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Rationality and Reality

A multi-perspective analysis of factors enabling and hampering the use of monitoring data in Ethiopian town water supply

Marieke Adank

Rationality and Reality
A multi-perspective analysis of factors enabling and hampering the use of
monitoring data in Ethiopian town water supply

Rationaliteit en realiteit
Een multiperspectiefanalyse van factoren die het gebruik van monitoring data in
kleinstedelijke watervoorziening in Ethiopia mogelijk maken of belemmeren

Thesis

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EXECUTIVE SUMMARY

Background and problem statement

Data volumes have grown considerably since the onset of the ‘information age’ in the late 1940s, enabled by technological developments and growing interest in performance monitoring and evidence-based decision-making driven by New Public Management principles.

In line with these trends, substantial volumes of water supply data are being produced and made available to decision makers and the general public. Water service providers produce asset and operational data as part of their day-to-day management responsibilities. Utilities increasingly convert data into performance data on specific indicators, facilitated by global initiatives and digitalisation. National-level water supply monitoring systems have been developed, especially in low- and middle-income countries, supported by development partners following Aid Effectiveness principles.

Despite large and growing data volumes and recognised importance of data use, literature on actual data use and studies of factors that enable and hamper data use in the water supply sector are scarce. There is growing suspicion that these data are often underused, raising questions about what factors enable and hamper data use. Better understanding of these factors is key to ensuring that produced data actually inform planning, decision-making, and learning.

Research approach and methodology

This thesis examined the use of monitoring data in town water supply in Ethiopia through a comprehensive case study approach. Ethiopia was selected as a typical case of a resource-constrained country where multiple monitoring initiatives resulted in different town water supply monitoring systems with overlapping objectives.

The central research question was: “How is monitoring data used in town water supply in Ethiopia, and what are the factors that enable or hamper this?” This central question was addressed through four specific research questions:

1. What are the different data use cases for town water supply monitoring data in Ethiopia? How have these been shaped?
2. How and to what degree are monitoring data actually used?
3. What factors enable or hamper actual monitoring data use? What conditions need to be in place for ensuring use of monitoring data?
4. What are the leverage points for enabling monitoring data use?

The research explored factors that enable and hamper actual data use from four theoretical perspectives:

- **Linear perspective:** With a focus on data characteristics and attributes
- **Relationship perspective:** With a focus on the quality of relationships between data producers and users, based on their structural, relational and cognitive social capital
- **Behaviour systems perspective:** With a focus on individual capacities, motivations, and organisational, sectoral and contextual opportunities for data use, using the Capabilities, Opportunities, Motivations, Behaviour (COM-B) model
- **Comprehensive systems perspective:** Integrates factors from the other three perspectives and uses MICMAC (Matrice d'Impacts croises-multiplication appliquée à un classment, or Cross-impact matrix multiplication applied to classification) structural analysis to identify leverage points

Data collection methods included literature review, review of grey literature and sector documents, review of monitoring data sets, and semi-structured interviews with national, sub-national and local stakeholders.

The monitoring landscape and data use cases

Ethiopia's town water supply monitoring landscape includes several systems at different institutional levels, with complementary, and sometimes overlapping objectives. The following monitoring systems were identified:

- Utility Management Information Systems (MIS) producing asset, operational and performance data;
- A regional utility monitoring and benchmarking system in Tigray Region, referred to in this thesis as the 'Tigray Utility Monitoring System' (TUMS);
- The national WASH Monitoring and Evaluation (M&E) MIS;
- The Performance Indicator & Benchmarking (PI&BM) initiative;
- Production of annual coverage data by the Ministry of Water, Irrigation and Electricity;
- The Joint Monitoring Programme (JMP).

The study identified 20 broad data use cases across six areas (policy-making, operational decision-making, tariff setting, planning, regulation, and reporting for accountability) and three institutional levels (national, sub-national, local), informed by one or multiple data sets.

Development partners played a strong role in shaping monitoring systems. The World Bank strongly influenced PI&BM and the initial development of the WASH M&E MIS, while UNICEF played a key role in operationalising the WASH M&E MIS through the first National WASH Inventory (NWI), and DFID in its further development and the second NWI. This shaped the intended data use cases and the systems components, in terms of indicators, data collection tools and processes, ICT systems and financial frameworks. However, systems components did not always align with explicitly stated objectives.

Despite significant investments, monitoring systems are generally weak and system components do not always enable intended data use. Data collection tools included many variables not linked to indicators, resulting in the classic "Data-Rich, Information-Poor" syndrome.

Actual data use assessment

Actual use of monitoring data to inform decision-making and ensure accountability was observed to be considerably below intended and potential data use. Using an assessment scale adapted from Knott and Wildavsky (1980), the study found that moderate to high data use occurred in only three cases:

- Utilities' operational data use: Moderate use of operational data for decision-making, with utility management using weekly meetings to discuss data and take corrective actions;
- TUMS regulatory use: High use by Tigray Regional Water Bureau for performance regulation through annual utility ranking and rewards;
- Ministry coverage data use: Moderate use for macro-level planning, directly informing baseline and target setting.

Low or no actual use was observed in the other data use cases, including:

- National utility performance data (PI&BM, WASH M&E MIS) were not used despite significant investment;
- JMP data showed no actual use at national level beyond occasional reference;
- Water Boards made little use of performance data for regulatory decisions;
- No systematic data use for downward accountability to water users.

Several cases showed process use rather than data use, where monitoring processes rather than data influenced decisions. For example, the JMP and PI&BM processes, rather than the produced data, informed the inclusion of performance standards in national planning documents.

Data were regularly used for reporting (for upward accountability), but there was limited evidence of rights holders using reported data to hold duty bearers accountable. No reporting for downward accountability was observed.

Enabling and hampering factors analysis

Linear perspective: Data attributes

Under the linear perspective, the data relevance, credibility, comprehensiveness, timeliness, accessibility, and availability of data in accessible formats were assessed for different data use cases. While most data sets were found to be relevant, in terms of content, scale and frequency, credibility and availability of data in accessible formats were the lowest-rated data attributes.

Data attributes were compared with the degree of observed actual data use. Cases with observed actual data use (regardless of the degree of use) were found to involve data with (at least) moderate attributes. However, data attributes could not explain the moderate and low degree of data use in these cases. Data attributes could also not explain lack of actual data use, in data use cases with strong data attributes. In these cases, lack of data use could only be explained by availability of alternative information or by limiting factors other than data attributes.

Overall, looking at the factors that enable and hamper data use from a linear perspective showed that relevant, credible, comprehensive, timely and accessible data are essential for the actual use of data, but having these data in place is no guarantee for actual use.

Relationship perspective: Social capital and networks

Under the relationship perspective, the quality of relationships between data producers and users was assessed for 6 data use cases. This assessment was compared with the observed degree of actual use.

The quality of relationships between data producers and users varied. Quality of relationships was especially low between actors with weak accountability relationships. High-quality relationships were observed in cases in which the data producer and user were the same or very close.

Data use cases with high-quality relationships involved data with strong (moderate to high) attributes. Data use cases with low-quality relationships mainly involved data with low-rated attributes, especially in terms of data credibility, timeliness and availability in appropriate formats.

Overall, the relationship perspective showed that the relationship between data producers and users contributes to the production of usable (reliable, credible, timely, comprehensive, accessible) data and their actual use, but good relationships do not guarantee actual data use.

Behaviour systems perspective: Capacity, motivation and opportunities

Under this perspective, individual capacity, motivation and several organisational, sectoral and contextual opportunities for data use were assessed for different data users involved in the identified data use cases.

Capacities, motivations and especially the opportunities for data use were found to be relatively weak, with low organisational financial capacity, lack of decision support tools, and especially weak data-use systems and incentives for data use.

