at the city level, in addition to planning carried out by external consultants instead of local authorities, causes a lack of ownership at the local level.

Lack of Coordination (32 respondents)

"To build a sewer, we need to coordinate between 11 different governmental departments" (SGV11). Apart from the aforementioned disconnect in levels of the government, there is also the challenge of institutional coordination to plan and implement sanitation solutions. Previous research shows that there is inadequate flow of information between 10 relevant agencies for the governance of small scale sanitation in the four selected Indian cities (Narayan et al., 2020). The overlapping jurisdictions of multiple agencies that are responsible for different aspects of the sanitation service chain, create bureaucratic silos that present a barrier to implement solutions quickly and easily (Workshop 3). The regular transferring of bureaucrats between various governmental departments (outside of the water sector) leads to a lack of continuity and poor institutional memory (Raman, 2020).

Lack of Financial Support (45 respondents)

"NUSP was not directly tied to any financial schemes" (PVT06). Although CSPs were required for the application of funding from national schemes, there were no exclusive financial resources for the sanitation planning process itself, leaving the cash-tight city governments to solely invest in the planning process (SGV15). Given that little time and money is available for the planning process even in mega cities, sanitation often fares low among competing urban priorities (Workshop 2). Adequate ring-fenced financial and human resources must be budgeted for the planning process, and this must be provided regardless of the schemes, in order for it to be comprehensive.

Lack of Political Support (49 respondents)

"Sanitation planning requires political support" (NRW01). Political will at all levels is required for effective sanitation planning since the process is costly, time consuming and is asynchronous with the election cycles (Chaplin, 1999; Hueso and Bell, 2013). Competing priorities include solid waste

[16] The national benchmarking schemes and the Swachh Survekshan ranking systems are however reported to boost healthy competition thereby creating a positive effect on the annual performance of cities in terms of provision of safely managed sanitation.

management and water supply (SGV11). Even at the local level, the ward councillors rely on these competing priorities to sway the vote bank (NRW05).

Lack of Community Involvement (38 respondents)

"Swachh Bharat Mission is a jan andolan (people's movement)" (NGV06). Community involvement allows for incorporation of local knowledge and increases acceptance of the solutions from the beneficiaries which is critical for long-term success, especially in low-income communities (McGranahan and Mitlin, 2016). However, community consultation at the ward level is given little importance and often follows technocratic decisions which are based on limited criteria that are not validated by the local residents (ACD01, PVT06).

5.5.2 Analysing differences in responses

While there was large agreement in the results, a number of differences in the elicited response was identified between the key informants grouped by the type of stakeholder, where they were from and their affiliation level (national, state, city) (See supplementary material for details).

The mega cities - Chennai and Bangalore have separate utilities that are mandated with sanitation provision and have at least 10 times more skilled labour in their force than their secondary city counterparts. They also follow a much more top-down approach with little community involvement (Workshop 2); this leads to increased reported ownership from the utility managers (SGV01, SGV02, SGV06, SGV10). Furthermore, non-sewered solutions are seen as interim and all state and city governmental stakeholders clearly indicated sewer-aspirations. *"Chennai will have 100% sewerage. FSM is only a stopgap measure for us"* (SGV06). The state government's vision document and action plan for central funding corroborates this (GoTN, 2017). In the case of the secondary cities – Coimbatore and Mysore, there is a more long-term vision of multiple solutions co-existing in these urbanising cities. The governmental stakeholders in these cities are cognizant of their limited planning capacities and rely on parastatal organisations for this purpose. Interestingly community participation through direct consultations and the involvement of NGOs are reported to be better in these smaller cities (Narayan et al., 2020).

There is a clear difference in perception and vision for urban sanitation between the national, state and city level stakeholders. National stakeholders strongly emphasise the importance of community participation and underscore the state's own financial contribution to the success of sanitation interventions (NGV05, NGV04). The state level stakeholders on the other hand make little reference to community involvement and refer to national schemes as the main source of urban infrastructure funding (SGV17, NRW05). The city-level stakeholders report that community involvement is a tedious process for which they have little time, and most of their capacities are utilised in urgently fixing the broken pipes (SGV10, SGV14, ACD05).

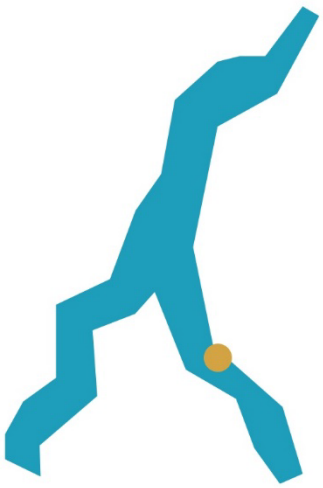
The stakeholder types also reflect in the priority reasons highlighted for causing failure in sanitation planning. Academic stakeholders predominantly stated the lack of a uniform planning framework and community participation. NGOs and resident associations also agreed on the latter and added the need for financial support for sanitation planning. Stakeholders from private companies reported a lack of inter-agency coordination and scheme-based approach as the main barriers. Inadequate community participation and a lack of planning frameworks were the main issues highlighted by international development agencies. Finally, all levels of government interviewees concurred that poor capacities and complexity in coordination within the governmental departments were their main hurdles for

effective sanitation planning. Almost all interviews and workshops without prompting arrived at the conclusion that political and financial support is essential for comprehensive planning for CWIS.

5.6 Conclusion

In the last decade, the Indian sanitation sector has witnessed an evolution with progressive policies, national level funding, political support and the world's largest sanitation campaign. In spite of these and a national urban sanitation policy mandating local authorities to prepare city sanitation plan, urban sanitation systems are generally poorly planned. With the advent of CWIS, multiple targets are explicitly placed for operational outcomes and functional linkages, which requires comprehensive planning that bridges top-down and bottom-up approaches. Although CWIS is widely accepted as the way forward towards achieving the urban sanitation SDGs, the complexity of planning CWIS in India remains to be a challenge.

This chapter has identified several key barriers to sanitation planning in India that stem from a fundamental lack of priority given to it at the national, state and city levels. Through the case study approach, it was found that the lack of a framework among others, impedes sanitation planning. Furthermore, the secondary cities, where community involvement is higher, have better sanitation outcomes than mega cities where this is absent. Political support for comprehensive planning and adequate ring-fenced financial and human resources for the planning process are major recommendations. Other reforms are development of planning capacities in local governments through large-scale training programmes, and improving inter-agency coordination through stronger institutional mechanisms.



SBM

NUSP

Despite a strong political will and progressive policies, urban sanitation in India remains inadequate.

UNEQUAL CITY

One reason for this is poor planning.

There are many barriers to sanitation planning in India.

such as lack of....

$ ₹

Financial Support

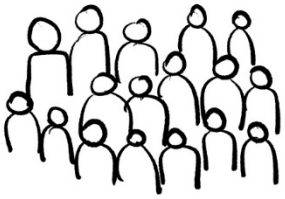
Political Support

Ownership Capacites

Coordination

Framework

and



Lack of community involvement in the planning process.

06

The Bridged Approach and the CWIS Planning Framework

> **Moving beyond conventional approaches towards sustainable urbanisation needs to follow both a top-down and a bottom-up approach**
>
> ***– Philippe Reymond***

This chapter at large has not been previously published anywhere. Two specific sections however have been published.

Section 6.5 on the CWIS Planning Framework has been published in part in: Narayan, A. S., Maurer, M., and Luthi, C. (2021b). The Clean Plan - Analysing sanitation planning in India using the CWIS Planning Framework. J. Water Sanit. Hyg. Dev. doi.org/10.2166/washdev.2021.130.

Box 6.1 on Tools and Capacity Development for CWIS has been previously published as: Narayan, A. S. and Spuhler, D. (2021): Tools and capacity development for scaling citywide inclusive sanitation. In: Equitable and Sustainable WASH Services: Future Challenges in a rapidly changing world. Proceedings of the 42nd WEDC International Conference. Loughborough University. Conference contribution.

https://hdl.handle.net/2134/16918504.v1.

C.L. and M.M. provided supervision and resources for this research.

6.1 Background to Bridging

6.1.1 Unconventional Planning

Planning for Citywide Inclusive Sanitation is a more complex mandate compared to conventional sanitation planning. This is because, in conventional sanitation planning, targets are often only two fold (i) number of people with access to improved toilets and (ii) percentage of wastewater safely treated (e.g., CPHEEO, 2013). This approach, similar to the Millennium Development Goals (MDG) targets on sanitation, has been criticised as being unable to deal with issues such as quality, reliability and sustainability and a need for comprehensive targets and indicators has been previously documented (Kvarnström et al., 2011; Satterthwaite, 2016). While these two targets are fundamentally important since they ensure safety and dignity, in light of the CWIS approach (as seen Chapter 2), other aspects such as equity, sustainability, and accountability are missing.

While the Global North has benefitted from conventional infrastructure focused planning processes for sanitation and wastewater management, (for example, ISO 55000 Asset Management Standards and the corresponding International Infrastructure Management Manual), there is ample evidence that the same approach is not appropriate in the Global South. This is because the contexts between the two are significantly different in terms of population density, capital availability, technical capacity, corruption, tenure issues, heterogeneity within cities, willingness to pay, housing and tenure, inequality, pollution standards, social cohesion, urbanisation rates, urban planning norms and practice, and quality of governance (Cohen, 2006; McGranahan and Satterthwaite, 2002).

Learnings from 26 WASH projects in the Asia-Pacific region shows that an infrastructure focused approach falls short since (i) they do not consider all sanitation options and are often only sewer aspirational, (ii) do not adequately benefit the poor, (iii) damages the environment when poorly planned and executed, (iv) do not account for stakeholder preferences, (v) do not properly judge demand, and (vi) do not focus on the institutional management and long term financial sustainability (ADB, 2006).

Previous scholarly work in the field of sanitation planning has also described the failure of conventional planning in cities of LMICs due to inappropriate technology choice (Spuhler et al., 2020), lack of consideration of behaviors, capacities and institutional support (Tilley et al., 2014), poor monitoring and accountability (Starkl et al., 2013), lack of contextual consideration (McConville, 2010) and inadequate user acceptance (Lüthi et al., 2010). In Chapter 1 (section 1.2), in the context of sanitation planning in LMICs, the desirable characteristics were listed as being multi-disciplinary, participatory, systematic, contextualised, and synergistic. This requires an unconventional planning approach.

The above arguments justify why conventional planning falls short in providing urban sanitation in LMICs. However, the question of why other existing sanitation planning approaches are not suitable for CWIS, remains open. Prominent sanitation planning methodologies such as SSA, CLUES, U-CLTS, CSP, San21, OPSS etc., (Schertenleib et al., 2021), take into consideration many of the aforementioned factors and are indeed multi-disciplinary, participatory, and contextualised, and some also systematic and synergistic. However, none of these approaches meet the multi-dimensional demands of planning CWIS, since they were not fundamentally designed considering these dimensions of CWIS. Similar to the Manila Principles, the CWIS Service Framework proposed by Schrecongost et al., (2020) includes the dimensions of equity, safety, sustainability, responsibility, accountability and resource planning and management. For example, CSP as a planning approach (see Box 7.1), does not explicitly have any steps covering the aspects of equity, accountability, and resource management. Similarly, Sanitation

21 does not have steps focusing on the aspects of equity and accountability, but has strong suits on responsibility and resource planning and management.

Therefore, while there is scope for modifying each of the aforementioned approaches to meet certain criteria of CWIS that it falls short on, developing a more targeted planning framework and approach for CWIS would be beneficial since the targets of the CWIS principles are more extensive than the earlier targets of sustainable sanitation. The latest examples of CWIS targets now include quantitative and qualitative factors such as (i) percentage of low-income population with access to improved sanitation, (ii) if there are unambiguous legal mandates for service delivery, and (iii) if there is a publicly accessible sanitation database (Athena Infonomics and BMGF, 2021). Therefore, we require a novel planning approach to meet the detailed targets and ambitious vision of CWIS through practical implementable steps, while still achieving the desirable characteristics of sanitation planning.

6.1.2 Top-Down & Bottom-Up Debate

Sanitation planning as separate field of inquiry originated in the 1980s with the introduction of first systematic approach to citywide sanitation planning called “Strategic Sanitation Approach” (Kalbermatten et al., 1980). It revolutionised sanitation planning since it was multidisciplinary, participatory and proposed non-conventional (including non-sewered) solutions to maximise public health benefits (Kennedy-Walker et al., 2014). Until then, sanitation planning predominantly meant only sewer master plans for major cities in the Global South that were construed by big conventional engineering firms from Europe and North America that were subsequently funded by development agencies such as the World Bank (Schertenleib et al., 2021). This new Strategic Sanitation Approach heavily influenced several approaches that followed, which aimed to be stakeholder inclusive such as CLUES, U-CLTS and HCES (Lüthi et al., 2011; Myers et al., 2018; Schertenleib et al., 2003).

Sanitation planning can be largely categorised into two normative modes namely, (i) top-down and (ii) bottom-up based on the level of stakeholder participation and domains of decision-making. Top-down refers to centralised planning and implementation in most cases by the public sector and sometimes private for the provision of services with little or no participation from other stakeholders including users. Bottom-up refers to more participatory decentralised planning where alternate service provides such as NGOs and CBOs lead the planning and implementation, and the government in fewer cases.

Debates on the appropriate approach for planning urban sanitation in LMICs, continue to exist between top-down planning (Mara, 2018; Schmitt et al., 2017) and bottom-up planning (McGranahan and Mitlin, 2016; Narayanan et al., 2017). A global meta-analysis on sanitation service provision in low-income settlements suggests that bottom-up approaches are more effective (Annamalai et al., 2016). Bottom-up approaches have 55% of the outcome evidence that has reported an improvement in access to sanitation, compared to the 28% in top-down approaches (Annamalai et al., 2016). Although in the aforementioned study, access to sanitation meant only provision of toilets and not safe management of the entire sanitation value chain. The evidence from this meta-analysis also points to better affordability and adequacy (Annamalai et al., 2016).

The success of bottom-up approaches owe it to their detailed diagnostic of local situation and thereby ability to make appropriate improved sanitation system designs (Narayanan et al., 2017). Due to the involvement of the end-users, there is higher acceptance of the sanitation intervention, which contributes to higher community ownership, better monitoring, operations resulting in long-term sustainability (Lüthi, 2010). Furthermore, the heterogeneity of contexts within cities of LMICs is better handled by bottom-up planning (Reymond et al., 2016). However, experience suggests that bottom-

up planning is more time and resource consuming, challenging to implement, and poor execution leads to failure (Lüthi et al., 2010; Mcgranahan, 2013). The biggest challenge reported by sanitation experts involved in bottom-up planning is the moderation capacity issue. A good community based planning process needs an exceptional planner who is able to make all the stakeholder voices heard equally and builds consensus among them.

Top-down planning on the other hand boasts of a much faster planning process due to its centralised, replicable, and straight-forward application, therefore scalability (Mara, 2018). Centralised planning, especially when carried out by the same governmental agency responsible for basic urban services (or through intra-governmental coordination), has a higher scope for better outcomes through synergies with water supply, stormwater, solid waste management and drainage etc. (Narayan et al., 2021; Scott et al., 2019). However, top-down planning also leads to inappropriate system selection due to a lack of contextual understanding (Kennedy-Walker et al., 2014; Spuhler and Lüthi, 2020). Even today, in most parts of the Global South, sanitation is predominantly viewed only as an infrastructural issue (Schertenleib et al., 2021). Therefore, sanitation planning still remains largely top-down and often leads to sanitation systems that do not sustain (ISF-UTS; and SNV, 2016; Tilley et al., 2014).

From the above debate, it is clear that neither of these two approaches can overcome all sanitation related challenges in all contexts. Each of these approaches have their individual benefits and weaknesses as listed. For planning CWIS, their individual strengths of contextualised and participatory (for bottom-up), and synergistic and systematic (for top-down) are of significant value in planning. This is because, as the CWIS service framework suggests, planning the multiple dimensions (equity, safety, sustainability, responsibility, accountability and resource planning and management) needs support from both ends of the stakeholder spectrum i.e., users, and service providers (and/or regulators). Therefore, there is significant justification for pursuing the creation of a new approach, bridging top-down and bottom-up approaches, to plan CWIS.