Comparing the strength of the behaviour system factors with the observed degree of actual use in the different data use cases revealed that actual data use could be explained by the factors of this third perspective for data use cases where other perspectives had not been successful in doing so. It showed that

- Weak individual capacity and motivation have a strong disabling effect on actual data use;
- Weak human and/or financial resources have a strong hampering effect on data use;
- Presence of decision support tools has a weak enabling effect on actual data use;
- Strong sectoral data-use systems, with clear incentives for data use are strong enablers for data use;
- Contextual opportunities for data use related to national culture and political economy can hamper or enable data use.

Overall, it found that motivation and capacity were a condition for enabling data use and that opportunity factors strongly influence actual data use.

Comprehensive systems perspective: Factor interactions and leverage points

The data attributes from the linear perspective, quality of relationships between data producers and users from the relationship perspective, and capacities, motivations and opportunities for data use from the behaviour systems perspective were combined into a fourth perspective on factors that influence data use: the comprehensive systems perspective. Overall, the comprehensive systems perspective showed that taking the factors from the other three perspectives together enabled explaining the degree of observed actual data use in all cases.

Based on the observations from the different data use cases discussed in this thesis, the level of influence of the different factors on each other was assessed. This resulted in a complex network of factors that enabled and hampered data use, either directly, or through the influence on each other.

Using the MICMAC method, political economy, national culture, strength of sectoral data-use systems, and organisational financial capacity for data use were revealed as the factors with the most influence and least dependency on other factors, making them possible leverage factors, with a strong steering potential on the factors that enabled and hampered data use. However, a political economy that stimulates and enables data use was also considered to possibly negatively influence other factors in the network, including data credibility or relevance.

Conclusion

This thesis showed that monitoring systems in Ethiopia display characteristics of ‘isomorphic mimicry’, with the development of elaborate data collection systems that mimic international best practices, but without creating genuine demand for data use.

Key conditions for enabling data use include:

- Accessibility of relevant, credible, comprehensive, timely data in suitable formats
- Good relationships between data producers and users;
- Capacity to use and act on data;
- Above all, motivation to use data supported by strong data-use systems and enabling political economy.

The thesis concludes that **motivation for data use is key**. If data users do not have intrinsic motivation to use data for informing decisions and ensuring accountability, then investing in production of data is a waste of resources. The rational assumption that producing data will automatically lead to its use has proven incorrect.

As a key leverage point, an enabling **political economy** would stimulate motivation for data use and strengthen data-use systems and incentives. This would, in turn, stimulate the allocation of human and financial resources for data use, the procurement and development of decision support tools, and enable good relationships between data producers and users. This would result in the production and use of relevant, credible, accessible, comprehensive, and timely data for informing effective and efficient decision-making and ensuring accountability, ultimately leading to reliable, safe, and accessible water services for all.

Contributions and Implications

This thesis makes several significant contributions:

Comprehensive documentation: This thesis provided a unique complete documentation of data use cases at multiple institutional levels within a single country's town water supply sector.

Multi-Perspective framework: It demonstrated the value of analysing data use through multiple theoretical lenses, showing that comprehensive understanding requires integration of multiple viewpoints.

Factor interrelationship analysis: It presented a unique analysis of the relationships between factors, identifying leverage points rather than just identifying enabling and hampering factors for data use.

Recommendations

For Development Partners: Shift focus from data production to building systems for data use. Integrate monitoring interventions with wider systems strengthening, assess actual demand for data use, and address political economy features that influence motivation.

For Governments: Establish clear data-use systems with roles, responsibilities and incentives. Create accountability frameworks requiring evidence-based decision-making and develop regulatory frameworks that use performance data.

For Utilities: Invest in integrated management information systems serving operational needs, improve data accuracy through better equipment and training, and establish regular data analysis processes.

The research demonstrates that successful monitoring interventions must move beyond technical data production to address the political, institutional and motivational factors that create genuine demand for data use in decision-making and accountability processes.

Limitations and Future Directions

The study had several important limitations that point to future research directions:

Single Case Focus: The focus on Ethiopian town water supply, characterised by weak utilities and limited capacities, may limit generalisability to other contexts with stronger institutions and higher digital maturity. Similar research in other contexts is therefore recommended.

Accountability Data Use: Due to their complexity, accountability data use cases were excluded from the analysis of enabling and hampering factors from the relationship and behaviour systems perspectives.

Subjective Assessment: The rating of factor strengths and influence was conducted by a single researcher, introducing potential bias despite systematic rating frameworks. It is recommended that future research engages participatory approaches, especially for rating factor influence.

Factor Interaction Complexity: The analysis of factor interdependence, while groundbreaking, represents a simplification of complex real-world relationships that, going forward, could benefit from more sophisticated analytical methods.

Temporal Dynamics: The research captured data use at specific points in time but did not track how data use patterns evolve, particularly important given rapid sectoral change.

SAMENVATTING

Achtergrond en probleemstelling

Sinds het begin van het 'informatietijdperk' aan het eind van de jaren veertig is de hoeveelheid data aanzienlijk toegenomen, dankzij technologische ontwikkelingen en een groeiende belangstelling voor prestatiebewaking en empirisch onderbouwde besluitvorming op basis van de principes van New Public Management. In lijn met deze trends worden grote hoeveelheden data over de watervoorziening geproduceerd en beschikbaar gesteld aan besluitvormers en het grote publiek. Drinkwaterleveranciers produceren activa- en operationele data als onderdeel van hun dagelijkse managementverantwoordelijkheden. Nutsbedrijven zetten data steeds vaker om in prestatiedata over specifieke indicatoren, wat wordt vergemakkelijkt door mondiale initiatieven en digitalisering. Er zijn ook nationale systemen voor monitoring van de watervoorziening ontwikkeld, vooral in lage- en middeninkomenslanden, ondersteund door ontwikkelingspartners die de principes van doeltreffende hulp volgen.

Ondanks grote en groeiende datavolumes en het erkende belang van datagebruik, is literatuur over werkelijk datagebruik en studies naar factoren die datagebruik in de watervoorzieningssector mogelijk maken en belemmeren schaars. Er is een groeiend vermoeden dat deze data vaak onderbenut zijn, wat vragen oproept over welke factoren datagebruik mogelijk maken en belemmeren. Beter begrip van deze factoren is essentieel om ervoor te zorgen dat geproduceerde data daadwerkelijk planning, besluitvorming en leren informeren.

Onderzoek aanpak en methodologie

Deze thesis onderzocht het gebruik van monitoringdata in stadswatervoorziening in Ethiopië aan de hand van een uitgebreide casestudy. Ethiopië werd geselecteerd als een typisch voorbeeld van een land met beperkte middelen, waar meerdere monitoringinitiatieven resulteerden in verschillende systemen voor het monitoren van watervoorziening in kleine steden, met overlappende doelstellingen.

De centrale onderzoeksvraag was: "Hoe worden monitoringdata gebruikt in de stadswater voorziening in Ethiopië, en wat zijn de factoren die dit mogelijk maken of belemmeren?" Deze centrale vraag werd beantwoord aan de hand van vier specifieke onderzoeksvragen:

1. Wat zijn de verschillende gebruikstoepassingen van monitoringdata voor de kleinstedelijke watervoorziening in Ethiopië? Hoe zijn deze tot stand gekomen?
2. Hoe en in welke mate worden deze monitoringdata daadwerkelijk gebruikt?
3. Welke factoren bevorderen of belemmeren het gebruik van monitoringdata? Aan welke voorwaarden moeten worden voldaan om datagebruik te waarborgen?
4. Welke hefboomen kunnen het gebruik van monitoringdata mogelijk maken?

Het onderzoek heeft vanuit vier theoretische perspectieven gekeken naar factoren die daadwerkelijk gebruik van data mogelijk maken of belemmeren:

- **Lineair perspectief:** Met focus op dataeigenschappen en -kenmerken;
- **Relatieperspectief:** Met focus op de kwaliteit van relaties tussen dataproducenten en -gebruikers, gebaseerd op hun structurele, relationele en cognitieve sociale kapitaal;
- **Gedragssystemenperspectief:** Met focus op individuele capaciteiten, motivaties, en organisatorische, sectorale en contextuele mogelijkheden voor het gebruik van data, aan de hand van het COM-B model;
- **Uitgebreid systemenperspectief:** Integreert factoren uit de andere drie perspectieven en maakt gebruik van MICMAC (Matrice d'Impacts Croisés-Multiplication Appliquée à un Classment, of cros-impact matrix multiplicatie toegepast op classificatie) structurele analyse om hefboomen te identificeren.

De methoden voor dataverzameling omvatten literatuuronderzoek, onderzoek van grijze literatuur en sectordocumenten, onderzoek van monitoringdatasets, en semigestructureerde interviews met nationale, subnationale en lokale belanghebbenden.

Het monitoringlandschap en voorbeelden van datagebruik

Het monitoringlandschap voor kleinstedelijke watervoorziening in Ethiopië omvat verschillende systemen op verschillende institutionele niveaus, met complementaire en soms overlappende doelstellingen. De volgende monitoringsystemen werden geïdentificeerd:

- 'Utility Management Information Systems' (MIS) die activa-, operationele en prestatiedata produceren;
- Een regionaal monitoringsysteem gericht op stedelijke watervoorziening en benchmarking-systeem in Tigray Regio, in deze thesis aangeduid als het 'Tigray Utility Monitoring System' (TUMS);
- Het nationale WASH M&E MIS;
- Het 'Performance Indicator & Benchmarking' (PI&BM) initiatief;
- Productie van jaarlijkse dekkingsdata door het Ministerie van Water, Irrigatie en Elektriciteit;
- Het Joint Monitoring Programme (JMP).

De studie identificeerde 20 brede voorbeelden van datagebruik verspreid over zes gebieden (beleidsvorming, operationele besluitvorming, tariefstelling, planning, regulering, en rapportage voor verantwoording) en drie institutionele niveaus (nationaal, subnationaal, lokaal), waarbij gebruik wordt gemaakt van een of meerdere datasets.

Ontwikkelingspartners speelden een belangrijke rol in het vormgeven van monitoring-systemen. De Wereldbank had een grote invloed op PI&BM en de initiële ontwikkeling van het WASH M&E MIS, terwijl UNICEF een sleutelrol speelde in het operationaliseren van het WASH M&E MIS door de eerste National WASH Inventory (NWI), en DFID bij de verdere ontwikkeling ervan en de tweede NWI. Dit heeft vorm gegeven aan de beoogde voorbeelden van datagebruik en systeemcomponenten, in termen van indicatoren, dataverzamelingstools en -processen, ICT-systemen en financiële kaders. De systeemcomponenten sloten echter niet altijd aan bij de expliciet geformuleerde doelstellingen.

Ondanks aanzienlijke investeringen zijn monitoringsystemen over het algemeen zwak en maken de systeemcomponenten het beoogde gebruik van data niet altijd mogelijk. Dataverzamelingstools bevatten veel variabelen die niet gekoppeld waren aan indicatoren, resulterend in het klassieke “data-rijk, informatie-arm” syndroom.

Beoordeling van werkelijk datagebruik

Het daadwerkelijke gebruik van monitoringdata om besluitvorming te informeren en verantwoording te waarborgen bleek aanzienlijk lager te liggen dan het beoogde en potentiële datagebruik. Aan de hand van een beoordelingsschaal aangepast aan die van Knott en Wildavsky (1980), vond de studie dat matig tot hoog datagebruik slechts in drie gevallen voorkwam:

- Operationeel datagebruik van nutsbedrijven: Matig gebruik van operationele data voor besluitvorming, waarbij het management van nutsbedrijven wekelijkse vergaderingen hield om data te bespreken en corrigerende acties te nemen;
- Gebruik van TUMS voor regelgeving: Intensief gebruik door Tigray Regional Water Bureau voor prestatieregulering door het jaarlijks belonen van goed presterende drinkwaterbedrijven;
- Gebruik van dekkingssgraad ('coverage') data: Matig gebruik voor planning op macroniveau, dat rechtstreeks als input diende voor het vaststellen van een baseline en doelstellingen.

In de andere gevallen van gegevensgebruik werd weinig of geen daadwerkelijk gebruik waargenomen, zoals:

- Nationale data over de prestatie van drinkwaterbedrijven (PI&BM, WASH M&E MIS) werden niet gebruikt ondanks aanzienlijke investeringen;
- JMP-data werden op nationaal niveau niet daadwerkelijk gebruikt, afgezien van incidentele verwijzingen;
- Water Boards maakten weinig gebruik van prestatiedata voor regelgevende beslissingen;
- Geen systematisch datagebruik voor neerwaartse verantwoording aan watergebruikers.

In enkele gevallen ging het eerder om procesgebruik dan om datagebruik, waarbij monitoringprocessen in plaats van data van invloed waren op beslissingen. Zo waren de JMP en PI&BM processen, en niet de geproduceerde data, bepalend voor de opname van bepaalde standaarden in nationaal beleid.

Data werden regelmatig gebruikt voor rapportage (voor opwaartse verantwoording), maar er waren weinig aanwijzingen dat rechthebbenden de gerapporteerde data gebruikten om plichtdragers ter verantwoording te roepen. Er werd geen rapportage voor neerwaartse verantwoording waargenomen.

Analyse van bevorderende en belemmerende factoren

Lineair perspectief: Data kenmerken

Onder het lineaire perspectief werden de relevantie, geloofwaardigheid, volledigheid, tijdigheid, toegankelijkheid, en beschikbaarheid van data in toegankelijke formaten beoordeeld voor verschillende gevallen van datagebruik. Hoewel de meeste datasets relevant bleken te zijn wat betreft inhoud, schaal en frequentie, scoorden de geloofwaardigheid en beschikbaarheid van data in toegankelijke formaten het laagst.

Data kenmerken werden vergeleken met de mate van waargenomen werkelijk datagebruik. Gevallen met waargenomen werkelijk datagebruik (ongeacht de mate van gebruik) bleken data te betreffen met (tenminste) matige kenmerken. Echter, data kenmerken konden de matige en lage mate van datagebruik in deze gevallen niet verklaren. Data kenmerken konden ook het gebrek aan werkelijk datagebruik niet verklaren in die gevallen van datagebruik met sterke data kenmerken. In deze gevallen kon het gebrek aan datagebruik alleen verklaard worden door beschikbaarheid van alternatieve informatie of door beperkende factoren anders dan de data kenmerken.

Over het algemeen toonde het bekijken van factoren die datagebruik mogelijk maken of belemmeren vanuit een lineair perspectief dat relevante, geloofwaardige, uitgebreide, tijdige en toegankelijke data essentieel zijn voor werkelijk gebruik van data, maar dat het hebben van deze data geen garantie is voor werkelijk gebruik.

Relatieperspectief: Sociaal kapitaal en netwerken

Onder het relatieperspectief werd de kwaliteit van relaties tussen dataproducenten en -gebruikers beoordeeld in 6 gevallen van datagebruik. Deze beoordeling werd vergeleken met de waargenomen mate van werkelijk gebruik.

De kwaliteit van relaties tussen dataproducenten en -gebruikers varieerde. Kwaliteit van relaties was vooral laag tussen actoren met zwakke verantwoordingsrelaties. Hoogwaardige relaties werden waargenomen in gevallen waarin de dataproducent en -gebruiker dezelfde waren of zeer nauw met elkaar verbonden waren.

Datagebruik met hoogwaardige relaties betroffen data met sterke (matige tot hoge) attributen. Datagebruik met laagwaardige relaties had voornamelijk betrekking op data met laagwaardige kenmerken, met name wat betreft datageloofwaardigheid, tijdigheid en beschikbaarheid in juiste formaten.

Over het algemeen toonde het relatieperspectief dat de relatie tussen dataproducenten en -gebruikers bijdraagt aan de productie van bruikbare (betrouwbare, geloofwaardige, tijdige, uitgebreide, toegankelijke) data en hun werkelijk gebruik, maar goede relaties garanderen geen werkelijk datagebruik.