6.1.3 Theoretical Basis for the Bridged Approach

The novel bridged planning approach benefits from being based on strong theoretical foundations. Therefore, we begin by exploring planning theory and the different modes and typologies of planning. Then we dwell into literature on sanitation planning and its typical steps to create the essential steps of the bridged approach. Next, we introduce the planning triangle, that further classifies top-down and bottom-up approaches. Finally, we will develop a planning framework specifically for CWIS, which will serve as the basis for developing the procedural steps for the bridged approach.

The following sections that build the theoretical basis for the bridged approach are therefore: 6.2 Planning Theory, 6.3 Procedural Sanitation Planning, 6.4 Planning Triangle, and 6.5 CWIS Planning Framework.

6.2 Planning Theory

6.2.1 Diffusing Duality

Despite of its prominence, the theory of planning is a recent yet heavily contested body of academic work. There are no formal definitions or first principles for planning, since the subject traverses through several broader disciplines including but not limited to law, economics, social science, public policy, political economy, engineering, public administration etc., (Friedmann, 1998). For example, on one hand planning is viewed as a product of economic and social reforms using a political economy lens and on the other hand, it is simply a consensus based on inter-personal relations based a new humanism lens.

The predominant typologies of planning theory are based on the distinction between (i) substantive, referring to the multi-disciplinary knowledge of the contents of planning, and (ii) procedural, referring to the methods of decision-making (Faludi 1973). While substantive and procedural planning approaches have their theoretical differences, planning as a pragmatic process blurs them into one (Allmendinger, 2018 and Yiftachel, 1989). Since this research aims to develop a planning approach specifically for CWIS, there is need for both - multi-disciplinary knowledge on sanitation systems (*substantive*), and a clear set of steps to follow to generate and fulfil sanitation demands (*procedural*). Such an approach also helps create double-loop learning where the planning process itself questions the beliefs and assumptions of the sanitation solutions and their outcomes. Therefore, the development of a "Bridged Approach to Inclusive Sanitation (BAIS)" must diffuse this duality.

6.2.2 Cherry Picking

While the duality is on hold, the developments in procedural planning theory happened in five major typologies namely (i) rational-comprehensive, (ii) incremental, (iii) advocacy, (iv) collaborative, and (v) post-modern (McConville 2010). While each of these have elements of each other in them, the crux of each of these typologies in the context of planning sanitation is provided in Table 6.1. Each of these typologies have elements that are appropriate according to the contextual needs and the stage of the planning process. However, no single typology satisfies all the wishful elements in the vision of a truly bridged approach (where the planning process is inclusive of all stakeholders resulting in a consensus-based masterplan with incremental action).

Therefore, in the context of comprehensively planning CWIS with meaningful stakeholder involvement (service provider, regulator and user), systematic optioneering, and strategic vision, we propose that a bridged approach has a list of select elements from the other typologies (marked in dark in Table 6.1). These indicate the planning focus, planner's role, method, participation and outcome. Three instances where mutual compatibility of multiple choices come into question are – the role of planner, planning method and outcome. All three can be achieved since the planner can indeed play the role of an objective expert and moderator (e.g. McConville et al., 2011), the planning method can weigh option based on quantitative analysis (e.g. Spuhler et al., 2020), and finally, through repeated consultations, masterplans can be incremental and consensus building (Goldenfum et al., 2008).

Table 6.1: Comparison of the different typologies of planning theories and the wishful elements for the bridged approach highlighted. Adapted from (ISF-UTS; and SNV, 2016; McConville, 2010)

	Planning Focus	Role of Planner	Planning Method	Participation	Outcome
Rational-Comprehensive	Achieving far-reaching global objectives	Objective expert	Based on quantitative analysis	Limited	Master Plan
Pragmatism / Incremental	Getting things done – no set objectives	Leader/ Facilitator: Act on sensible ideas and help others to act	Agreement after weighting specific options and outcomes	Generally by strong or well articulated players	Compromise patchwork plans
Advocacy	Solutions to address power inequalities	Advocate: giving a voice to interest groups	Debate and discussion	Through representatives	Political debate
Collaborative	Agreement through free and open discussion	Moderator: enabling communication between stakeholders	Open dialogue leading to consensus	Decentralised: invitation to everyone who wishes to communicate	Consensus for action
Post-Modern	Understanding and sharing fragmented visions – no great vision	Narrator: allowing individuals to express their viewpoints	Iterative and participatory, but individualised	Network for those who can engage in planning	Civic culture, but individual action
BRIDGED	Achieve long-term goals through incremental action	Objective Expert and Moderator	Based on quantitative and qualitative analysis and agreements after weighing specific options and outcomes	Through representation at decision making and direct consultation	Master Plan arrived from consensus

6.3 Generic Steps in Sanitation Planning

Sanitation planning, in line with procedural planning theory follows three main questions (Mugabi et al., 2007):

1. Where are we now?
2. Where to go?
3. How to get there?

McConville, (2010) summarises the five generic steps in sanitation planning namely: (i) problem identification, (ii) definition of objectives, (iii) design of options, (iv) selection process, and (v) action planning. ISF-UTS and SNV, (2016) provides a slightly different variation in their classical steps in sanitation planning as follows: (i) contextual analysis, (ii) define goals, (iii) assess options, (iv) create a sanitation plan and (v) create an implementation plan. While steps (i), (ii), (iii) and (v) are common, step (iv) differs between each of them (selection process vs creation of sanitation plan, respectively). However, in both these generic interpretations, an important step is missing namely, step zero for generating demand for urban sanitation among different stakeholders, in order to begin the planning process itself (Lüthi et al., 2011; Murray and Ray, 2010). More specifically, creation of demand for CWIS among various stakeholders also needs sensitisation and advocacy on CWIS, since it is a more intensive process that involves significant change in standard sanitation planning practices (Gambrill et al., 2020).

For a bridged approach, we must move away from a linear planning methodology and adopt an iterative and double-loop feedback process. This is because of the consultation process that brings feedback from various stakeholders that have to be accounted in the planning process (See Table 6.2). One aspect of step-zero is (a) demand generation; other aspects to include are (b) preliminary contextual analysis, and (c) setting the rules of the planning process itself. These steps (a), (b) and (c) feed into each other to help formally begin the sanitation planning process. For example, before setting out to create demand, a preliminary analysis helps answer – why (with clear data for advocacy), and for whom (which stakeholders are motivated for change). Similarly, clarifying who the decision makers are, and how the planning process would take place, is also part of preparation process that forms step-zero.

Table 6.2: Generic Steps in Sanitation Planning. Adapted from (ISF-UTS; and SNV, 2016; McConville, 2010)

Sanitation Planning Steps	Preparatory Steps			Where are we now?	Where to go?	How to get there?			
Mcconville (2010)	-			Problem identification	Define objectives	Design of options	Selection process		Action planning
ISF-UTS and SNV (2016)	-			Contextual analysis	Define goals	Assess options	Create a sanitation plan		Create an implementation plan
Bridged approach	Preliminary analysis	Demand generation	Rules of planning process	Detailed contextual analysis	Define objectives	Design of options	Consultation	Selection process	Incremental action plans

6.4 Sanitation Planning Triangle

Top-down planning could take two major forms – "technocratic" and "bureaucratic". Technocratic planning shares the same elements as rational-comprehensive theory, where the focus is far-reaching goals, and the planner is a technical expert who uses quantitative methods with limited participation to produce a sanitation master plan. Bureaucratic planning on the other hand shares elements of pragmatism planning theory. Here, the planner is a bureaucratic leader who focuses on the urgent tasks on the table, where using some weightage and participation from powerful stakeholders in the sector provides quick fixes using a patchwork of plans.

Bottom-up planning on the other hand has its major form as "democratic planning" and it strongly incorporates aspects of communicative or collaborative planning (Lüthi et al., 2010). The focus is on building agreement through open discussions, where the planner's role is to bring various stakeholders to the table and moderate the communication between them. The participation is decentralised and open, where the decision-making is based on transparent and open dialogues. Therefore, the outcome of democratic planning is a sanitation plan that is arrived through a consensus.

According to the Manila Principles on CWIS, planning needs to be comprehensive in terms of stakeholder inclusion, consideration of the sanitation value chain, short and long-term vision, and synergistic of other basic urban goals. For example, it needs community involvement (characteristic of bottom-up democratic approach), objective option assessment for long and short-term (characteristic of top-down technocratic approach), and inter-agency coordination (characteristic of top-down bureaucratic approach). Therefore, as seen in section 6.1.2, planning would benefit from the bridging of top-down and bottom-up planning approaches, and furthermore draw from all three modes of planning (technocratic, bureaucratic, and democratic). This helps in the introduction of the Planning Triangle, where the two top vertices indicate technocratic and bureaucratic planning, while the bottom vertex indicates democratic planning, the bridged approach would strive to be in the centre (Figure 6.1). This is of course only a wishful ambition; the real place a bridged approach occupies will depend on the contextual factors including stakeholder power dynamics, the planner's capacity and the planning process itself.

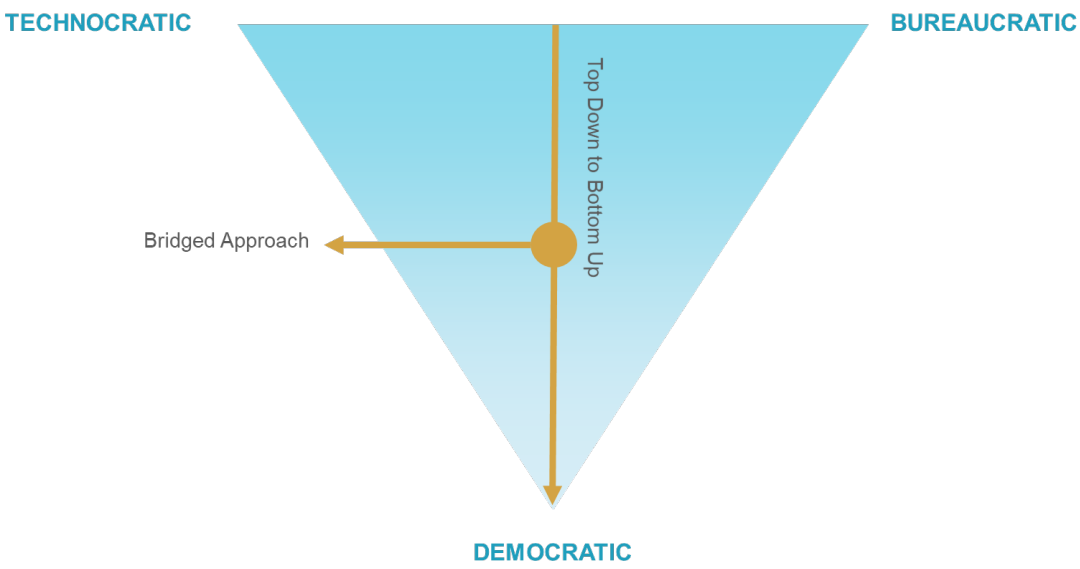


Figure 6.1 Where a bridged approach fits in the planning triangle

Such a bridged approach, that balances technocratic, bureaucratic and democratic modes of planning, is not available in the current sanitation planning landscape. Other prominent approaches fall somewhere within the triangle in different parts. For example, CLUES would feature towards the democratic corner, and the Sanitation 21 planning guidelines would lie closer to the technocratic corner, whereas the CSP approach would fall closer to the bureaucratic corner.

6.5 CWIS Planning Framework

With the advent of CWIS, which views sanitation as a holistic service and puts equity, safety, accountability, resource management and sustainability in focus, planning sanitation interventions according to its principles needs to be more comprehensive (Schrecongost et al., 2020). Currently, there are no planning frameworks that have been exclusively developed, or existing frameworks adapted to meet this promising yet, complex mandate. While it would be useful to adapt existing planning frameworks for CWIS, a theoretical basis for CWIS planning is necessary to test their performance in terms of the outcome of the plans and the planning process itself. This helps diffuse the aforementioned duality of substantive and procedural planning theories.

The proposed CWIS planning framework sets the theoretical basis for a contextualised methodology for planning CWIS. It places the bridging of top-down and bottom-up approaches as a centerpiece. The framework is based on the largely agreed Manila principles (Narayan and Luthi, 2020). As seen in Chapters 1 and 2, CWIS has gained significant uptake across the sanitation sector, and upcoming CWIS projects need to go beyond latrine construction, and incorporate indicators and targets that espouse equity, safety, sustainability, responsibility, accountability etc., (Schrecongost et al., 2020). Examples of such targets are (i) sanitation worker safety, (ii) certification mechanism for treated biosolids, (iii) ring-fenced sanitation budget, and (iv) transparency of performance data (Athena Infonomics and BMGF, 2021).

Due to the various dimensions that CWIS brings together, planning needs to be comprehensive[17], which itself is one of the key CWIS principles (Gambrill et al., 2020; Lüthi and Narayan, 2018; Schrecongost et al., 2020). But in order to embark in such a planning exercise, there must be clear understanding of what the guiding principles of such a planning process – in terms of its process and outcomes.

For this purpose, the CWIS Planning Framework is developed, which directly draws all its elements from the Manila principles on CWIS (Box 1.2). The CWIS Planning Framework (Figure 6.2) places comprehensive planning at the centre, surrounded by four operational outcomes that include: (i) **Public Health**, (ii) **Environmental Health**, (iii) **Mix of Technologies**, and (iv) **Mix of Business Models**. These are taken from the principles 2, 3, and 4; while the other three principles contribute to the formation of functional linkages.

[17] Comprehensive planning refers to planning with inclusion of all stakeholders, consideration of the entire sanitation value chain, incremental with short and long-term vision, and is synergistic of other basic urban development goals such as water supply, solid waste, and stormwater. Comprehensive planning in the case of CWIS also refers to the consideration of all other principles of CWIS.

The following functional linkages described below and connected with the outcomes appropriately:

(a) **Safety** refers to the safe management of all human waste as defined by the JMP (UNICEF and WHO, 2016). One difference with the JMP is the inclusion of shared sanitation systems when it meets certain criteria (such as water access, privacy, lockable doors etc.) as identified by Schelbert et al., (2020).
Here it links outcomes (i) and (iii), since safety is achieved only when the entire value chain is managed while ensuring public and environmental health.

(b) **Sustainability** refers to both environmental and financial sustainability, by using a life-cycle approach to resource management of finances, labour, water, energy for infrastructure and service operation and maintenance (Schrecongost et al., 2020).
Here it links outcomes (ii) and (iii), since mix of technologies allows for contextual and incremental improvements offering financial viability. Environmental health outcomes directly impact environmental sustainability.

(c) **Accountability** refers to the clear institutional mandates for sanitation service provision and the transparent monitoring of their performance (ESAWAS, 2020).
Here it links (iii) and (iv), since a mix of technologies and business models inherently increase operational and governance complexity. Therefore, clear accountability mechanisms enhance the long-term functionality of a mix of sanitation services.

(d) **Equity** refers to absence of disparities in sanitation service access and outcomes rather than service provision, regardless of location of residency, wealth quintiles, gender, ethnicity, religion, health status, and sexual orientation. This might need some form of affirmative action in most cases (Luh et al., 2013).
Here it links (iv) and (i), since equitable sanitation leads to everyone in the city receiving equal public health outcomes while enjoying equal quality and affordability of sanitation services from any operating business model.

These operational outcomes and functional linkages are supplemented with the conceptualised four ‘S’ pillars (4S) of comprehensive planning:

1) **Situation analysis**
2) **Stakeholder participation**
3) **Synergies with other sectors** and
4) **Strategy for long term**.

These 4S pillars emerged from the aim of bridging top-down and bottom-up approaches. While top-down approaches provide the advantages of exploring synergies with other public services and strategies for long-term, bottom-up approaches encourage detailed situational analysis through co-production of knowledge and meaningful stakeholder participation.

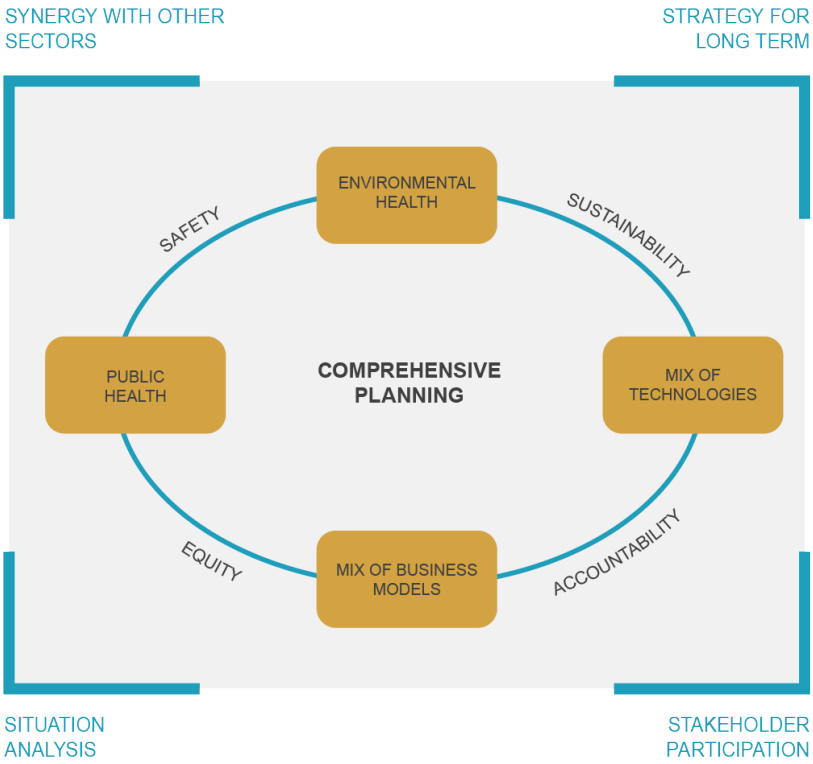


Figure 6.2: CWIS Planning Framework

The CWIS planning framework is useful when designing CWIS projects, in order to highlight key aspects of the CWIS concept; the operational outcomes serve as the targets to operationalise in project, and the functional linkages serve as the essentials of the project'approach. This framework is only a guide to the planning process. The specific planning process needs the operationalisation of CWIS targets, which must be contextualised and incremental in line with the fundamental premise of CWIS (Lüthi and Narayan, 2018). The outcomes of environmental health and public health must follow the respective jurisdiction's legal standards for e.g., discharge standards, containment structure guidelines etc., (Schellenberg et al., 2020). The mix of technologies and business models must be chosen according to the needs of the particular city/neighbourhood (Mitra et al., 2022; Schrecongost et al., 2020).

The functional linkages on the other hand allow the design of the enabling environment of sanitation systems; for example, the tariff structure for the services are set equitably with targeted subsidies for the poor (World Bank, 2019), or that the institutional mandates are clarified so that there is clear accountability for service provision (ESAWAS, 2020). These functional linkages provide guidance on reaching the aforementioned outcomes.

The 4S pillars serve as the crosscutting means to achieve the CWIS outcomes during the entire process of planning. These pillars help decide the planning approach and the steps involved in it. Following the bridged approach typology envisioned in section 6.2 and the generic planning steps seen in section 6.3, the planning process begins bottom-up with (1) situational analysis, which helps set operational targets for CWIS, and then (2) closely engage community and stakeholders throughout the planning process. As seen in section 6.1.1 and section 6.4, the top-down approach has support from the public sector which helps foster coordination between various institutions to (3) plan for long-term and (4) synergise with other related urban services such as water supply, solid waste management, stormwater drains and slum redevelopment.

To put simply, from the CWIS Planning Framework- the operational outcomes and functional linkages help to set the targets and outcomes for the planning process (substantive planning). The 4S pillars on the other hand, help to formulate the steps in the planning methodology (procedural planning) for CWIS. The CWIS Planning framework as a whole can also be used to analyse sanitation planning practices retrospectively and propose ways forward.

6.6 Bringing theories together

The above sections provide the theoretical foundations for developing a novel planning approach for CWIS that can bridge top-down and bottom-up planning approaches. This new planning approach is called the "Bridged Approach to Inclusive Sanitation (BAIS)". This approach builds on four levels of theoretical justifications (i) the typology of planning (section 6.2), (ii) steps in sanitations planning (section 6.3), (iii) level of stakeholder involvement (section 6.3) (iv) CWIS outcomes (section 6.4). Simply put, these justifications provide answers to the questions of (i) which planning theory to follow?, (ii) what are the basic planning steps?, (iii) what type of stakeholders are involved and how?, and (iv) how can the planning approach be CWIS specific?, respectively.

It builds on the following elements (Figure 6.3):

- Bridged typology with selected elements from the planning theory
- Generic sanitation planning steps with inclusion of preparatory steps
- Planning triangle bridging top-down and bottom-up approaches by balancing technocratic, bureaucratic and democratic modes of planning
- The CWIS Planning Framework, specifically the 4S pillars

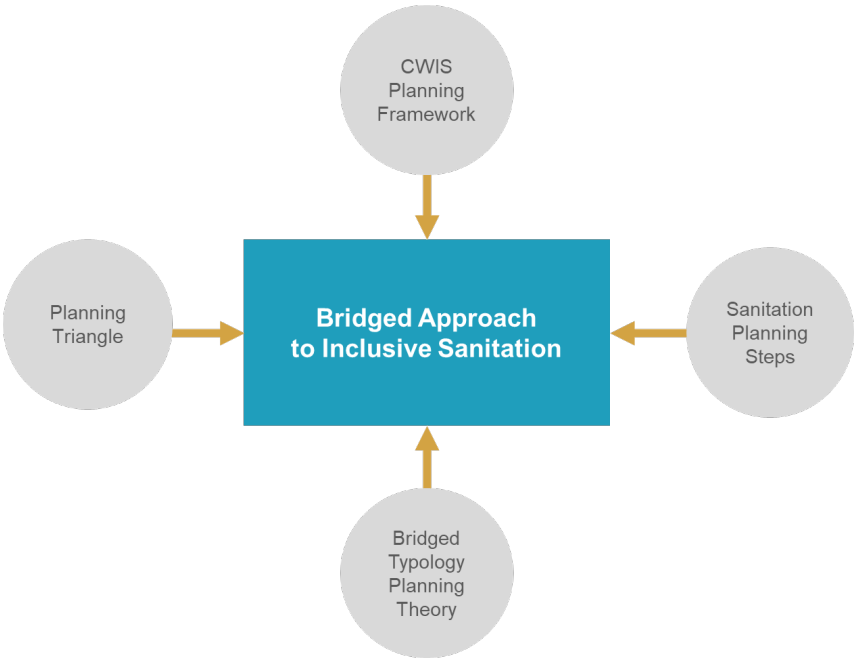


Figure 6.3: Theoretical background to the Bridged Approach to Planning CWIS

In addition to the theoretical background to developing the approach, the specific steps and their loops were prototyped in two workshops where expert feedback was collected, and then incorporated to arrive at this version of BAIS.

BAIS is a systematic set of guidelines to arrive at a contextually appropriate planning methodology. The 10 steps and the characteristics of the approach are provided in sections 6.7 and 6.8. It may be useful to note that BAIS concludes with the creation of a CWIS plan, and does not venture into implementation and monitoring.

6.7 Bridged Approach to Inclusive Sanitation

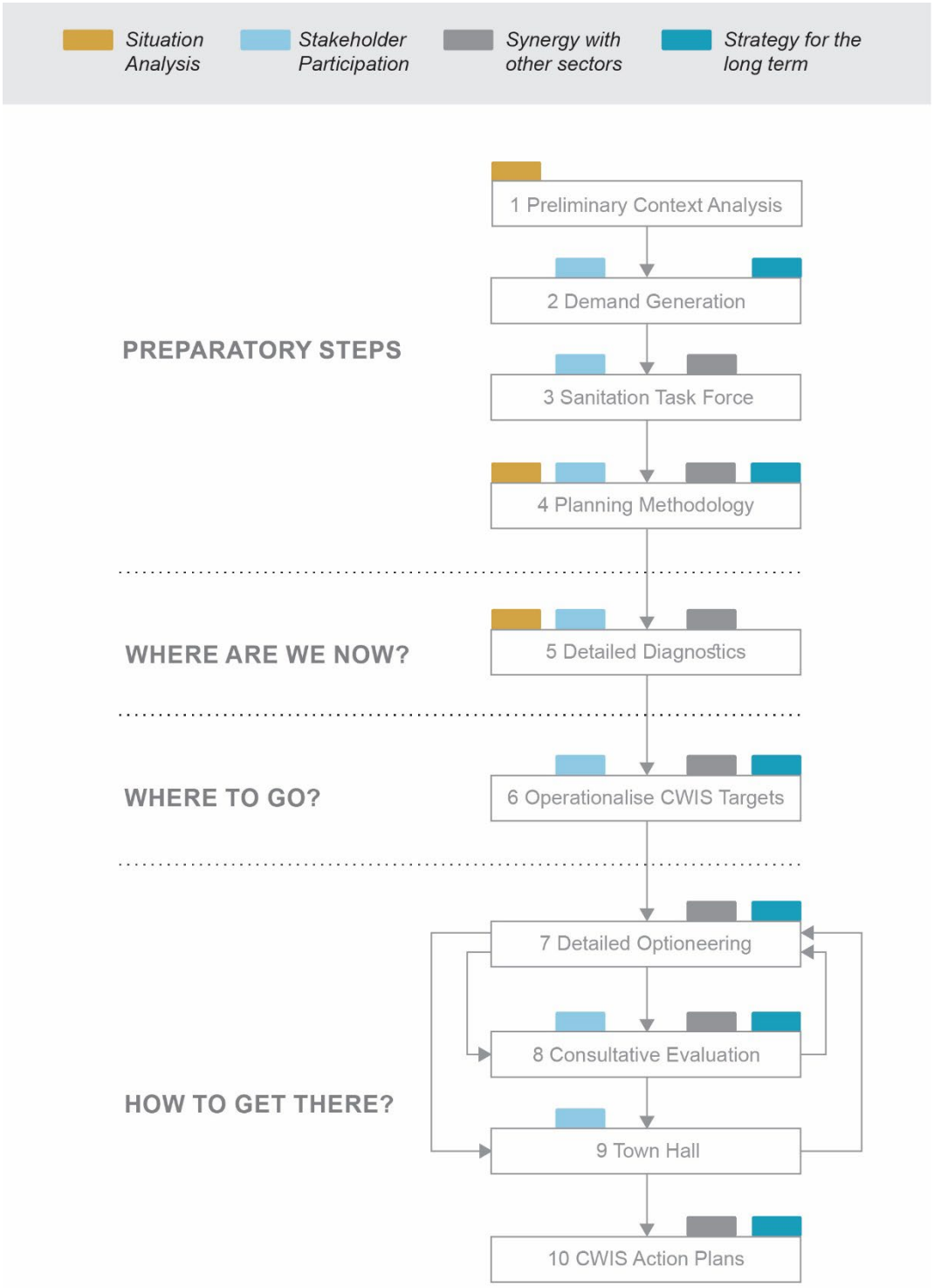


Figure 6.4: 10 Steps of the BAIS

Step 1: Preliminary Context Analysis

The objective of this step is to gather preliminary information on the sanitation situation in a given context. In order to begin a sanitation intervention, there needs to be some basic understanding of the social, institutional, and technical aspects. The main questions to answer here are borrowed from the operational outcomes of the CWIS Planning Framework. They include but are not limited to the following:

1. How is the current public health of the area?
    a. Access of improved sanitation.
    b. Vulnerabilities and exposure to faecal waste.
2. How is the current environmental health?
    a. Percentage of faecal waste collected.
    b. Percentage of faecal waste safely treated and disposed.
3. What sanitation technologies are in place?
    a. Sanitation systems throughout the value chain?
    b. Percentage sewered and non-sewered.
4. Who is providing the services?
    a. Is it the municipality, utility or private sector providers?
    b. What are the various service models in place?
    c. Who are the different key stakeholders in the sanitation chain?

Most of the work for this step could be carried out through a Shit Flow Diagram (SFD) process. There are other tools such as the World Bank Rapid Assessment, an excel based checklist document which gives an overview of the technical, social and institutional aspects of the sanitation value chain.

Step 2: Demand Generation

The objective of this step is to create demand for CWIS among both the governmental decision makers and the community-based end users. This is a crucial step, without which none of the following steps can take place. Demand for sanitation interventions are needed for change to be endogenous, which ultimately matters in long-term sustainability (WSUP, 2019). The need for demand creation are well documented (Murray and Ray, 2010; Okurut et al., 2015; Winters et al., 2014). That is why in other prominent urban sanitation planning approaches, including U-CLTS and CLUES; demand creation is an initial step.

Demand creation however has to happen both top-down and bottom-up. Worldwide sanitation is a public service mandate, and without the support of the local government there is no scalable sanitation intervention. Similarly, without adequate demand for safe sanitation among the users, sanitation services are bound to fail (O'Reilly and Louiss', 2014; Okurut et al., 2015). Lastly, in case of settings where the public sector is stifled, private sector involvement is essential for service provision. Therefore, demand from such sanitation entrepreneurs is also necessary (Ramani et al., 2017).

An important aspect to note here is that this step could take between weeks to even years. CWIS is a new approach and needs to be advocated strongly among the decision makers and users, since solutions may not always be the conventional options these groups have in mind. Further, for CWIS and its non-conventional solutions, there needs to be an accommodative institutional, regulatory and social environment. Creating such an enabling environment in many cases would be a significant challenge (See section 2.5.5).

There are several tools that are useful in the advocacy and demand creation process for example, SFDs, community-based meetings and workshops on CWIS advocacy, social marketing including street art, and exposure visits for decision makers, to mention a few.

Step 3: Creation of Sanitation Task Force

The objective of this step is to create a consultative and coordinating body with representatives from different stakeholder groups. The sanitation task force concept is borrowed from the Indian CSP process (GIZ, 2016), since the analysis showed that the task force was an essential component in the planning process that ensured stakeholder involvement and pragmatic solution formulation.

The duty of the sanitation task force is to bring various perspectives into the decision making table and in turn, sensitise their own stakeholder groups on CWIS. Upon the constitution of the task force, the process of planning CWIS begins.

The sanitation task force must constitute the right members from different stakeholder groups. They should include key representatives from the following:

- Municipal government
- Various line agencies interacting with sanitation
- Water and Sanitation Utility
- Private service providers
- NGOs
- CBOs
- Resident welfare organisations
- Academia
- Sanitation experts/consultants

The task force must also be emboldened with duties and powers within the regulations of the local government. This could be done through creation of local bye-laws or powers delegated by the Mayor. The task force must have enough authority to make decisions mentioned in Step-4. They should not merely be a consultative body with no real influence on decision-making with respect to the sanitation plans. The task force is not a one-time meeting council, rather must have regular meeting through the course of the planning process in order to create checks and ensure the involvement of various stakeholders.

Step 4: Decision of Planning Methodology and Planning Boundaries

This is the first order of business for the sanitation task force. The objective of this step is to delineate clearly the steps, time, budget and the boundaries of the planning process. This therefore is a very decisive step in planning process and influences all other steps that follow. This step inherently also decides the level of engagement of various stakeholder and thereby finds a spot within the planning triangle.

The key decisions to make include:

- Planning horizon
- Spatial boundaries

- Timeline of planning
- Budget for planning
- Internal and external expertise required
- Planning tools to use
- Sectoral focus (defining synergies to explore)

Most other planning approaches in water and sanitation have not explicitly held this as a separate step. Given the impact of these decisions on rest of the planning process and the availability of myriad of planning tools, this is a separate step in BAIS, following the recommendations of McConville, (2010).