Gedragssystemenperspectief: Capaciteit, motivatie en kansen

Onder dit perspectief werden individuele capaciteit, motivatie en verschillende organisatorische, sectorale en contextuele kansen voor datagebruik beoordeeld voor verschillende datagebruikers betrokken bij de geïdentificeerde datagebruik voorbeelden.

Capaciteiten, motivaties en vooral de kansen voor datagebruik bleken relatief zwak te zijn, met lage organisatorische financiële capaciteit, gebrek aan besluitvorming ondersteunende tools, en vooral zwakke systemen voor datagebruik en prikkels voor datagebruik.

Het vergelijken van de sterkte van de gedragssysteemfactoren met de waargenomen mate van daadwerkelijk datagebruik in de verschillende gevallen van datagebruik onthulde dat werkelijk datagebruik verklaard kon worden door de factoren van dit derde perspectief voor datagebruikscases waar andere perspectieven daar niet in waren geslaagd. Daar bleek dat:

- Zwakke individuele capaciteit en motivatie een sterk remmend effect hebben op daadwerkelijk datagebruik;
- Zwakke menselijke en/of financiële middelen een sterk belemmerend effect hebben op datagebruik;
- Aanwezigheid van beslissingsondersteunende tools heeft een zwak stimuleren effect op daadwerkelijk datagebruik;
- Sterke sectorale systemen voor datagebruik, met duidelijke prikkels voor datagebruik, zijn sterke stimulansen van datagebruik;
- Contextuele kansen voor datagebruik die verband houden met de nationale cultuur en politieke economie kunnen datagebruik belemmeren of bevorderen.

Over het algemeen bleken motivatie en capaciteit voorwaarden te zijn voor het mogelijk maken van datagebruik en opportuniteitsfactoren bleken werkelijk datagebruik sterk te beïnvloeden.

Uitgebreid systemenperspectief: Factorinteracties en hefboom punten

De data kenmerken uit het lineaire perspectief, kwaliteit van relaties tussen dataproducenten en -gebruikers uit het relatieperspectief, en capaciteiten, motivaties en kansen voor datagebruik uit het gedragssystemenperspectief werden gecombineerd tot een vierde perspectief op factoren die datagebruik beïnvloeden: het uitgebreide systemenperspectief. Over het algemeen toonde het uitgebreide systemenperspectief dat het samennemen van de factoren uit de andere drie perspectieven het verklaren van de mate van waargenomen werkelijk datagebruik in alle gevallen mogelijk maakte.

Op basis van de observaties uit de verschillende datagebruikscases die in deze thesis zijn besproken, werd het niveau van invloed van de verschillende factoren op elkaar beoordeeld. Dit resulteerde in een complex netwerk van factoren die datagebruik mogelijk maakten en belemmerden, hetzij direct, of door invloed op elkaar.

Gebruikmakend van de MICMAC-methode werden politieke economie, nationale cultuur, sterkte van sectorale systemen voor datagebruik, en organisatorische financiële capaciteit voor datagebruik onthuld als de factoren met de meeste invloed en minste afhankelijkheid van andere factoren, waardoor ze mogelijke hefboomen werden, met een sterk sturend potentieel op de factoren die datagebruik mogelijk maken of belemmeren. Echter, een politieke economie die datagebruik stimuleert en mogelijk maakt werd ook beschouwd als een mogelijk negatieve invloed op andere factoren in het netwerk, inclusief datageloofwaardigheid of relevantie.

Conclusie

Deze thesis toonde dat monitoringsystemen in Ethiopië kenmerken vertonen van 'isomorfe nabootsing', met de ontwikkeling van uitgebreide dataverzamelingssystemen die internationale beste praktijken nabootsen, maar zonder het creëren van echte vraag naar datagebruik.

Belangrijke voorwaarden voor het mogelijk maken van datagebruik omvatten:

- Toegankelijkheid van relevante, geloofwaardige, uitgebreide, tijdige data in geschikte formaten
- Goede relaties tussen dataproducenten en -gebruikers;
- Capaciteit om data te gebruiken en er actie op te ondernemen;
- Bovenal, motivatie om data te gebruiken ondersteund door sterke systemen voor datagebruik en een gunstig politieke economisch klimaat.

De thesis concludeert dat motivatie voor datagebruik essentieel is. Als datagebruikers geen intrinsieke motivatie hebben om data te gebruiken voor besluitvorming en het waarborgen van verantwoording, dan is investeren in de productie van data verspilling van middelen. De rationele aanname dat het produceren van data automatisch zal leiden tot gebruik ervan is onjuist gebleken.

Als belangrijk hefboomeffect zou een faciliterende politieke economie de motivatie voor datagebruik en de systemen stimuleren en prikkels voor datagebruik versterken. Dit zou op zijn beurt de toewijzing van menselijke en financiële middelen voor datagebruik stimuleren, de aanschaf en ontwikkeling van besluitvormings tools, en goede relaties tussen dataproducenten en -gebruikers mogelijk maken. Dit zou resulteren in de productie en het gebruik van relevante, geloofwaardige, toegankelijke, uitgebreide, en tijdige data voor het informeren van effectieve en efficiënte besluitvorming en het waarborgen van verantwoording, uiteindelijk leidend tot betrouwbare, veilige, en toegankelijke waterdiensten voor iedereen.

Bijdragen en implicaties

Deze thesis levert verschillende significante bijdragen:

Uitgebreide documentatie: Deze thesis bood een unieke complete documentatie van datagebruikscases op meerdere institutionele niveaus binnen de stedelijke drinkwater-voorzieningssector van een enkel land.

Multi-perspectief raamwerk: Het demonstreerde de waarde van het analyseren van datagebruik vanuit meerdere theoretische invalshoeken, en laat zien dat een uitgebreid begrip de integratie van meerdere standpunten vereist.

Analyse van onderlinge relaties tussen factoren: Het presenteerde een unieke analyse van de relaties tussen factoren, waarbij niet alleen factoren die gegevensgebruik mogelijk maken of belemmeren worden geïdentificeerd, maar ook de factoring die een hefboom functie kunnen hebben in het beïnvloeden van het factor netwerk.

Aanbevelingen

Voor ontwikkelingspartners: Verschuif focus van dataproductie naar het bouwen van systemen voor datagebruik. Integreer monitoringinterventies met bredere systeemversterking, beoordeel de werkelijke vraag naar datagebruik, en pak politieke economie kenmerken aan die motivatie beïnvloeden.

Voor regeringen: Stel duidelijke systemen voor datagebruik vast met rollen, verantwoordelijkheden en prikkels. Creëer een verantwoordingskader die data-gestuurde besluitvorming vereisen en ontwikkel regelgevend kaders die prestatiedata gebruiken.

Voor drinkwaterbedrijven: Investeer in geïntegreerde managementinformatiesystemen die voorzien in operationele behoeften, verbeter de nauwkeurigheid van data door betere apparatuur en training, en stel regelmatige processen voor data-analyse vast.

Het onderzoek toont aan dat succesvolle monitoringinterventies verder moeten gaan dan technische dataproductie en ook de politieke, institutionele en motivatie factoren moeten aanpakken die een echte vraag naar datagebruik in besluitvorming en verantwoordingsprocessen creëren.

Beperkingen en toekomstige richtingen

De studie had verschillende belangrijke beperkingen die wijzen naar toekomstige onderzoeksrichtingen:

Focus op één casus: De focus op Ethiopische stadswatervoorziening, gekenmerkt door zwakke nutsbedrijven en beperkte capaciteiten, kan de generaliseerbaarheid naar andere contexten met sterkere instellingen en hogere digitale maturiteit beperken. Soortgelijk onderzoek in andere contexten wordt daarom aanbevolen.

Gebruik van Verantwoordingsdata: Vanwege hun complexiteit werden voorbeelden van gebruik van verantwoordingsdata uitgesloten van de analyse van stimulerende of belemmerende factoren uit de relatie- en gedragssysteem perspectieven.