Step 5: Detailed Diagnostics

This step builds on the preliminary analysis from Step 1. The objective of this step is to understand the current sanitation landscape in the intervention area in a much more comprehensive manner. Without a detailed analysis of the situation at present, it is difficult to plan the future steps. Establishing baseline data is also useful for future implementation monitoring. This step therefore must rely on both primary data and secondary data including past reports, documents etc. There could be co-production of knowledge wherever possible to get nuanced local knowledge (Narayanan et al., 2017).

The main aspects to understand include:

1. Technical (along the sanitation service chain, spatial growth etc.)
2. Socio-cultural (user preferences, behaviors, norms etc.)
3. Regulatory (policies and regulations at local, state and national levels)
4. Legal (legislative boundaries)
5. Economic (Costs of service provision, willingness to pay etc.)
6. Institutional (various entities involved in service provision and decision making)
7. Climatic (vulnerability assessment)
8. Synergistic (interactions with other related basic services)

There are several tools and toolkits available for carrying out detailed sanitation diagnostics such as the FSM ToolBox, CLUES Toolkit, UCLTS Tools, City Service Delivery Assessment, Social Network Analysis, Stakeholder Mapping, SaniPath, GIS tools, Enabling Environment Assessment, Transect Walks, Household surveys, etc.

Step 6: Operationalising CWIS Targets

The CWIS concept is broad and abstract. The objective of this step is to operationalise the principles into clear and quantified targets. Only such quantified targets can be tracked, and therefore planned for implementation. Not all of the six CWIS principles are equally applicable in all contexts. In some cases, the principle on equity is more important while in others a single type of technology might be appropriate throughout the city. The targets that are quantified and verifiable are then used as the results framework for the CWIS implementation process. Since CWIS advocates for an incremental approach, without detailed situational assessment, these targets cannot be set. That is why, unlike the conventional Structured Decision Making (SDM) process, in BAIS the targets are set after the detailed diagnostics.

There are already indicator lists and service frameworks present for CWIS (Athena Infonomics and BMGF, 2021; Schrecongost et al., 2020), and this step can borrow and further build on them. Some examples for operationalised CWIS targets include:

1. 80% of Low-Income population will have access to safe individual/shared household latrines.
2. 100% of wastewater delivered to treatment plant is treated
3. Non-sewered sanitation solutions are objectively considered during the planning process
4. 40% of the sanitation planning experts are women
5. 30% of the faecal sludge and septage are collected by private operators
6. 100% of the operational expenditure is recovered by the third year

Step 7: Detailed Optioneering[18]

The objective of this step is to identify all viable options for sanitation systems and service models. Detailed optioneering builds on the previous two steps of where we are (detailed diagnostics) and where we want to go (CWIS targets). This step will provide possible pathways for this transition. This exercise leans more towards the technocratic approach, as we do not want to disqualify any conventional, non-conventional or emerging technology options.

Two simple and useful tools that aid in this process are (i) SaniChoice, an online decision support tool that enables systematic identification of appropriate sanitation system options, and (ii) Compendium of Sanitation Systems and Technologies, a resource material which provides various technological options for stages in the sanitation value chain. While the former needs minimal software training, the latter needs an expert to interpret and contextualise the system options.

There may be expert-driven brainstorming and interview-based arrival at different sanitation options. But they need to be 1) transparent, 2) systematic, and 3) locally appropriate. This needs to be part of a SDM process, regardless of the tools used. It is in this stage that the factors of long-term and synergy with other sectors need to be explored in greater detail. Along with the technical options for sanitation systems, this step needs to provide estimations for costs for construction and operations, service coverage, and resource consumption/recovery potential. The outcome of this step is a set of sanitation system options accompanied by their costs and benefits.

Step 8: Consultative Evaluation

This is an important step where the system options from the earlier step are evaluated. The objective of this step is to carry out meaningful consultations of the system options and systematically evaluate them according to the CWIS targets set. This is a step where the expert planners and the sanitation task force work in tandem.

The consultation takes place with both the decision makers and community of users simultaneously. There are various tools that could be used, including workshops (where moderation is extremely important), individual interviews (where unbiased preferences are elicited) and other transdisciplinary techniques such as critical heuristics. The consultations aim to build consensus towards the most appropriate solution.

[18] Optioneering refers to systematic option generation

The evaluation itself must be expert-driven, systematic with clear weights and objectives that are arrived from the consultation experience. Several data sources such as cost-benefit analysis, service level and coverage, synergy potential etc. must be used in the decision making process. It would be only in rare instances where steps 7 and 8 would be a linear process. In most cases the feedback must be looped back to step 7 of optioneering.

Step 9: Town Hall / Open Consultation

The objective of this step is to present the top sanitation solutions to the wider public in case someone's voice was left out in the earlier step. This way the consultations become more democratic. It is important that this step is neither done after the final choice is already made, nor presented at an initial stage where the options are too many and poorly conceived. There needs to be a balance in what is expected out of this step between listening to feedback from the public and letting the public make the final decision often with insufficient information. The planner here must moderate the consultation process with care and caution to prevent elite capture of audience, and deliberately make the voice for the less privileged communities well heard. In cases where this is not possible due to the power dynamics at public play, step 7 must be carried out through targeted consultations with the marginalised and vulnerable communities.

In larger cities and mega cities, such town halls are difficult and impractical for receiving feedback from thousands of people who are impacted by this intervention. Therefore, the town halls need to be complemented with digital town halls where the detailed options are provided on the municipal website and widely advertised inviting feedback. Steps 7 and 8 could be carried out iteratively based on the feedback received in the town hall.

Step 10: Action Plans

The final step of the planning process is creation of action plans that are aimed at incremental implementation. The objective of this step is to produce modular and comprehensive CWIS plans that could be funded. Such a planning document has the larger vision and CWIS targets for the city and has detailed project plans that can be modular and implemented incrementally as and when funding is available.

It is important that the planners also connect these plans to possible funding options both nationally and internationally wherever possible. The sanitation task force may have completed their task, but need not be dissolved just yet. The task force may choose to oversee the implementation process as per need.

Taking the extra step into Implementation and Monitoring

As mentioned earlier, BAIS concludes with the completion of the CWIS plan. After this, implementation begins, for which monitoring is necessary. From the implementation process, learnings are documented and shared during the planning of the next incremental intervention. While the planning process may officially conclude with the submission and endorsement of the CWIS plan, plans should not be one time documents but be kept alive. The CWIS plan must be constantly updated since the modular plans must be ready to go whenever financial and implementation opportunities arise.

6.8 Characteristics of the approach

BAIS provided above is a set of guidelines for planning CWIS. The exact methodology itself depends on the local context and is decided as part of the process in step 4. This way, the bridged approach is generic, has scope for customisation, and can leverage the necessary expertise, tools and policy strategies depending on contextual needs. There are few aspects of the approach to consider in order to realise the aims of this approach in developing a modular, incremental and implementable plan.

The planner

The planner is a sanitation champion who can be an insider as part of the local, state or national Government, or could be a member of the local community or part of local NGOs. They could also be an outsider coming from an international development agency or a donor organisation.

Skills needed

Since the planner(s) is essential to the planning process, there needs to be careful consideration of the skills required to execute the planning process. BAIS is multi-dimensional, therefore needs a planning team of multi-disciplinary members. This includes planners with expertise not just in sanitary engineering but also in governance, community and finance. While this expertise can be brought in through consultants, a crucial part is the facilitation of the planning process which needs strong people skills to be able moderate and communicate with the different stakeholders.

Time needed

Since this planning approach has not been tested, there is no reliable data to predict the time requirements. However, there are estimates that could be made based out of experience from other planning approaches. CLUES took about a year on average to carry out the planning steps. CSPs in India and Indonesia took over a year to arrive at good quality plans, which included detailed diagnostics. The Sanitation Master Plan for Bangalore city took over two years to develop. World Bank planning operations to arrive at Project Appraisal Documents take anywhere between one to three years. Therefore, the estimated time for BAIS to be executed is around one year excluding the demand generation step, which is hard to predict.

Money needed

This is also a number that is hard to predict since there is no field validation of the approach. However, CLUES estimates a cost of USD 15,000, the initial CSPs in India costed anywhere between USD 5,000 to 100,000 in secondary cities. Sanitation master plans for mega cities cost much higher amounts in the scale of 100,000s. Therefore, there is no reliable estimate of the cost for applying BAIS to plan CWIS.

Tools and Capacity

BAIS needs the support of tools and capacity development programmes for its own uptake, and more broadly, the implementation of CWIS at scale. Box 6.1 provides a summary of this challenge and lists prominent tools and capacity development efforts for scaling CWIS.

Other Challenges

BAIS as an approach has significant demands on the planner and the contextual setting itself. In practical instances, the BAIS approach will encounter significant challenges of technical capacity, political will, community acceptance and cooperation, lack of data, competing interests etc. Therefore, realistic ambitions need to be placed with consideration of the contextual constraints. BAIS described

here is the 10 steps under ideal conditions for planning CWIS. Chapter 7 explores the challenges of BAIS and CWIS in the case of India.

BOX 6.1

Tools and Capacity Development for scaling Citywide Inclusive Sanitation

Introduction to Citywide Inclusive Sanitation

Citywide Inclusive Sanitation (CWIS) presents an elevated thinking in urban sanitation that goes beyond just access to improved sanitation, but covers the entire sanitation value chain from a service perspective. The essence of the approach is covered by the six Manila Principles on CWIS that include (i) equity (ii) public and environmental health (iii) mix of technologies (iv) comprehensive planning (v) monitoring and accountability and (vi) mix of service models (Narayan and Luthi, 2020). Conventional practice seldom has such diverse targets and usually considers only the number of households to be connected and centralised sewer plans. CWIS on the other hand brings in multiple indicators to perform against, that go well beyond just the physical infrastructure (Gambrill et al., 2020). Planning for CWIS is therefore a complex multi-criteria decision making problem involving different sustainability dimensions, an overwhelming number of technology options (sewered and non-sewered), and stakeholders with varying interests.

If CWIS were truly to be implemented at scale in cities of low- and middle-income countries (LMIC) that urgently require attention, we need appropriate sanitation planning tools and capacities that can deal with such complexity. In the last decade, a number of novel tools have been developed, but have limited uptake due to capacity and contextualisation challenges (Schertenleib et al., 2021). “A tool is only as good as the hand that wields it”. Currently, a shortfall of 800,000 skilled water and sanitation professionals exists in just ten LMICs (IWA, 2014). Fortunately, efforts have already begun in meeting these dual needs. This article takes stock of these efforts and presents an overview of the various tools and capacity development programmes aimed at supporting scaling up of CWIS and further highlights the gaps to be filled.

The Tools Challenge

Tools are a necessary support for the various stages involved in comprehensive planning: advocacy, diagnostic, design, implementation and monitoring. While several existing tools such as the Faecal Waste Flow Diagram (SFD), City Service Delivery Assessment (CSDA) and Stakeholder Engagement tools are versatile and are useful in the initial stages, new tools are required to (i) estimate costing of different solutions, (ii) understand regulatory requirements and (iii) compare different technological choices. New tools such as the World Bank’s CWIS Costing tool, Gates Foundation’s CWIS Service Assessment and Planning (CWIS SAP) tool and Eawag’s SaniChoice are aimed at filling these respective gaps. An overview of the tools landscape featuring prominent tools for CWIS are given below (Figure 6.5). The figure also highlights the gap for tools in the implementation and monitoring stage and those that have low data and resource requirements, which are a significant concern in LMICs.

The Capacity Development Challenge

A key challenge in scaling up CWIS is the lack of human capacity in the target cities in the form of local government officials, consultants, and urban planners, with experience in planning CWIS and exposure

to the available tools. There is an urgent need for rapidly expanding capacity development programmes through innovative formats that can then bridge the gap between the requirement and supply of skilled sanitation professionals (Suter and Lüthi, 2021). Recent efforts have been made towards a global outreach for capacity development on CWIS through multiple platforms such as worldwide academic programmes (e.g.: Global Sanitation Graduate Schools), capacity development programmes for consultants (e.g.: ConCaD), public sector professionals (e.g.: Sanitation Capacity Building Platform in India), institutional development and strengthening existing sanitation networks (e.g.:FSM Alliance, African Water Alliance, Sustainable Sanitation Alliance), and learning via massive online open courses (e.g.: Eawag's Water, Sanitation and Solid Waste for Development).

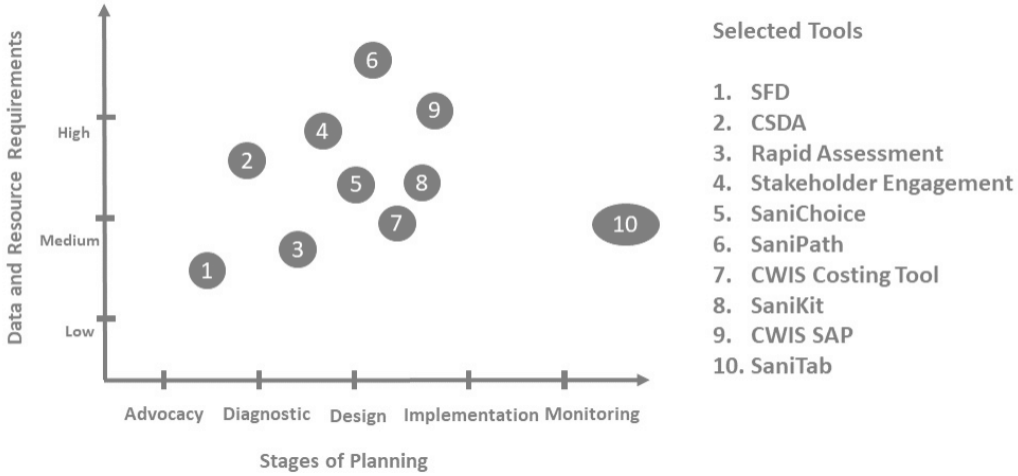
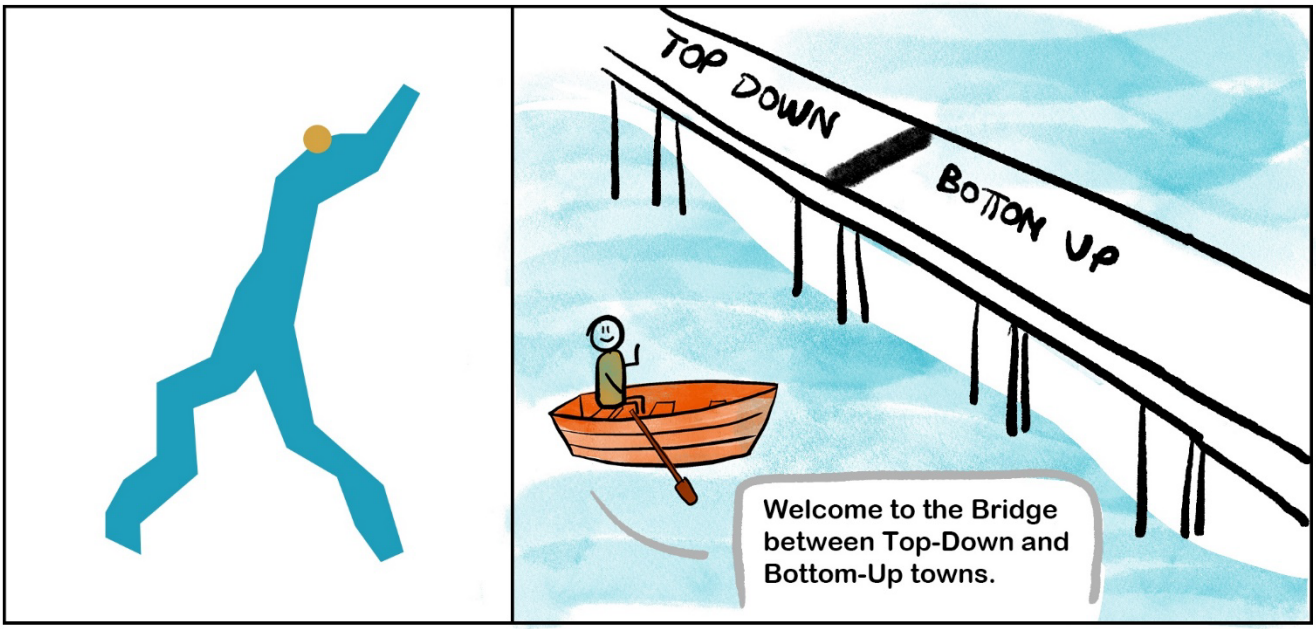
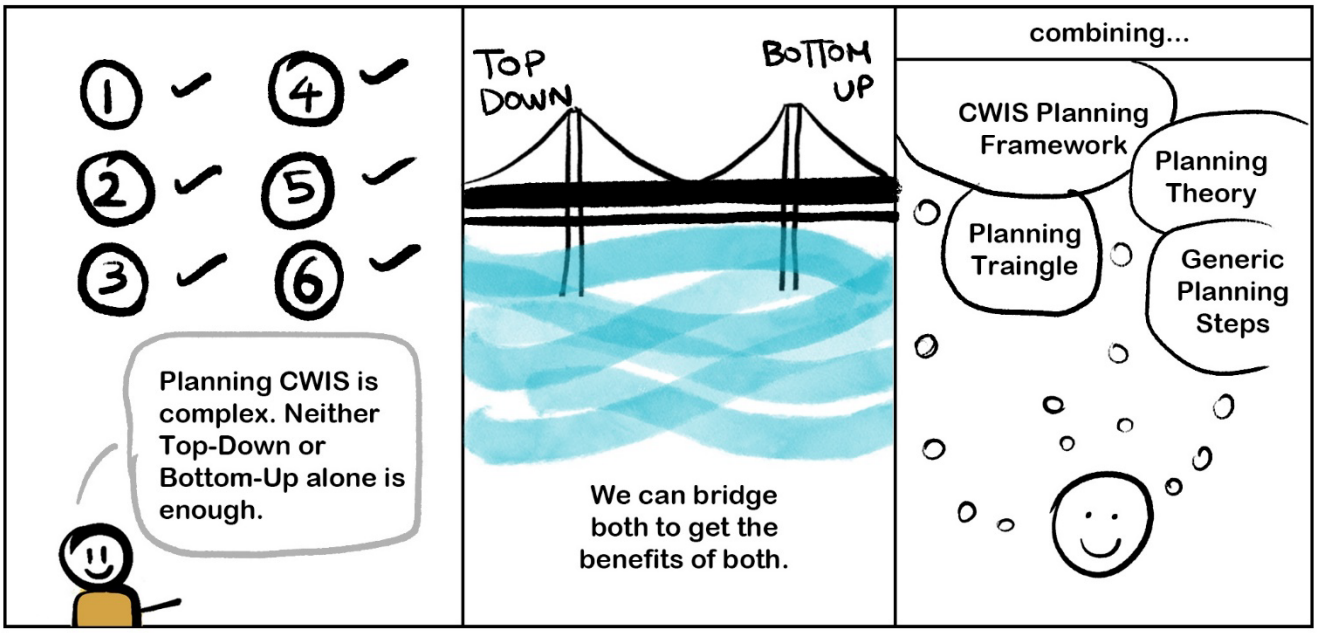


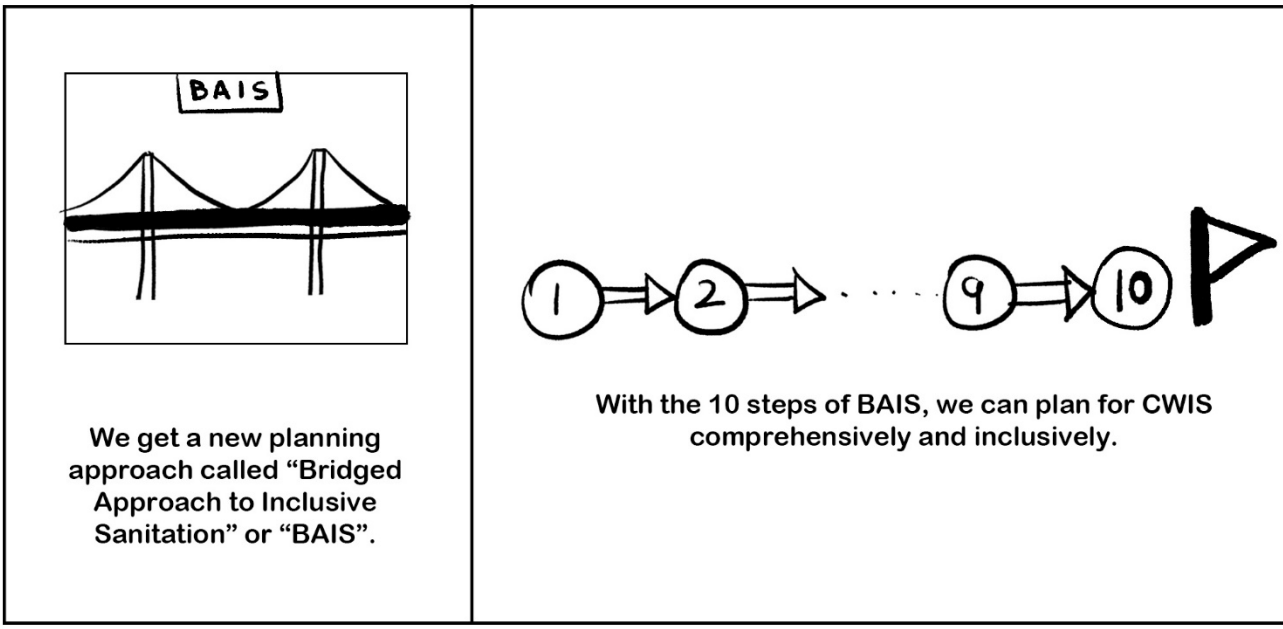
Figure 6.5: Illustration of various CWIS tools placed according to their requirements and stage of execution

Conclusion

With tremendous efforts that have recently gone into developing both tools and capacities that are practice-oriented and demand-driven, there is potential to scale up CWIS. These efforts however would benefit from better coordination and contextualisation to avoid replication, and instead focus efforts on filling the gaps identified in both tool and capacity development. Further, these efforts should also consider the upcoming challenge ahead - the need for holistic planning approaches that look at integrated urban water management. This requires the consideration of the inter-linkages between related urban sectors (e.g. water and solid waste) which in turn allows for efficient management of material and energy flows at the city scale.


TOP DOWN
BOTTOM UP
Welcome to the Bridge between Top-Down and Bottom-Up towns.


1
2
3
4
5
6
Planning CWIS is complex. Neither Top-Down or Bottom-Up alone is enough.
TOP DOWN
BOTTOM UP
We can bridge both to get the benefits of both.
combining...
CWIS Planning Framework
Planning Theory
Planning Traingle
Generic Planning Steps


BAIS
We get a new planning approach called “Bridged Approach to Inclusive Sanitation” or “BAIS”.
1
2
9
10
With the 10 steps of BAIS, we can plan for CWIS comprehensively and inclusively.

07

Applicability of the Bridged Approach in India

> **Policy alone does not drive change, the systems, budgets and human resources need to be in place to scale CWIS**
>
> ***– Roshan Shrestha***

Section 7.1 is an adapted version of Box 4.3 in: Schertenleib, R., Lüthi, C., Panesar, A., Büürma, M., Kapur, D., Narayan, A. S., Pres, A., Salian, P., Spuhler, D., and Tempel, A. (2021). A Sanitation Journey – Principles, Approaches & Tools for Urban Sanitation. Dubendorf: Sustainable Sanitation Alliance. The contents of the original version of this section were jointly conceptualised, analysed and written by A.S.N, D.S. and D.K. Validation of these challenges with stakeholders was done by D.K. The adapted version of this section to CWIS and BAIS is done by A.S.N.

Section 7.2 on the CWIS Planning Framework application in India has been published in part in: Narayan, A. S., Maurer, M., and Luthi, C. (2021b). The Clean Plan - Analysing sanitation planning in India using the CWIS Planning Framework. J. Water Sanit. Hyg. Dev. doi.org/10.2166/washdev.2021.130.

Box 7.1 has been previously published as a factsheet in: Schertenleib, R., Luthi, C., Panesar, A., Büürma, M., Kapur, D., Narayan, A.S., Pres, A., Salian, P., Spuhler, D. and Tempel, A., 2021. A Sanitation Journey-Principles, Approaches & Tools for Urban Sanitation. Sustainable Sanitation Alliance (SuSanA), GIZ Sector Programme Sustainable Sanitation, Eawag-Sandec, Bonn, Germany and Dübendorf, Switzerland. This factsheet has been conceptualised and written by A.S.N.

While the Bridged Approach to Inclusive Sanitation (BAIS) is provided in a generic format that could potentially be applicable in any urban sanitation context, in this thesis, a reflective discussion on its applicability is made with respect to India. Sanitation planning in Indian cities as explained in Chapters 2, 3, and 4, is complex and any new planning approach or decision support tool faces challenges in its uptake and usage. This section therefore captures few of these challenges, explores how the CWIS planning framework can overcome the barriers to sanitation planning that were identified, provide drivers and barriers for each of the steps in BAIS and finally explore an enabling environment for CWIS.

7.1 Challenges for the uptake of BAIS and related CWIS approaches

Generally, all sanitation planning approaches and tools face challenges in their uptake due a variety of inherent reasons that include – (i) complexity and usability, (ii) ability to meet desired planning outputs, (iii) data requirements, (iv) time and resource requirements and, (v) customisability. In addition to these, there are significant contextual challenges that hinder their uptake in specific contexts. In the case of India, despite the existence of several novel sanitation approaches and tools that suit a wide variety of contextual needs, most are not organically taken up or commonly used. With the few exceptions such as the SFDs, most sanitation planning approaches and tools that have been (widely) used in India owe their success to the financial and technical support from their developers and promoters. Based on the broad set of challenges identified by Schertenleib et al., (2021), specific challenges relevant to the uptake of CWIS and BAIS in India are:

7.1.1 Leadership challenges

- CWIS brings about significant change to the conventional approach to sanitation and therefore needs strong support from the political and bureaucratic leadership, since this also affects the standard procedures of their functioning.
- Strong project leadership is needed to ensure that joint decisions are followed by action. Especially post the planning process (using BAIS), the sanitation task force must see to the conversion of the plans into implementation.
- BAIS requires political will from officials to prioritise sanitation planning process to build stakeholder trust and gain access to data, which is otherwise publicly unavailable.

7.1.2 Resource challenges

- BAIS requires significant financial and human resources for the entire planning process, in addition to the strong commitment and involvement of stakeholders at all levels.
- Granular data is required to make informed decisions about providing a mix of technological and business solutions.
- Co-production of knowledge for the detailed diagnostics required is also time, stakeholder and cost intensive.
- Time constraints affect the uptake, since BAIS and most of the related tools and guidelines, despite their significance, take up more time than conventional top-down utility led planning.

7.1.3 Capacity challenges

- The availability of expert skills for facilitation to make sure that all stakeholders understand the process and its results and that the stakeholder demands are well understood and effectively translated into the final CWIS plan.
- An enabling environment for the planning process where structured, comprehensive, and inclusive planning, as suggested by the bridged approach, is accepted as a separate goal.
- The degree of organisation of the community for its effective engagement in the planning project.
- Capacity development of local planners to make sure that the use of BAIS and/or related planning tools are not part of the normal curricula of municipal officials.

7.1.4 Contextual Challenges

- Contextualisation of the CWIS principles to local conditions and embedding them in the existing institutional framework requires: (i) understanding of local needs, (ii) balancing site-specific plans and citywide master plans, (iii) balancing needs of top and bottom stakeholders, (iv) coordination with other sectors and their departments, and (v) capacity development for CWIS contextualisation.
- Keeping the plans alive with constant updating. Since the plans are meant to be incremental, the plans need to be updated with these developments.
- Navigating a plethora of sanitation planning and decision support tools, many of them providing similar services (for example., CWIS costing tools developed by multiple development agencies).
- Confusion from programmes that are promoted by the same international agencies, which sometimes have overlapping or competing goals (for example, water wise cities, water sensitive urban design or climate sensitive urban sanitation etc).

7.1.5 Institutional Challenges

- The stability of the institutional setting and staff. The constant transfer of trained staff creates the lack of availability of skilled planners and continuity in sanitation programmes.
- Linking CWIS plans resulting from BAIS to modular investment opportunities for creating incremental improvements.
- Coordination with relevant synergistic departments and agencies to identify joint projects (for example, integrating stormwater drainage and sewerage needs coordination from multiple departments in India).

7.2 CWIS Planning Framework application in India

Prime Minister Narendra Modi stated *"To reach India's sanitation goals, we need 4Ps – Political Leadership, Public Funding, Partnerships and People's Participation"*. There is a need for a fifth 'P' - Planning. In order to achieve the operational outcomes and functional linkages of CWIS in India, comprehensive planning is necessary. Based on the 4S pillars provided in the CWIS Planning Framework (Chapter 5) and the qualitative analysis of sanitation planning in India (Chapter 4), overarching ways forward to overcome these barriers are identified and provided below as recommendations.

7.2.1 Situational Analysis

In India, there is a lack of planning capacity in terms of human and financial resources allocated for analysing the local situation and its unique context. This requires a systematic methodology that places situational analysis as an initial step. Such detailed information helps create advocacy for political will and community acceptance. Tools that aid in analysing the local context greatly reduce the time and money otherwise spent at this stage, and support the existing capacities for planning (Schertenleib et al., 2021). Bottom-up sanitation planning practices in particular have been proven to generate detailed knowledge on the local context through co-production in India (Narayanan et al., 2017). Situational analysis also provides the data which forms the basis for setting targets for the operational outcomes for CWIS (step 6 in BAIS). However, in order to conduct a detailed analysis, targeted capacity development programmes for public sector workers and private consultants are key (Dash and Kapur, 2021). Overall, these steps help address aspects of community participation, political will and planning capacities that were earlier identified in section 5.5 as barriers to sanitation planning in India.

7.2.2 Stakeholder Participation

Community and stakeholder participation were mentioned by more than half of the stakeholders interviewed on sanitation planning in India, as a crucial aspect of successful since it allows incorporation of local knowledge and improves acceptance. However, most interviewed community-based organisations did not report meaningful participation as common practice in the four cities. The few cases that reported involvement of local stakeholders in sanitation planning were NGOs in the secondary cities of Coimbatore and Mysore, where the sanitation situation is also seen to be faring better (Table 5.1). Sanitary workers, who are a primary stakeholder, are almost always excluded from planning, which leads to inequitable decisions having detrimental effects for social, public and environmental health (Sharada Prasad and Ray, 2019).

Community-based organisations have already been recognised as a catalyst in bringing various stakeholders together and recommended in India through national policy documents (UMC, 2019). However, a planning approach that clearly emphasises this, such as the CSP with its city sanitation task force, needs to be implemented in spirit and not merely remain a checklist item. Further, social specialists and institutional special purpose vehicles[19], are required to coordinate and build consensus during such stakeholder intensive planning process. This step helps enhance ownership, community involvement, and political will since it directly engages the public, thereby making sanitation a high visibility issue.

[19] A governmental multi-institution coordination agency working towards a specific, clearly defined purpose. This is popularly used in the Indian government.

7.2.3 Synergy with other sectors

One of the reasons for poor coordination that was identified as a key barrier to sanitation planning in section 5.5, is the jurisdictional overlap between various agencies, which happens because of the crosscutting nature of sanitation. Coordination is required horizontally; within the sanitation service chain, for example, training masons to use the standardised septic tank designs or planning monitoring mechanisms to ensure that the private vacuum truck operators dispose faecal waste only at the treatment sites (Dash and Kapur, 2021; Sharada Prasad and Ray, 2019). Coordination vertically with other basic services such as water supply, storm water and solid waste management would also be pertinent for achieving safe sanitation (Narayan et al., 2021; Scott et al., 2019). For example, planning flush toilets in areas with intermittent water supply or designing small-bore sewers in areas with poor solid waste management will hinder the functionality of the sanitation systems. The NUSP already highlights collaborative planning with the aforementioned sectors, and should be brought to practice (GoI, 2008).