Subjectieve Beoordeling: De waardering van de sterkte en invloed van factoren werd uitgevoerd door een enkele onderzoeker, wat ondanks systematische beoordelingskaders tot mogelijke vertekening kan leiden. Aanbevolen wordt om in toekomstig onderzoek gebruik te maken van participatieve benaderingen, vooral voor het beoordelen van de invloed van factoren.

Complexiteit van de interactie tussen factoren: De analyse van onderlinge afhankelijkheid van factoren is weliswaar baanbrekend, maar vertegenwoordigt een vereenvoudiging van complexe relaties in de praktijk, die in de toekomst baat zouden kunnen hebben bij meer geavanceerde analytische methoden.

Temporele Dynamiek: Het onderzoek legde datagebruik vast op specifieke tijdstippen, maar volgde niet hoe de patronen in datagebruik evolueren, wat bijzonder belangrijk is gezien de snelle veranderingen in de sector.

PROLOGUE

In the 2010s, I became involved in the development and implementation of project- and country-led monitoring systems in the water supply sector, mostly in Africa, producing vast amounts of data. At that time, an increasing amount of monitoring data was becoming available. This was not just a trend in the water supply sector in the global South, but a global phenomenon. Technology was facilitating the collection and presentation of big data sets. I even observed this in my daily life in the Netherlands. More and more data were becoming available to me, including performance and health data produced by my watch, data on electricity and gas use, produced by my service provider, data on screen time, all of which available on dashboards on my phone.

I strongly, possibly/probably naively, believed that this increasing amount of monitoring data would have the potential to support people in making better decisions. I believed that the increasing amount of data available in the water supply sector would inform and improve management and governance decisions and would as such contribute to achieving sustainable water supply for all. I believed that if new monitoring systems could make data accessible to a wide range of stakeholders, these data would inform decision-making, accountability and learning by local and national government, water service providers, private sector, civil society, NGOs, academics and development partners. I believed in 'If you build it, they will come'¹.

However, I observed that potential data users often actually did not 'come' to use the data produced by the newly 'built' monitoring systems and data were not being used to their full potential. There was a clear disconnect between the rationality of the use of monitoring data and its reality.

This led me to ask myself: to what extent was the increasing amount of data that was being produced, actually used by different actors at different levels? And how could the use of monitoring data be stimulated and improved? This fed my desire to study how and to what degree monitoring data are actually used, why these data are often not used to their full potential, and what could be done to improve the use of monitoring data. This resulted in the thesis that is before you.

I am very grateful for the support of many during my (long) PhD journey. I owe a great deal of gratitude to my promoter Prof. Dr. Jurian Edelenbos, who guided, inspired, and stimulated me, and to my co-promoter, boss, and friend Dr. Patrick Moriarty, who challenged and encouraged me along the way.

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1. As often misquoting the 1989 movie *Field of Dreams*, in which protagonist (played by Kevin Costner) hears a voice saying "If you build it, he will come", resulting in him building a softball field which summon several dead baseball players, including Shoeless Joe Jackson.

without whose support I would probably not have made it to the finish line. And of course to the late, great Ton Schouten, who was instrumental in pushing me towards the topic of the use of monitoring.

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ABBREVIATIONS

ACTA	Applicability, Comprehensiveness, Timing and Accessibility
ADA	Austrian Development Agency
AfDB	African Development Bank
AfD	French Development Aid (Agence Française de Développement)
BCURE	[capacity building programme for evidence based policy-making]
BMZ	Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (German Federal Ministry for Economic Cooperation and Development)
CAS	Complex Adaptive System
CMP	Community Managed Project
COM-B	Capability, Opportunity, Motivation Behaviour (model)
COSMOS	Coffey Spatial Mobile Solution
COWASH	[Ethiopian -innish project]
CRA	[regulatory agency in Mozambique]
CRELE	Credibility, Relevance, Legitimacy (framework)
CSA	Central Statistical Agency
CSRP	Civil Service Reform Program
CWA	Consolidated WASH Account
CWSA	Community Water and Sanitation Agency
D&A	Data & Analytics program
DaaS	Data-as-a-service
DDDM	Data-driven-decision-making
DFAT	Department of Foreign Affairs and Trade (Australia)
DFID	[UK's Department for International Development]
DGIS	Directorate-General for International Cooperation (Netherlands)
DHS	Demographic Health Survey
DIKW	Data-Information-Knowledge-Wisdom
DRIP	Data-Rich, Information-Poor
DST	Decision Support Tools
EBC	European Benchmarking Co-operation
EC	Ethiopian Calendar
EIB	European Investment Bank
EPRDF	Ethiopian People's Revolutionary Democratic Front
ERSAR	[regulatory agency in Portugal]
ESS	Ethiopian Statistical Services
ETB	Ethiopian Birr
EUWI	EU Water Initiative
EWf	Ethiopian Water Federation

FCDO	Foreign, Commonwealth & Development Office (UK)
GDP	Gross Domestic Product
GoE	Government of Ethiopia
GLAAS	Global Analysis and Assessment of Sanitation and Drinking-water
GTP	Growth and Transformation Plan
GWC	Global Water Challenge
HIS	Health Information Systems
HR	Human Resources
IBNET	International Benchmarking Network
IDC	Italian Development Corporation
IEAG	Independent Expert Advisory Group on a Data Revolution for Sustainable Development
IMF	International Monetary Fund
iNGOs	international Non-governmental organisations
IoT	Internet of Things
IWA	International Water Association
JMP	Joint Monitoring Programme (of UNICEF and WHO)
KPI	Key Performance Indicator
LPCD	Litres per capita per day
M&E	Monitoring and Evaluation
M&E MIS	Monitoring and Evaluation Management Information System
MDG	Millennium Development Goals
MDGs	Millennium Development Goals
MICMAC	Matrice d'Impacts Croises-Multiplication Appliquée à un Classment (Cross-impact matrix multiplication applied to classification)
MICS	Multiple Indicator Cluster Survey
MIS	Management Information System
MoFED	Ministry of Finance and Economic Development
MOUDC	Ministry of Urban Development and Construction
MoWIE	Ministry of Water, Irrigation and Energy
MSMSP	Monitoring, Support and Maintenance Sub-Process
MSF	Multi-Stakeholder Forum
NGO	Non-governmental organisation
NPC	National Planning Commission
NPM	New Public Management
NRW	Non-Revenue Water
NWASH	[Nepal's water, sanitation and hygiene system]
NWCO	National WASH Coordination Office
NWIPO	National WASH Inventory Project Office
NWSC	National Water and Sewerage Corporation
NWTT	National WASH Technical Team
ODA	Official Development Assistance

OECD	Organisation for Economic Co-operation and Development
OFWAT	[regulatory agency in the UK]
OWNP	One WASH National Programme
PASDEP	Plan for Accelerated and Sustained Development to End Poverty
PI&BM	Performance Indicators and Benchmarking
POM	Program Operational Manual
PURC	Public Utilities Regulatory Commission
PUT	Professionals Unite Together
RAPID	Research and Policy in Development
RIPPLE	Research-inspired Policy and Practice Learning in Ethiopia and the Nile region
SDC	Swiss Agency for Development and Cooperation
SDG	Sustainable Development Goals
SEDI	[programme focused on political economy of evidence-based policy-making]
SI	Supplementary Indicators
SIASAR	Rural Water and Sanitation Information System
SIWI	Stockholm International Water Institute
SNV	[Dutch development organisation]
SNNPR	Southern Nations and Nationalities People's Region
SWA	Sanitation and Water for All
TPLF	Tigrayan People's Liberation Front
TUMS	Tigray Utility Monitoring System
U-UAP	Urban-focused Urban Access Plan
UAP	Universal Access Plan
UK	United Kingdom
UN	United Nations
UNICEF	United Nations Children's Fund
USA	United States of America
USAID	United States Agency for International Development
VEI	Vitens Evides International
WASH	Water, Sanitation and Hygiene
WDC	Water Development Commission
WHO	World Health Organization
WPMU	WaSH Programme Management Unit
WPdx	Water Point Data Exchange
WRDF	Water Resources Development Fund
WSP	Water and Sanitation Program (World Bank)

1 INTRODUCTION

Decision makers, practitioners, and the general public have access to a growing volume of water supply data that has the potential to inform decisions and enhance accountability. However, whether and how these data are actually used, is often unclear. This disconnect is concerning, given that the sector faces increasing pressures, including rising water demand due to population and economic growth, coupled with diminishing or less reliable supply caused by climate change (Bettin, 2023).