Stakeholders from the National Government that were interviewed, reported that such an integrated approach could benefit from lesser financial needs due to the gains of synergistic planning, opportunity to tap funds from varying sources and receive higher priority in fund allocation. However, further research is needed to provide evidence for the gains from such synergistic planning. While the planning process is encouraged to be integrated, the implementation could still function as per the existing institutional set-up as long as coordination between the relevant institutions is strengthened. Integrated planning reduces the number of interfaces for the stakeholders, but increases the planning complexity and need for policy changes geared towards planning CWIS. Through this step, two of the barriers that were identified earlier i.e., coordination and financial support could be overcome.

7.2.4 Strategy for long term

Although political support was listed as a crucial factor by most of the stakeholders interviewed, sanitation planning has to take a longer-term view compared to the five-year election cycles in India. According to stakeholders who identified scheme-based approach as a key barrier to sanitation planning, reasoned that schemes exist due to the short-term political vision, and are a reason for lack of planning incremental sanitation and a lack of institutional strengthening in the sector in India. Scheme-based setting of targets and financing could be beneficial for a mission mode of operation, such as the SBM which set the goal of eliminating open defaecation. However, schemes have a tunnel vision, and in the past, total sanitation schemes in India have fizzled out at the onset of competing priorities (Hueso and Bell, 2013). Even the flagship SBM fell short in managing the other parts of the sanitation service chain since it focussed only on the construction of toilets.

CWIS requires planning clear accountability mechanisms, a service model that considers an optimal mix of technologies, and private sector partnerships which in turn enhances financial sustainability. CWIS plans based on the above framework must be flexible to address emerging social and natural issues such as equity and climate change, in order to remain relevant despite changes in political priorities. By strategising for the long-term and being flexible, some of the barriers identified in section 5.5, such as the scheme-based approach could be overcome, and potentially gain political support since planning traverses political timelines.

7.3 Drivers and Barriers for the Bridged Approach in India

While the overarching barriers for sanitation planning could be addressed through CWIS Planning Framework, there are specific drivers and barriers associated with each of the steps in BAIS. The important drivers and barriers among many others corresponding to each of these are mentioned in Table 7.1. Many of these barriers are crosscutting in nature and may spill over into each other.

Table 7.1: Drivers and Barriers corresponding to each of these steps.

Steps in BAIS	DRIVERS	BARRIERS
1. Preliminary Context Analysis	• Tools for this step, such as SFD are widely used in India. • Mega cities in India have extensive data. • All cities in India have basic sanitation data as part of the national census.	• Needs initial funding to even begin this process for advocating further funding. • Despite the existence of data, they are often unreliable, outdated and not disaggregated for use.
2. Demand Generation	• Political will for sanitation exists at the national level with the Swachh Bharat Mission (SBM). • Historical evidence on success of demand based sanitation services in parts of urban India.	• City and state governments could have competing priorities, especially if politically misaligned with national government. • Access of top-level stakeholders is difficult • Advocacy with user groups needs insider support and access from gatekeepers.
3. Sanitation Task Force	• CSP process as part of NUSP already prescribes such a task force (See Box 7.1). • Conventionally existing Special Purpose Vehicles (SPVs) can function complimentarily with the task force.	• Committed participation from task force members difficult to enforce. • In SBM 2.0, stakeholder involvement in the high powered committee is absent in the guidelines. • Powerless task force is merely a checklist item.
4. Planning Methodology	• Clarifying boundaries and steps involved makes the stakeholders informed. • Bureaucrats and local Administrators benefit from clear planning.	• Too many tools and guidelines could be confusing. • Needs capacities and expertise from multiple disciplines including planning. • Overlapping jurisdictions.
5. Detailed Diagnostics	• Generates useful primary data. • In line with previous sanitation policies such as the NUSP.	• Requires time, money and expertise to make good diagnostics. • Coproduction with stakeholders needs time and effort.

6. Operationalise CWIS Targets	• Tangible results framework makes the procurement process easier to monitor.	• Quantifying all the CWIS principles and targets is not easy. • Needs multi-disciplinary expertise.
7. Detailed Optioneering	• A technocratic approach, therefore easier to execute.	• Mental barriers to consider non-conventional technologies.
8. Consultative Evaluation	• Individual stakeholder engagement process makes preference elicitation easier. • Increases individual buy-in from various stakeholders.	• Ensuring transparency in evaluation is often not easy. • Creating a systematic evaluation framework including complex weighting is difficult. • Reconciling with reported differences.
9. Town Hall	• Democratic process is appreciated by all stakeholders. • Town halls common in India for urban projects in big cities. • In line with SBM being hailed as "jan andolan" or people's movement.	• Creating consensus and a unified vision in limited time is unlikely. • Managing the power dynamics between various stakeholder groups is difficult. • Ensuring equitable representation, especially in big cities is difficult.
10. CWIS Action Plan	• In line with the Detailed Project Report (DPR) format, that is convention in administration in India. • In line with the established schematic approach to funding in India.	• Action Plans need constant updating. • Tying action plans to funding mechanisms is difficult and opportunity dependent. • Monitoring the implementation and managing the big picture needs effort and buy in.

7.4 CWIS in relation to CSP and CSAP

As seen in the earlier chapters exploring the India urban sanitation sector (Chapters 2, 3 and 4), the policies concerning them are often well developed and have placed planning prominently. Despite the policy directions and availability of theoretical foundations, India, similar to many countries worldwide, has a lack of putting them into practice (Joy and Bhagat, 2016; Starkl et al., 2013). While Chapter 5 has addressed these in detail, it is worthwhile reflecting on where CWIS and the BAIS fit within the sanitation (planning) policy space in India.

Box 7.1 explains in detail about the City Sanitation Plan (CSP) process as part of the National Urban Sanitation Policy (NUSP), which is a comprehensive planning framework. However, CSPs still lacked the full scope of CWIS and missed operationalising the principles of equity and mix of business models, both of which are critical to achieve the SDGs. The CWIS planning framework on the other hand, clearly sets out the objectives of sanitation planning that is in line with the SDGs and the latest development in the global urban sanitation sector i.e., the CWIS principles. CSPs were completely procedural and

lacked substantive aspects that could be customised to the contextual needs. The CWIS Planning Framework on the contrary begins with a theoretical backing based on which the hybrid (substantive-procedural) Bridged Approach is developed.

The sanitation landscape in India is complex and rapidly changing. During the thesis writing process, the Swachh Bharat Mission 2.0 was launched along with its Operation Guidelines, which supersedes the existing NUSP and the CSP process. Herewith, it introduces the "City Sanitation Action Plan" (CSAP) mandate for all cities to focus on preparing a bureaucratic gap analysis of sanitation infrastructure at the latrine and the wastewater management levels.[20] It has several synergies with the proposed CWIS planning framework. There is a strong approach to use of a mix of technologies in the same city (but still with the long-term vision of 100% sewers). There is a strong push for private sector involvement through Public-Private Partnerships (PPP). Solid Waste is included as part of the SBM 2.0 strategy. Co-treatment and resource recovery are prescribed wherever applicable. There are high-powered committees to oversee the planning and implementation process of the mission, however they lack the involvement of non-governmental stakeholders.

The inclusion of CWIS, its planning framework and the BAIS will certainly strengthen the SBM 2.0 strategy in making the country's urban sanitation sector more sustainable and equitable. It could be carried out without any major disruptions to the current strategy, since it only compliments the operational guidelines. Such a situation where the sanitation policy is progressive and the sectoral environment is enabling for an ambitious approach, such as CWIS, to be incorporated has never occurred in India until now. Therefore, this opportune moment must be leveraged for scaling CWIS in India.

7.5 Enabling Environment for BAIS

In the last decade, the Indian sanitation sector has witnessed an evolution with progressive policies, national level funding, political support and the world's largest sanitation campaign. In spite of these and a national urban sanitation policy mandating local authorities to prepare city sanitation plan, urban sanitation systems are generally poorly planned. With the advent of CWIS, multiple targets are explicitly placed for operational outcomes and functional linkages, which requires comprehensive planning that bridges technocratic, bureaucratic and democratic approaches. Although CWIS is widely accepted as the way forward towards achieving the urban sanitation SDGs, the complexity of planning CWIS in India remains to be a challenge. Most of the barriers to sanitation planning through the case studies stem from a fundamental lack of priority given to it at the national, state and city levels.

While the CWIS Planning Framework and BAIS overcomes the barrier of a lack of a planning framework identified in Chapter 4, their uptake needs an enabling environment at the city, state and national levels. The aspects of the enabling environment required for sanitation planning adapted from CLUES are: (i) political will, (ii) institutional support, (iii) policy and regulations, (iv) long-term financing, (v) planning capacities, and (vi) socio-cultural acceptance (Lüthi et al., 2011). (Figure 7.1).

[20] In the Swachh Bharat Mission, the focus is now going towards safe management of the entire value chain. Wastewater treatment is referred to as usedwater management.

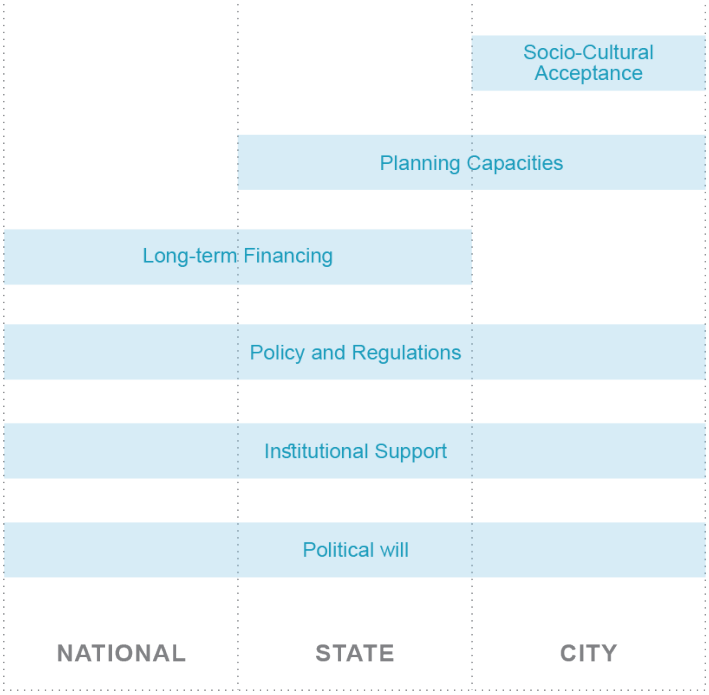


Figure 7.1 - Enabling Environment at various levels for Bridged Approach to CWIS Planning

Political will at all governing levels is essential for the uptake of CWIS and BAIS, especially since these approaches deviate from standard urban sanitation planning practices. In order to do this, advocacy programmes from national and international organisations are helpful. Existing initiatives such as the Tamil Nadu Urban Sanitation Support Programme, INK@WASH by Administrative Staff College of India (ASCI) and Government of Telangana, the Bill and Melinda Gates Foundation's partnerships[21] in urban sanitation with Governments of Maharashtra, Telangana, and Orissa are already providing support for the CWIS initiative.

Institutional support is required at all levels in order to plan and implement the CWIS approach. This begins with institutional strengthening in terms of human capacities, financial and technical resources to follow the BAIS planning methodology. For example, generating good baseline data and maintaining records needs institutional support. Capacity development programmes such as the efforts from the National Institute of Urban Affair's Sanitation Capacity Building Platform (SCBP) (Dash and Kapur, 2021) and Eawag's ConCaD programme are examples of strengthening institutional capacities in India.

Policy alignment with CWIS is perhaps the one aspect of the enabling environment that needs least effort in the case of India. As seen in section 7.4, the existing policies at the National level, such as NUSP are already comprehensive and accommodative of the CWIS approach and the BAIS methodology. Regulations at the city level on the other hand, might challenge the steps in BAIS such as the delegation of powers to a city sanitation task force. However, with political will these regulations can be easily modified.

Long-term financing is an aspect of the enabling environment that is relevant at the national and state levels, since these are the revenue producing and allocating levels of government in India. As seen in Chapter 5, funding for urban sanitation needs to go beyond schemes and have funds allocated through the mainstream financial commission. In the 2020-21 financial commission, 50% of the funds allocated

[21] See www.gatesfoundation.org/our-work/places/india/sanitation

to urban local bodies (city governments) are conditional, where the funds have to be spent on improving the basic services of ambient air quality, drinking water, and solid waste management (Mehta et al., 2020). Urban sanitation has been left out in this case, and therefore cities are dis-incentivised to prioritise sanitation investments from their allocated funds.

Planning capacities are relevant at the state and city levels, the former is more relevant in secondary cities, which do not have their own planning departments for water and sanitation. This aspect of the enabling environment is the weakest in India, as seen in Chapter 5. As more research goes into scaling CWIS, developing tools for supporting sanitation planning, contextualising and refining BAIS for India, capacity development for planning will become more targeted and easier. However, as seen in Box 6.1, tools and guidelines cannot replace planning capacities. In fact, there needs to be specific trainings for their usage. Fortunately, capacity development programmes for public officials have already begun. For example, an online certificate programme on "Leadership Development for CWIS" was jointly hosted by ASCI and the ADB Institute[22] for senior planners and administrators. However, more systematic integration of urban sanitation and its planning is required in public health, engineering and urban planning curriculums.

Socio-cultural acceptance for CWIS is a critical but an understudied area. There is evidence that city administrators and planners prefer 100% sewered solutions as against a mix of technologies, as seen in Chapter 5. However, there is little understanding of the user expectations and preferences in a situation with a planned mix of technologies (for e.g., will urban residents prefer sewers over septic tanks in India? And will this create unplanned disparities in service outcomes and user experience?). There are also concerns regarding the acceptance of specific CWIS solutions such as scheduled desludging (Mehta et al., 2019) or regular and transparent monitoring of private small-scale sanitation systems (Reymond et al., 2020). In BAIS, with respect to the stakeholder participation, there may be challenges in social acceptance voicing concerns by marginalised communities in an open town hall or arriving at consensus for an intervention. Socio-cultural acceptance is however much more localised at the city level, than all other aspects of the enabling environment.

[22] See www.inkwash.in/asci-adbi/index.php#about

BOX 7.1

City Sanitation Plan from India's National Urban Sanitation Policy

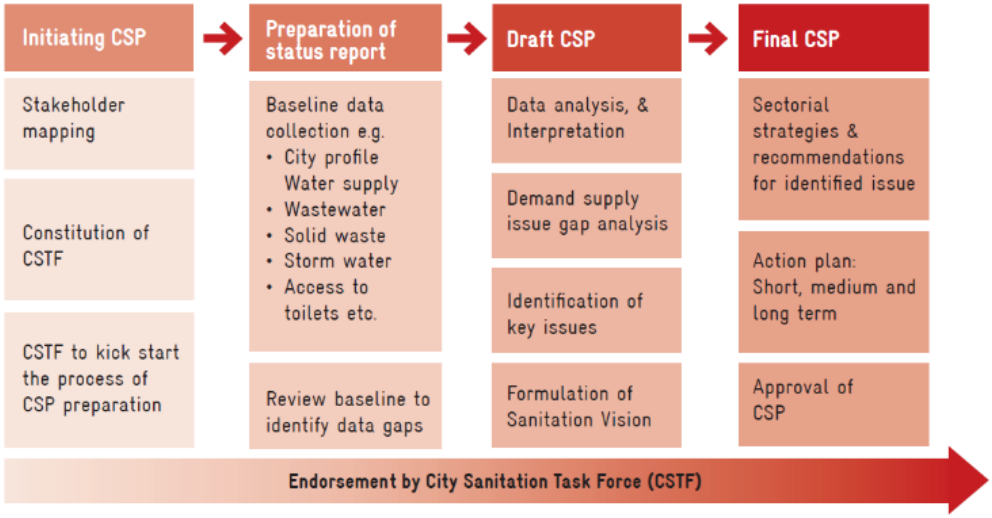


Figure 7.2: Steps of CSP Preparation (GIZ, 2016)

Overview

CSP is a comprehensive citywide planning and decision making framework that consequently includes stakeholders to plan citywide sanitation by prioritising investments and selecting the most viable projects. The CSP process is technology-agnostic and aims to arrive at locally appropriate sanitation systems. CSP's framework is broadly defined and includes a comprehensive list of factors to consider. Therefore, the framework can be adapted to the particular city's needs and aspirations. The technical aspects often include water supply, wastewater, solid waste and drainage. There is no uniform definition of a CSP. Several organisations have developed different concepts. This factsheet is based on the concept applied in India.