This chapter establishes the premise of this thesis by presenting the background and problem statement (Section 1.1), defining its conceptual and practical contributions (Section 1.2), and outlining the research objectives and questions (Section 1.3). The thesis outline is presented in the final section (Section 1.4).

1.1 Background and problem definition

1.1.1 Increased production and availability of data

Data volumes have grown considerably since the onset of the ‘information age’ in the late 1940s (Kroll, 2013; McGinnes and Elandy, 2012; Provost and Fawcett, 2013). This was enabled by several technological developments, including (home) computers, the internet, mobile phone applications, and the Internet of Things.

Growing interest in performance monitoring and evidence-based decision-making also drove data production in the private and public sector. This emerged from the rational planning systems found in the private sector of the 1960s (Carter, 1998). The public sector adopted these practices in the 1970s and 1980s to improve bureaucratic efficiency and effectiveness, at a time of economic decline and neo-liberal politics resurgence (McGinnes and Elandy, 2012).

Advocates of this New Public Management (NPM) attributed high priority to performance measurement and management (Thiel and Leeuw, 2002). They believed performance indicators would enable government to control costs, increase accountability, and improve services (Hailey and Sorgenfrei, 2004). The UN, OECD and World Bank / IMF actively promoted the adoption of NPM in low- and middle-income countries (Ohemeng, 2005).

The 1990s saw a surge in ‘evidence-based’ approaches in public sector decision-making, aligned with NPM principles. In the UK, evidence-based policy-making became prominent with the New Labour government taking power in 1997. This contributed to the spreading of the concept in the development sector and subsequently in low- and middle-income countries supported by UK’s DFID (Punton, 2016). Head (2008) considered this evidence-based movement the latest version of the search for usable and relevant knowledge to help address and resolve problems, with an emphasis on rational problem-solving.

The United Nations’ Millennium Development Goals (MDGs) launched in 2000, and the Sustainable Development Goals in 2015, also stimulated data production, especially in low- and

middle-income countries. The UN anticipated that the SDGs would trigger a ‘data revolution’, with increased data supply and demand from all parts of society, ensuring that people could monitor progress, hold governments accountable, and foster sustainable development (UN IEAG, 2014). The United Nations Secretary-General’s Independent Expert Advisory Group on a Data Revolution for Sustainable Development (IEAG) called data *‘the lifeblood of decision-making and the raw material for accountability’* (UN IEAG, 2014).

1.1.2 Data production in the water supply sector

In line with these trends, substantial volumes of water supply data are being produced and made available to decision makers and the general public.

Water service providers produce asset and operational data as part of their day-to-day water supply management responsibilities. These providers include water utilities managing complex piped schemes, and community-based committees mainly managing point sources or small piped schemes, particularly in low- and middle-income countries. Utilities are increasingly extending into rural areas and small and medium towns, or being introduced there. This observed ‘utilitisation’ trend will likely shape the water supply sector in the coming years (Adank et al., 2021; Franceys, 2019).

Utilities and other service providers responsible for piped-scheme management produce data through mechanisms and tools, including for asset management, billing and financial management, leakage detection and management, water quality management, customer and complaint management, and human resource management (Carriço and Ferreira, 2021; Filali-Meknassi et al., 2018; Grueau et al., 2019). Digitalisation and the Internet of Things (IoT) contribute to the growing volumes of utility asset, operational, and water quality data. These data are intended to inform utilities’ operational and strategic decision-making.

Utilities increasingly convert data into performance data on specific indicators. Global initiatives have stimulated and facilitated these practices in low- and middle-income countries. These include the International Water Association (IWA)’s performance indicator work, the World Bank’s International Benchmarking Network (IBNET), and the InterAmerican Development Bank’s AquaRating (Sattarov and Volkova, 2020). These utility performance and benchmarking data aim to inform operational and strategic decision-making within utilities, as well as the identification of areas for improvement (Kayaga et al., 2018; Mugisha, 2007). They can also ensure accountability towards stakeholders (Roth, 2020) and give regulators the required framework to operationalise regulatory mandates (Mugisha, 2007), in line with NPM objectives.

NPM-style sector reforms in the 1990s resulted in the establishment of regulatory agencies and contracts. Regulatory agencies that were established, include ERSAR in Portugal, OFWAT in the UK, PURC in Ghana, and CRA in Mozambique for example. Performance contracts between service providers and authorities were especially prevalent in France and francophone countries, but also beyond. For example, Uganda’s national utility NWSC signed performance contracts with the Ministry of Water, Lands and Environment and the Ministry of Finance, Planning and Economic Development (Schwartz, 2008). This further contributed to increased data collection, reporting, compilation, processing, and visualisation.

In the 2010s, national-level water supply monitoring systems were developed, especially in low- and middle-income countries. Development partners supported and facilitated these developments, following the NPM-influenced Aid Effectiveness principles of the 2005 Paris Declaration: ownership, alignment, harmonisation, managing for results, and mutual accountability. Mobile-phone data collection tools like Akvo FLOW and mWater enabled this development.

Danert (2015), inspired by Segone (2009), refers to the resulting monitoring systems as 'country-led monitoring systems', emphasised that while government-led, these systems may involve local government and civil society. Examples include SIASAR (Rural Water and Sanitation Information System), applied in several Latin American countries, Ghana's National Monitoring System (CWSA, 2014), Uganda's national monitoring systems with its golden indicators (Ssozi and Danert, 2012), Sierra Leone's WASH portal (WASH data Sierra Leone), Nepal's NWASH MIS (Dashboard - NWASH), and Ethiopia's National Water, Sanitation and Hygiene Monitoring and Evaluation Monitoring Information System (WASH M&E MIS). These systems produce asset data, particularly on rural water points, service provider performance, and service level data, providing insight into which parts of the population have access to what levels of water services (in terms of reliability, quantity, quality, and accessibility), for various potential data users across institutional levels.

Local governments also produce / compile growing volumes of water supply data to inform area-based master or investment plans, especially in low- and middle-income countries. (I)NGOs or development partners often support these planning processes (Adank, 2025), facilitated by the availability of mobile-phone based data collection tools. These data include asset, service provider performance, and service level data, providing insight into which parts of the population have access to what levels of water services (in terms of reliability, quantity, quality, and accessibility). Garriga, de Palencia, and Foguet (2015) stress the need to provide policymakers and practitioners with appropriate data and decision-support instruments for planning, targeting, and prioritisation.

National statistical agencies produce increasing volumes of household survey data, including coverage and service level data. The number of household surveys conducted globally was especially high in the MDG era, as shown by the analysis of the number of household surveys in the International Household Survey Network (IHSN)'s database, presented in Annex 1.

At global level, the Joint Monitoring Programme of UNICEF and WHO (JMP) compiles household survey (and administrative) data on water service levels from various sources, producing national and global service level data. Other global initiatives also produce and compile water supply data. IBNET compiles utility performance data. The Water Point Data Exchange (WPdx) of Global Water Challenge (GWC) compiles asset data from NGOs and governments, mainly on water points. WHO's Global Analysis and Assessment of Sanitation and Drinking-Water (GLAAS), compiles and produces national and global data related to the enabling environment. These global data sets are publicly available online.