Highlights

- The CSP provides a single-point document for the city government to make informed decisions about achieving sustainable sanitation in the city.
- The technical components of a CSP are not just restricted to access to toilets and wastewater and faecal sludge management, but also include water supply, storm water drainage, and solid waste management.
- A comprehensive CSP needs adequate support from the city government for human and financial resources allocated to its preparation and implementation.
- Stakeholder involvement via a City Sanitation Task Force (CSTF) is key. For an effective CSTF, the members have to be carefully chosen, considering their stakeholder group, local and technical knowledge, and, importantly, their commitment towards the process.

Why was it developed?

Although urban sanitation has always been recognised as an important aspect of public and environmental health, there were no clear national policies regarding its implementation in India until the launch of the NUSP. The two main instruments for achieving the policy's goals are the State Sanitation Strategy (SSS) and the City Sanitation Plan (CSP) that translates the national policy into

structured implementation plans for sustainable sanitation at the state and city levels. Since the CSP framework in the NUSP is comprehensive, yet broadly defined, the corresponding support programme (SNUSP) by GIZ published a series of toolkits, training manuals and practical user guides that have been widely taken up. Likewise, with impetus from the national governments of Indonesia and Nepal, CSP frameworks with similar fundamental steps were created, in accordance with the respective country's policies and vision.

What purpose does it serve?

The CSP aims to be cross-sectoral, citywide, inclusive, incremental, and holistic. The City Sanitation Task Force acts as the focal stakeholder group that ensures that the preparation of CSP is inclusive, consultative and iterative. The plans have short, medium and long-term actionable steps, ensuring that an incremental approach is adopted. Understanding the current sanitation situation and projecting future scenarios in the city is emphasised through three stages of baseline data collection for (i) preparatory action, (ii) vision setting and information campaign, and (iii) planning and implementing institutional changes, social mobilisation, and investments. CSPs could potentially catalyse change in the institutional, financial, technical aspects of sanitation, while improving general awareness, capacity development and long-term monitoring agenda.

Current status / practical experiences

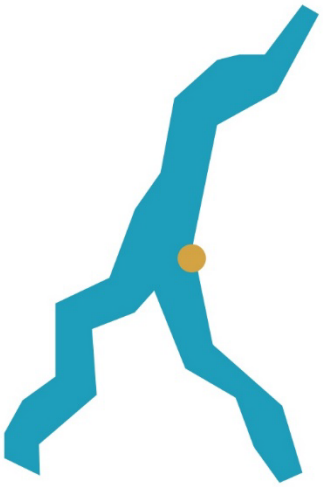
As part of the NUSP, several CSPs for cities across India were commissioned and developed to obtain funding from former national schemes. With the introduction of newer national programmes, such as 'AMRUT' and 'Swachh Barat Mission', CSPs have been replaced with Service Level Improvement Plans, Citywide Concept Plans, and Swachhata City Plans. However, a few states, such as Kerala and Telangana, have institutionalised CSPs through legislative and state level policies. There have been no reports that CSPs in Indonesia and Tanzania have gained any traction once projects, focusing on city sanitation planning, ended in these locations.

Where has it been used

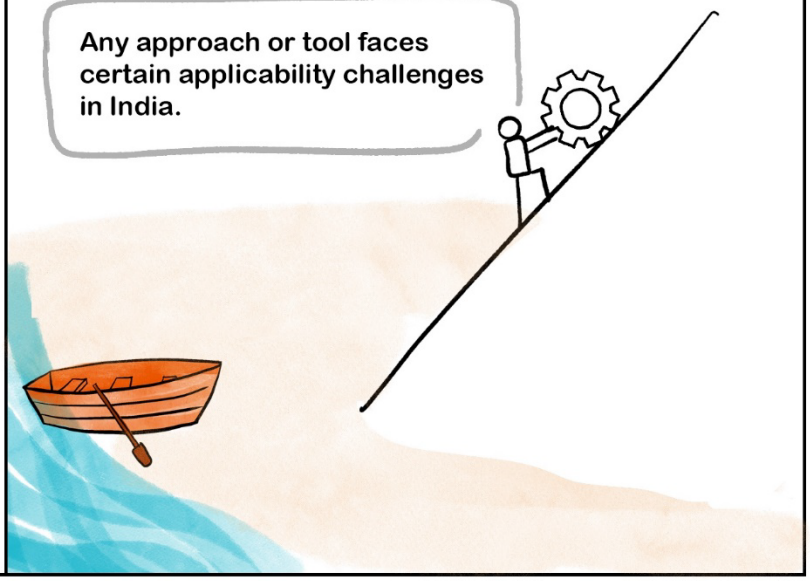
Over 200 CSPs are reported to have been drafted across India. However, far fewer have been formally approved and actively used in making decisions related to sanitation investments. Prominent CSPs in India include Raipur, Kochi, Hoshangabad, and Shimla. Denpasar, Indonesia, Tikapur, Nepal, and Dar as Salam, Tanzania, are other notable international examples.

Discussion

CSPs were aimed as living documents to be used by cities to make informed decisions about sanitation investments. Such blueprint documents require city governments to have adequate technical capacity and to take ownership of the preparation. Due to the lack of both, in many cases the preparation was outsourced to consultants with little or no ownership of city government; hence, the CSP was developed only for checklist purposes limiting the intended benefits of the process itself to catalyse change, capacity development and awareness. A comprehensive CSP needs leadership and adequate funding, time, effort, and expertise for preparation, which are often limiting factors. Some of the successful CSPs have been developed only with external support from international development agencies. In order for the CSP to be useful, it needs to be followed by funding (e.g. from national schemes) for implementation, otherwise it risks being only a reference document.

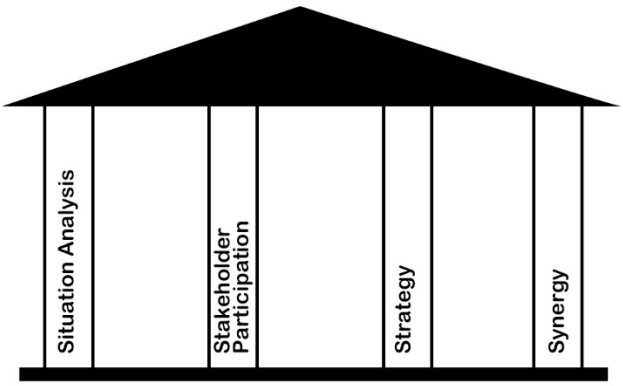


Any approach or tool faces certain applicability challenges in India.

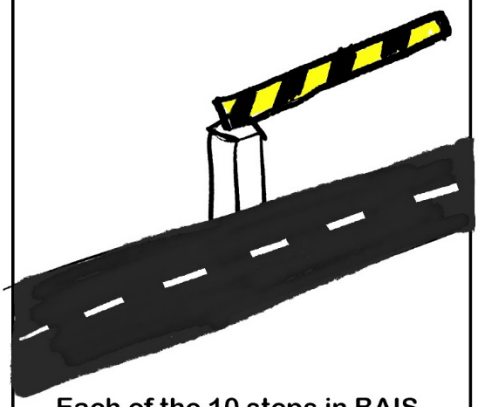


What kind of challenges?

It could be leadership, resource, capacity, institutional or contextual challenges.

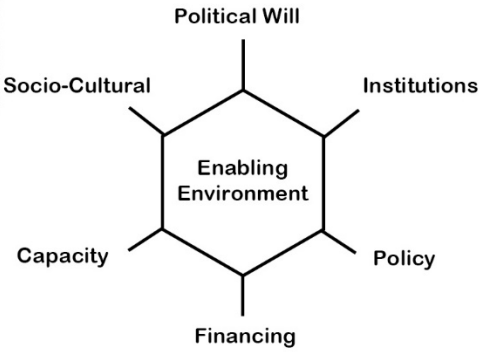


But by using the 4S pillars, we can overcome some of these and the barriers to sanitation planning in India.



Each of the 10 steps in BAIS have drivers and barriers in India.

For CWIS and BAIS to be taken up in India, we need an enabling environment at the National, State and City levels



08

Conclusions

> **No one is safe until everyone is safe. That's why we need the CWIS approach**
>
> ***– Christine Moe***

8.1 Key Findings & Implications

This thesis had a three-pronged approach to answer the research questions of (1) What is CWIS?, (2) What is the urban sanitation situation in India from a planning perspective?, and (3) How can we plan CWIS by bridging top-down and bottom-up approaches?. The key findings and the implications thereof, from each of the research questions are summarised below.

8.1.1 Citywide Inclusive Sanitation (CWIS)

- This research presented the historical context and the recent advancements in urban sanitation that led to the emergence of the CWIS narrative. The evolution of urban sanitation began with the understanding in 1970s-80s that appropriate low-cost technologies are the requirement in the Global South. In the 1990s-early 2000s, urban sanitation approaches were widely acknowledged to be multi-disciplinary and participatory as seen in the Bellagio Principles for sustainable sanitation. The recent advancements in non-sewered, decentralized and resource recovery technologies, in strategic community-involved planning approaches and tools, and the international significance sanitation gained through the ratification of the human right to sanitation and SDGs, created the necessary conditions for the emergence and wide uptake of CWIS.

- CWIS through a collaborative and transdisciplinary approach has been defined as a holistic approach to urban sanitation, and outlined through the six Manila Principles: (i) Equity, (ii) Environmental and Public Health, (iii) Mix of Technologies, (iv) Comprehensive Planning, (v) Monitoring and Accountability, and (vi) Mix of Business Models. These principles are abstract since they can take different forms in different contexts. For each of these six principles, a lighthouse study and a specific research summary provides the necessary context for its operationalisation. In the process, the research has contributed to building consensus on the concept and contributed to capacity development initiatives and advocacy for scaling up CWIS.

- CWIS has gained a high amount of uptake and visibility in the research and practice domain, especially in the international development agencies. Prominent institutions like the World Bank, ADB, AfDB among others have incorporated CWIS in their lending practices to country programmes and have made billions of USD in investments on implementation projects globally under the CWIS label. There are several dedicated education and capacity development programs, and research initiatives geared towards supporting the rising demand for CWIS implementation. These large-scale initiatives mark CWIS as a shift in the paradigm of urban sanitation. However, at this inflection point, evidence of its benefits and practical lessons learned from its implementation is crucial for its eventual scale up and long-term sustenance.

8.1.2 Sanitation in India

- Sanitation in India is a state subject, yet it has historically been governed by various national level laws, policies and schemes. Urban sanitation in India requires political alignment and multi-level coordination between national, state and city governments, without which, it remains a governance problem. Although the constitution calls for devolution of power to the local governments, the national policies and funding schemes currently stifle the implementation flexibility at the local level. These policy and schemes should empower the city governments to plan according to the local needs and be flexible on adoption of sanitation technology. Marginalization based on caste, gender and slums has influenced urban sanitation implementation, such as sanitation worker safety, public and community toilets, and tenure issues related to sanitation provision. This needs to be considered in all future policies and programmes on urban sanitation in India.

- A detailed analysis of the complex urban sanitation landscape of India with a special focus on the alternate sanitation solutions of Faecal Sludge Management (FSM) and Small-Scale Sanitation (SSS) provides evidence for their prominence in the last two decades. While uptake of SSS was triggered by an unintended policy, the FSM policies were triggered by the reality of its uptake. These alternate sanitation solutions have been found to be significantly integrated into the sanitation landscape of the four case studies without the cities having planned for it. Looking ahead, sanitation planning in India could systematically consider FSM and SSS as solutions in their portfolio along with centralised sewers, and provide them institutional, operational and maintenance support.

- The Social Network Analysis (SNA) methodology has been tested to be effective in the fine-grained understanding complex governance systems from a coordination point of view. The novel validation methodology proposed can overcome the challenge of incomplete data and unreliable social network graphs by using expert information systematically elicited from a combination of fewer respondents who are insiders and outsiders to the network. Such an insider-outsider lens also widens the perspective of the SNA and makes it more reflective of the real governance and stakeholder context. This novel validation methodology therefore facilitates the use of SNA in research in data constrained settings, that WASH programming often encounters. SNA is also a useful tool in planning CWIS, where the identification of current institutional actors, marginalised stakeholders, policy entrepreneurs, and advocacy coalitions is important.

- The SNA of the SSS in four Indian cities, using the novel validation methodology that was used due to poor data accessibility, provides clarity on the institutional stakeholders involved in the governance of SSS and further reveals the differences in SSS governance between mega and secondary cities. The visible differences in the network graphs such as the centrality of the stakeholders involved and the overall network density or cohesion are example aspects that are uniquely identified by the SNA. The differences in the institutional set up, community engagement, funding availability, and uptake of SSS that are seen between mega and secondary cities are largely representative of the differences in WASH governance in such cities across India. Using the SNA results, useful changes to the current governance structures could be done to overcome challenges in coordination and monitoring. For example, it is suggested that the utility (in mega cities) and municipal corporation (in secondary cities) are better positioned to monitor SSS than the pollution control boards that currently carry out this activity.

- Sanitation planning in India is recognised for its importance in the National Urban Sanitation Policy's City Sanitation Plan. Yet sanitation planning in India faces significant challenges, especially in the context of CWIS, that arise from a fundamental lack of priority

given to it, at the national, state and city levels. Specifically, eight key barriers to sanitation planning are identified including inadequate planning capacities, poor community involvement, absence of a uniform planning framework, poor coordination, lack of ownership, scheme-based approach, and unreliable political and financial support. These challenges highlight that progressive policies must be followed with adequate ring-fenced human and financial resources for planning, capacity development programmes at the local levels, and changes to the institutional mechanisms where the disconnect between city, state and national levels is addressed.

- This research helps inform the design and implementation of the Swachh Bharat Mission 2.0 which aims to manage the rest of the sanitation value chain (containment to treatment, as opposed to SBM 1.0's toilet infrastructure focus), and the upcoming National Urban Sanitation Policy 2.0. With the prominence of SSS and FSM highlighted, and barriers to sanitation planning analysed and recommendations to overcome them provided in this research, SBM 2.0 and NUSP 2.0 could have a special focus on planning with the incorporation of multiple stakeholders, disciplines and technologies. Overall, the policy can be closely aligned with the CWIS principles that takes a holistic view on sanitation. Such an alignment with CWIS in the national flagship programmes also facilitates strong partnerships with international development agencies on urban sanitation that could bring further financial assistance and sector expertise.

8.1.3 Bridged Approach to Inclusive Sanitation (BAIS)

- Sanitation planning in a top-down or bottom-up approach has its own benefits and limitations in terms of scalability, contextual understanding, resource requirement, community acceptance etc. BAIS fills the long-founded gap of systematically bridging top-down or bottom-up planning approaches. Planning for CWIS requires the multi-dimensional targets of equity, safety, sustainability, responsibility, and accountability to be met. BAIS provides the first comprehensive planning methodology for CWIS. It integrates the consideration of these multi-dimensional targets, and balances the involvement of both top and bottom stakeholders, that other sanitation planning approaches lack.