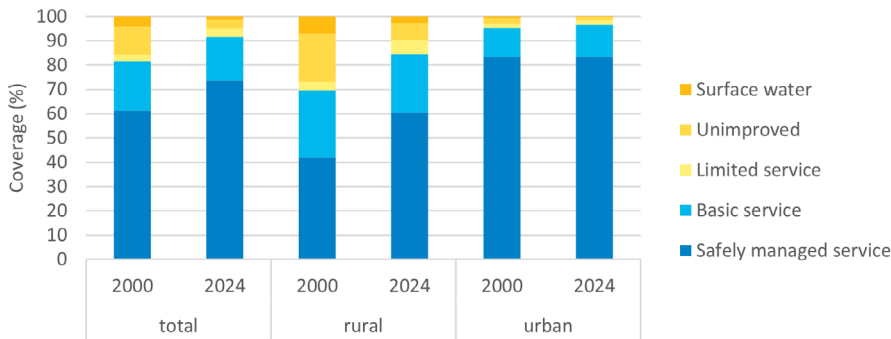
A growing volume of water supply data is thus being produced by utilities, regulators, government agencies, and development partners, who are expected to use these data to inform accountability and decisions across institutional levels. This raises the question: How are these data actually used?

1.1.3 The importance of data in water supply

Before addressing this question, this section highlights the relevance and importance of data use in water supply.

Despite progress towards universal access to water supply over the last 25 years, more than one-quarter of the world's population still lacks access to water supply on their premises, that is available when needed and free from contamination (termed 'safely managed water supply'). Figure 1-1 shows that global safely managed coverage is higher in urban than in rural areas. However, urban safely managed water coverage has, percentage-wise, hardly increased since 2000, merely keeping up with population growth. Progressing from basic (from an improved source, within a 30 minute round trip) to safely managed water requires ensuring on-premises access to water (primarily by increasing the number of household connections), and improving water service reliability and quality through infrastructural and managerial improvements. Data plays a key role in these processes.

Figure 1-1: Global water service levels



Source: WHO/UNICEF, 2025

The world's population is growing and becoming increasingly urban, with the urban population having surpassed the rural population in 2007. This increases demand for water services, while there is less reliable or decreasing water supply due to climate change and aging infrastructure. This places pressure on the water supply sector to be as effective, efficient, and legitimate and transparent as possible. Monitoring data are widely recognised as crucial for effective and efficient decision-making and ensuring accountability and transparency (Bartram, 1996).

A business-as-usual approach solely focusing on infrastructure implementation is insufficient to address these challenges. Systems approaches, which recognise the complexity of multiple actors and factors involved in water supply, have therefore gained traction. Strong systems are increasingly recognised as essential for achieving universal and sustainable water service provision (Casella et al., 2015; Huston, 2021; Lockwood et al., 2016; Neely, 2019, 2013; Valcourt et al., 2020b, 2020a; WaterAid, ; Wiek and Larson, 2012). Interest, insight, and understanding of water supply as a complex adaptive system emerged approximately a decade ago, in the mid-2010s. Since then, researchers have applied this concept to rural (Casella, 2021;

Casella et al., 2015; Huston, 2021; Neely, 2013; Valcourt et al., 2020b) and urban water supply (e.g. Dunn et al., 2017; Kanta L. and Zechman E., 2014; Wan Rosely and Voulvoulis, 2023).

Monitoring and data use are key to systems approaches. Information feedback loops steer adaptive change in complex adaptive systems (Huston and Moriarty, 2018). Furthermore, monitoring is often considered a building block of service provision systems, producing data and information for use in other building blocks, including planning, regulation, and asset management.

1.1.4 Literature on data use in the water supply sector

Despite large and growing data volumes and the recognised importance of data use, literature on actual data use (WaterAid,) and studies of the factors that enable and hamper data use in the water supply sector are scarce.

A 2013 symposium in Addis Ababa brought together 410 participants to discuss monitoring experiences and challenges. The resulting publication (Schouten and Smits, 2015) identified that data often exist, but are not used, are not relevant, or lack ownership and purpose. The symposium included surprisingly little focus on the use of monitoring data. The work presented by Norman and Franceys (2013) provided an exception, offering insights from Norman's PhD dissertation (Norman, 2013), which found that monitoring can inform national policies, strategies, planning, and regulation and that monitoring systems should be designed around clearly defined objectives.

Documentation of actual water supply data use mainly includes anecdotal descriptions of use of specific data sets for specific purposes, including:

- The use of monitoring data to inform formulation of project strategies, ensuring prioritisation of the water supply sector and selection of interventions (Bartram, 1996);
- The use of utility performance to inform reporting and cross-comparison of utility performance, but not for informing operational decision-making in Canada (Haider et al., 2016);
- The use of benchmarking data to inform utility improvement plans (de Goede et al., 2016) and efficiency improvement (Cabrera et al., 2011; De Witte et al., 2007) in the Netherlands and Ethiopia (Adank et al., 2018) and for informing utility strategic plans, budgets, and development of initiatives to address identified priority gaps in the USA (Matichich et al., 2014).
- The use of data in district-level decision-making to inform asset development (Welle, 2005), corrective actions, and planning processes (Adank, 2025, 2017),
- The use of water quality data in evidence-based decision-making by water service providers and government agencies in Malawi, Ecuador, and Brazil (Amjad et al., 2018), and by water service providers, surveillance institutions, and regulators in six countries in sub-Saharan Africa (Kumpel et al., 2020).

In her dissertation on performance monitoring in rural water supply in Ethiopia, Welle (2012) found that the presumed linear relationship between monitoring information and decision-making was limited. However, this research was conducted before large data sets became available from major recent initiatives, including the National WASH Inventory and the Performance Indicator and Benchmarking initiative (PI&BM).

Despite limited evidence on actual use of water supply data and its benefits (or lack thereof) (Norman, 2013), there is growing suspicion that these data are often underused (Cross, 2015; Norman, 2013; Perera et al., 2024; WaterAid, ; Welle, 2012). This raises another question: **What factors enable and hamper data use?**

Only a few recent studies have explored factors enabling or hampering water supply data use. WaterAid () examined how development partners could engage with country-led monitoring initiatives. It included a brief literature review on evidence-based policy-making and behaviour literature and three case studies (Nicaragua, Sierra Leone, and Timor-Leste). Building on the framework presented in this study, (Kimbugwe et al., 2022) assessed the extent to which different factors were believed to have contributed to ensuring continuous data production and use in Cambodia, Myanmar, Papua New Guinea, and Uganda. Boulouvar and Adank (2022) studied factors enabling or hampering the use of specific data sets in specific decision-making processes: local water supply management in Ghana; district-level planning of asset development in Ghana, Sierra Leone, and Uganda; and regional planning processes in Colombia.

1.1.5 Literature on data use beyond water supply

Beyond the water supply sector, there is a substantial body of literature addressing data use. This includes knowledge and evidence use, and performance information and management literature. Studies into data use have covered a range of sectors, including the service provision-oriented health and education sector.

1.1.5.1 Knowledge utilisation and evidence-based decision-making

The 1970s and 1980s are considered the ‘golden age’ of knowledge (Court and Young, 2006) and evaluation (Henry and Mark, 2003) utilisation studies. Interest in research utilisation took off mainly in the USA (Beyer and Trice, 1982; Court and Young, 2006), with empirical studies focusing on social research use in policy-making (e.g. Caplan et al., 1975; Knorr, 1977; Rich, 1975; Weiss, 1980; Patton et al., 1997). These studies showed that although intended to inform policy-making, social research hardly ever did so in reality (Bailey and Mouton, 2005), at least not in a linear, rational, instrumental way. This led to attention on other uses of research, including Weiss’ (1979) enlightenment and political roles of knowledge use.

The rise of political emphasis on evidence-based and evidence-informed policy² and decision-making in the early 2000s renewed academic interest in the topic. Instrumental and rational perspectives persisted, aligned with UK New Labour’s idealistic conceptualisation of evidence and policy-making (Smith, 2013). Development partners pushed for evidence-based decision-making in low- and middle-income countries (Broadbent, 2012)³. However, actual use

2. It should be noted that in literature, policy-making does not strictly refer to policy-making in terms of development of policy documents, but rather to decision-making involving trade-offs between multiple competing values and interests (Parkhurst, 2017).