- BAIS is developed based on the CWIS planning framework that has the operational outcomes and functional linkages outlined in the Manila Principles. It also introduces the 4S pillars of comprehensive planning i.e., situation analysis, stakeholder participation, synergies with other sectors and strategy for long term. It achieves its goal of bridging top-down and bottom-up approaches by systematically integrating the characteristics and corresponding advantages of the two types which the 4S pillars are based on. BAIS also builds on theoretical justifications made in terms of (i) the bridged typology based on planning theory, (ii) the preparatory steps for sanitation planning, (iii) the planning triangle that introduces technocratic, bureaucratic and democratic forms of planning.

- The ten steps of BAIS incorporate the 4S pillars in the entire process. It includes the preparatory steps among which the creation of the task force is crucial since it empowers a group of representative stakeholders to make key decisions on sanitation planning and implementation. The step on detailed diagnostics encourages co-production of knowledge and looks at other interacting sectors, such as water supply and solid waste, in identifying

synergies. The step of operationalising CWIS targets considers the multi-dimensional aspects mentioned in the CWIS planning framework. The iterative steps of stakeholder consultation and evaluation leads to a CWIS action plan that is modular and geared towards incremental implementation. BAIS does not include any steps beyond the creation of an action plan, although the task force created as part of the planning process could continue to be involved in implementation and monitoring.

- BAIS is a comprehensive planning process that requires adequate resources and expertise in planning. Since BAIS relies on the enabling environment and the willingness of a city to invest in detailed sanitation planning, in its current state it may better suit a supply-led sanitation planning programme by a national government or an international development agency than an organic uptake by a city government. However, in cases where urban sanitation is already prioritised by the city and further advocacy not needed, and if the process is led by an expert planner, sanitation planning is likely to be carried out well, and the use of BAIS only marginally enhances it but aligns it specifically towards CWIS.

- BAIS encounters issues of planning capacity, process costs, political will, good quality data, community acceptance etc., and does not directly offer ways to overcome these challenges. The only step that may help these issues is demand generation, which takes an undefined amount of time and its success highly contextual therefore, not guaranteed. Similarly, the sanitation task force unless constituted by a right mix of involved representatives and given adequate authority over the process, may remain a checklist item with no meaningful contribution. Finally, the last preparatory step that decides the planning methodology and boundary needs to be carried out by experienced professionals who are adept with the latest developments in the sector and are open to testing these in a given case.

- The steps in BAIS are generic and could be adopted to the contextual needs and the degree of stakeholder involvement may vary accordingly. Whether the goal of bridging top-down and bottom-up approaches is achieved, could be judged only based on these contextualised steps and how the stakeholders are involved throughout the planning process. This also depends on the political economy of the city and the vision of planner itself. In many ways BAIS is overly reliant on the skills and expertise of the planner to make the approach reach its goals, which in many contexts may be a significant challenge.

- The 4S pillars of the CWIS planning framework show that it can potentially overcome barriers to sanitation planning in India, that were identified earlier. But it requires political will to influence institutional coordination, develop local capacities and change national funding mechanisms. Each of the ten steps of BAIS has its drivers such as alignment with SBM 2.0, and barriers such as financial resources required for planning and monitoring. In India, BAIS provides an opportunity to leverage sanitation, which is already a flagship agenda, for making progress in other urban development aspects including housing, circular economy, and municipal governance, which currently are not priority agendas for the government. BAIS and CWIS at large needs an enabling environment at the national, state and city levels for its adoption towards sustainable and equitable urban sanitation in India.

8.2 Reflections on the Research Limitations

Despite the broad and transdisciplinary nature of the study, the research work presented in this thesis is subject to certain limitations. They are as follows:

- CWIS is a highly complex, vast and abstract topic. Although this research tried to address some of its foundations, the topic still has several unanswered questions. Most of the justification provided relies on primary expert provided data, but it lacks direct implementation and operational evidence of CWIS in the real world. Unfortunately, during the duration of this research, such practical evidence on the implementation of CWIS was scarce. However, this is changing fast.
- BAIS is arrived from an inductive approach to theory development. Its drivers and barriers are analysed with primary data from India. However, BAIS has not been empirically validated in a real case study yet, which is a limitation.
- Although the ten steps of BAIS have been clearly described and structured, they are not adequately complimented with guidance materials and tools. Therefore, their ease of use and practicality in the real world in its current form is limited.
- The research has three distinct research questions on CWIS, India and BAIS. Although the research objectives are inter-related, due to the independent publications that the thesis draws from, there may be limited integration of these three objectives in the individual chapters.

8.3 Future Research

This research is a first attempt to explore CWIS and develop theories and methodologies on it. This experience however points towards several directions for future research. Few of the many interesting research possibilities are:

- Case studies of CWIS implementation to understand the complexities and practical challenges in the real world. This needs to be pursued through a multi-disciplinary and transdisciplinary approach.
- Research on each of the CWIS principles –
    - How to put equity into practice? Moreover, how to measure and monitor it in various contexts?
    - What are the cost-benefits of investments in environmental health? How can they be quantified?
    - How can we systematically integrate a mix of technologies in a city's sanitation plan? How can we determine the degree of scales sanitation systems in such a mix?
    - How can we embed sanitation plans into a city's larger urban development agenda? How can water supply, solid waste management, stormwater drainage, and climate goals be achieved by leveraging sanitation and vice versa?
    - How can we innovatively monitor and regulate a mix of business and service models in terms of the CWIS planning framework's functional linkages of equity, safety, sustainability and accountability?
    - Why does the market need to be regulated for the involvement of the private sector? How can such a market regulation be designed?

- Process tracing method to understand planning methodologies currently being used for CWIS and their individual principles.
- Empirical validation of BAIS in various contexts such as small towns, mega cities, India, South Asia, Sub-Saharan Africa, Latin America etc.
- Development of a detailed urban sanitation diagnostic methodology using co-production of local sanitation knowledge by various stakeholders.
- Studies on the enabling environment especially, policy, regulatory and business models for scaling CWIS in India.

8.4 Final Remarks on CWIS

- CWIS is not a universal panacea

CWIS offers a comprehensive perspective of urban sanitation by espousing equity and sustainability in equal measure. It is the much-needed shift in the urban sanitation paradigm, moving away from a infrastructure led approach that often left the urban poor and the marginalised behind. However, CWIS is not a universal panacea. It does not have all the answers to the harsh realities in the cities of India or elsewhere. We need to look beyond just sanitation; but leverage sanitation to achieve other important outcomes in water, waste, climate, nutrition, health and more.

- Further Research on CWIS is essential

CWIS has come a long way in the short span since its conceptualisation. But it is far from being fully understood or practised. From its nascent stage, CWIS needs the support of more fundamental sanitation research that helps provide evidence of why this holistic approach is better than conventional and importantly, how this can be applied in practice. Without such compelling evidence, urban sanitation programming may revert to its conventional form of top-down infrastructure focused approach with little consideration of the service outcomes mentioned in the CWIS planning framework

- CWIS is an approach, not a state

No single city is likely to accomplish all outcomes that the CWIS principles envisage. But the CWIS approach provides a direction for progress and a framework to align urban sanitation developments. Cities that follow this approach will need constant development to keep pace with the urbanisation and climate instabilities looming our futures.

- Scaling up CWIS needs an ecosystem

CWIS is not a one-person or even a one-agency task. It needs an entire ecosystem for it to scale up. Advocacy and capacity development are needed in the public sector that governs sanitation, and the private sector that provides services for it. A multi-disciplinary training on CWIS should be provided to the next generation of sanitation engineers and planners. Moreover, sanitation will need to be accepted as a field that requires multi-disciplinary professionals. Continued development of robust and cost-effective technologies and technical know-hows are required for the sanitation value chain.

- Support is required for CWIS transitions

There is a reason why governments like well-established centralised systems – evidence that it works and clear guidelines on how to keep it working. Local governments need the same kind of evidence and guidelines to enable the transition towards CWIS. This includes information on how regulations and policies can facilitate incremental uptake of sustainable non-sewered and decentralised systems. It also requires appropriate standards to measure performance of service providers. The governance arrangement, and operations and maintenance of a mix of sanitation technologies and services also have to be researched further.

- Creating a Sanitation Economy needs a Public Economy

Sanitation is a public service that can be augmented, but not replaced by the private sector. In order to bring safely managed sanitation to billions of people, we need billions of dollars to go into sanitation markets to incentivise the creation of the sanitation (circular) economy. This must come from the public economy since it is a public good.

- Prevent "CWIS-washing"

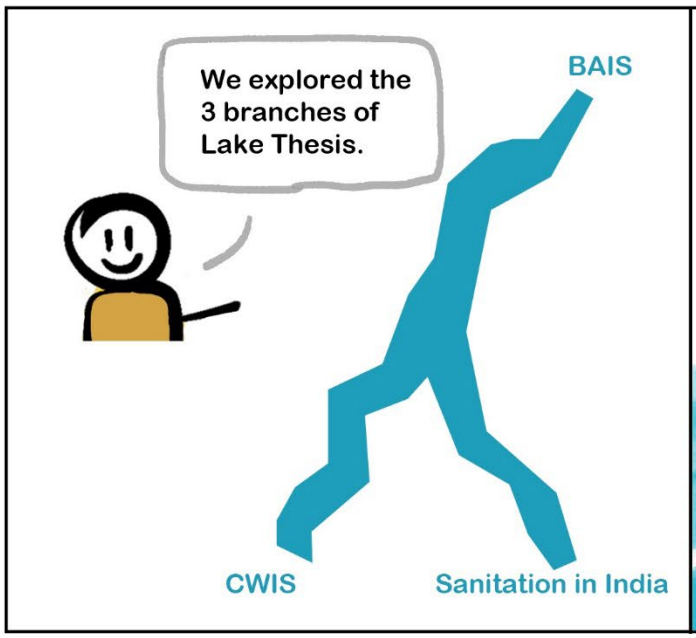
CWIS has attracted a lot of attention to the sanitation sector due to its progressive thinking. However, we need to be careful to not stamp every new (and past) project in urban sanitation with the CWIS label. There needs to be agreement on the minimum requirements for a project to be called CWIS.

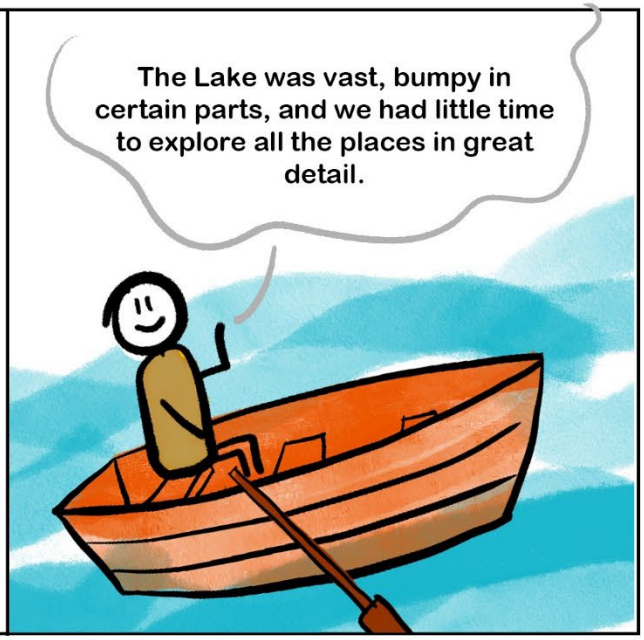
- Bridge the gap between Science and Practice

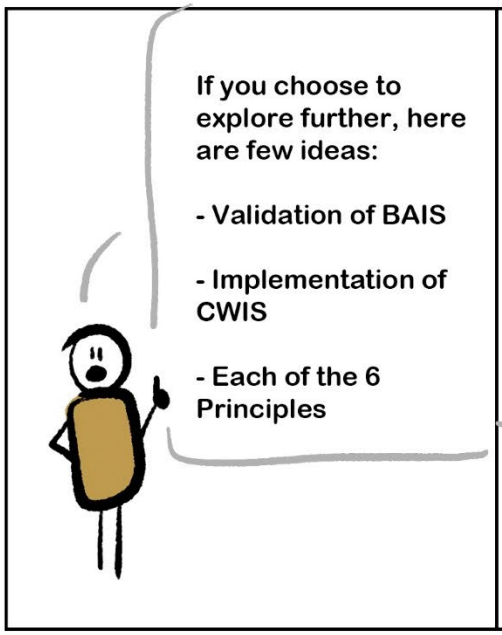
The conceptualisation and the evolution of CWIS is evidence that when scientists and practitioners come together, critical problems can be solved equitably and sustainably (at least create a blueprint for a solution). The conversation around CWIS must remain inclusive and regular lookbacks, learnings, innovations, must be shared between the imaginary walls of science and practice. With regular coordination and feedback, the CWIS agenda can move forward at great lengths swiftly.

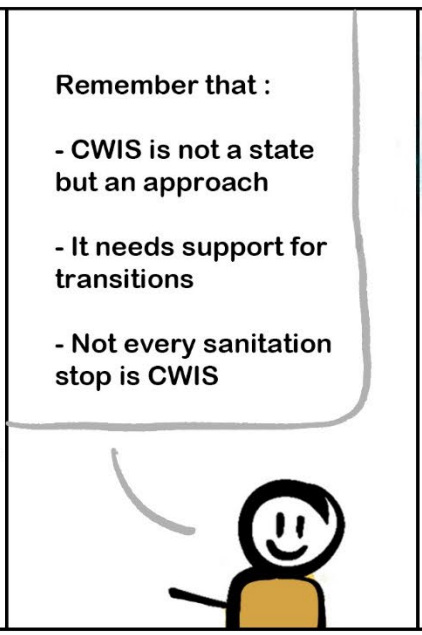
With all these reflections, my outlook remains that CWIS can indeed become the new 'business as usual' and then we will have finally arrived at the new sanitary paradigm that CWIS promises.


Our short boat ride through Lake Thesis finishes here.
Thanks for joining !


We explored the 3 branches of Lake Thesis.
BAIS
CWIS
Sanitation in India


The Lake was vast, bumpy in certain parts, and we had little time to explore all the places in great detail.


If you choose to explore further, here are few ideas:
- Validation of BAIS
- Implementation of CWIS
- Each of the 6 Principles


Remember that :
- CWIS is not a state but an approach
- It needs support for transitions
- Not every sanitation stop is CWIS


See you next time on another boat ride!

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EDUCATION

ETH Zürich 2018 - 2022
Switzerland

- (PhD) in Environmental Engineering
- Topic: Planning Citywide Inclusive Sanitation

Oxford University 2016 – 2017
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- MSc in Water Science, Policy and Management
- Graduated with overall distinction and Best Master Thesis Award

Anna University 2012 – 2016
India

- BTech in Chemical Engineering
- Graduated with overall distinction and Best Outgoing Student Award

EXPERIENCE

Eawag-Sandec 2018 – 2022
Switzerland

- Doctoral Researcher
- WASH projects in South Asia and Sub-Saharan Africa

World Bank 2020 – 2022
United States

- Consultant on urban sanitation at the Water Global Practice
- Conducted a portfolio review of CWIS projects

UNESCO-IHE Delft 2019 – 2021
Netherlands

- Guest Lecturer for the MSc non-sewered sanitation
- Delivered similar courses and lectures at ETHZ, EPFL, TU Berlin and Oxford University

HONOURS

- Green Talent Award 2021 from the German Ministry of Science and Research
- Leader of Tomorrow Award 2021 from the St.Gallen Symposium
- Junior Researcher Award 2020 from the Swiss Humanitarian Aid
- Unleash Talent 2019 from Unleash Global Innovation Lab
- Commonwealth Scholarship 2016 from the UK Government

ACTIVITIES

- Swiss Water Partnership – Youth Management Committee and Steering Board Member
- Sustainable Sanitation Alliance – Working Group Lead and Core Committee Member
- Water Science Policy – Advisory Board and Contributor
- World Economic Forum – Global Shaper at the Zurich Hub
- Eawag – Co-Organizer of Science to Policy and Practice Discussion Series