3. Research and support programmes on evidence-based policy-making in developing countries have included the UK’s RAPID programme (Research and Policy in Development) (2002-2012), BCURE programme, focused on capacity building for evidence-based policy-making (2012-2017) and SEDI, focused on understanding the political economy of evidence-based policy-making (2019-2024), the USA’s MEASURE Evaluation programme, focused on evidence-based health care.

of evidence remained low (Broadbent, 2012; Jennings and Hall, 2012; Landry et al., 2001a; Smith, 2013). The realisation (re)emerged that assuming direct and unproblematic links between evidence, policy decisions and outcomes is naïve (Cairney, 2016; Parkhurst, 2017). This resulted in more attention on the role of politics in evidence-based policy-making since the 2010s (Jones et al., 2009; Parkhurst, 2017; Shaxson et al., 2016; Smith, 2013).

Knowledge and evidence utilisation literature recognises the need for gathering and analysing information from different sources (Backer, 1991; UK Cabinet Office, 1999; Weiss, 2001; Head, 2010; Langer et al., 2016), but particularly champions the use of scientific evidence from research (Parkhurst, 2017). ‘Knowledge utilisation’ and ‘research utilisation’ are often used interchangeably (Bailey and Mouton, 2005).

1.1.5.2 Use of performance information in performance management

While knowledge utilisation and evidence-based literature focus on the use of research knowledge, performance management literature examines the use of performance information. Performance management is a management style that incorporates and uses performance information in policy- and decision-making, and management processes (Dooren et al., 2015). Measuring performance is only deemed worthwhile if information is eventually considered in decision-making (Dooren and Van de Walle, 2010; Tantardini and Kroll, 2015). For a long time, performance management and measurement literature focused on data production rather than use. Researchers assumed that performance information would be used when available (Dooren and Van de Walle, 2010). Data were expected to inform four groups of actors: 1) professionals delivering public services, checking their performance and seeking improvement measures, 2) managers, checking that their organisations are delivering services in line with goals and targets; 3) oversight bodies for holding managers accountable; and 4) the public, checking service performance, to inform their voting choices, or to inform the choice in public service providers (Bird et al., 2005). However, data use was often the weakest element in performance information systems (Dooren and Van de Walle, 2010).

Interest in actual use of performance data and information took off in the new millennium (Dooren and Van de Walle, 2010), with a growing body of research on use and non-use of performance information (e.g. Ammons and Rivenbark, 2008).

1.1.5.3 Data use in the health and education sector

Evidence-based literature in the health sector has been focused on Evidence-Based Medicine and evidence-based policy-making. Evidence-based medicine emerged in the late 1990s as the *‘use of current best evidence in making decisions about the care of individual patients’* (Sackett et al., 1996). In the early 2000s, evidence-informed decision-making and accountability were increasingly seen as a priority in the health sector (Best et al., 2009).

The World Health Organization (2010) identified health information systems as one of six health system building blocks, recognising that sound and reliable information is the foundation for decision-making across other health system building blocks. Knowledge is expected to enable policy-makers to underpin policies, by practitioners to make decisions on organisational management and day-to-day practices, and by patients and the general public to inform their options (Bailey and Mouton, 2005; Davies et al., 2016; Graham et al., 2006).

Education sector literature has focused on evidence use by education professionals at different levels, for example in schools and in administrative units responsible for overseeing and supporting schools. Research into evidence use in education took off in the early 2000s, mainly in the USA, with President Bush's 2001 'No Child Left Behind' Act, that put data-driven decision-making (DDDM) at the centre of education policy and practice (Coburn et al., 2009; Mandinach et al., 2006; Marsh et al., 2006). Since then, the US government has devoted hundreds of millions of dollars to supporting data use, including through President Obama's Statewide Longitudinal Data System Grant Program (2005-ongoing) and the Race to the Top initiative (2009-2015) (Turner and Coburn, 2012). Beyond the USA, schools are also increasingly held accountable for their, and their students', performance. This has increased emphasis on evidence-based decisions (Schildkamp et al., 2013). The UNICEF-funded 'Data Must Speak' initiative launched in 2014 stimulates the production of context-specific tools and resources for understanding education data in low- and middle-income countries, as they consider the use of information as critical for building stronger and more equitable education systems (Voogt and Pieters, 2019).

Marsh et al. (2006) observed that DDDM in education was modelled on successful practices in industry and manufacturing, including total quality management and organisational learning. Coburn et al. (2009) observed that evidence is often assumed to have linear relationships with decision-making. However, they argue that developing policies and incentives that can support the realisation of the promise of evidence use is only possible through a thorough understanding of decision-making processes and of the conditions that shape these processes in social and political systems.

1.1.6 Research into factors that enable or hamper data use

By the 2010s, the low observed levels of evidence-use in policy-making prompted an increase in academic work on factors that enable and hamper evidence use. Enabling and hampering factors have been explored and reviewed for the education sector (Coburn et al., 2009; Lai and Schildkamp, 2013; Marsh et al., 2006; Marsh, 2012), health sector (Clar et al., 2011; Harrison and Nutley, 2010; Innvaer et al., 2002; Lavis et al., 2005; Li et al., 2018; Liverani et al., 2013; Orton et al., 2011; Wallace et al., 2012; Wickremasinghe et al., 2016), environmental management sector (McNie, 2007), development sector (Caio et al., 2018; Viswanathan et al., 2021) and performance management (Kroll, 2015). However, similar analyses for the water supply sector are rare. While literature initially covered evidence use in high-income countries, recent studies increasingly also cover low- and middle-income countries (Rendell et al., 2020; Verboom and Baumann, 2022).

This expanding body of literature mainly focuses on the utilisation of scientific and research information by policy makers (Crona and Parker, 2011; McNie, 2007; S. Nutley et al., 2007). While this is different from the use of monitoring data, this literature provides useful insights for this thesis.

Different frameworks and studies have considered, categorised and grouped the different factors. Landry et al. (2003) observed that the pioneering studies on knowledge utilisation in the late 1970s and early 1980s mainly focused on characteristics of research production. This was followed by a phase in the 1980s and early 1990s which emphasised policy-makers and their context. In the 1990s, emphasis moved to exchanges and relationships between producers and users of evidence. Landry et al. (2003) refer to the supply-focused explanatory variables

as engineering explanations, and to demand- and relationship-focused variables as socio-organisational explanations.

Nutley, Walter, and Davies (2007) identified four sets of issues key to understanding research use: (1) nature of the evidence (supply side); (2) personal characteristics of both evidence producers (supply side) and potential users (demand side); (3) links between producers and users (relationships); and (4) context for evidence use. Oliver et al.'s (2014) review of 45 studies from 59 countries (including 33 from low- and middle-income countries) on enabling and hampering factors, categorised these into the following themes: 'Research and researcher characteristics', 'Policymaker characteristics', 'Policy characteristics', 'Organisations and resources', and 'Contact and collaboration'. Crewe and Young's (2002) RAPID framework for understanding the use of research in policy-making, recognised the following critical dimensions: 1) evidence, 2) links between actors, and 3) context in terms of political and institutional structures and interests of key policy makers and researchers.

Schildkamp and Kuiper (2010) hypothesised that the following sets of factors could play a role in influencing data use in schools in the Netherlands: data characteristics, data user characteristics, and organisational characteristics. In their 2013 book, they added policy context as a group of factors that are likely to influence these factors. Voogt and Pieters (2019) argued for adding the educational system and national culture as additional factors. Henig (2012) argued that going from data to practice is mediated by various factors, including characteristics of data, organisational culture and capacity, and fiscal and political context.

Best et al. (2009) and Best and Holmes (2010) identified three generations in thinking about knowledge use: 1) linear models, focusing on knowledge as a product, generalisable across contexts, whose use depends on effective packaging; 2) relationship models, focusing on the interactions between people producing and using knowledge, with social networks, identity, and willingness to work with others as key factors; and 3) systems models, considering knowledge products as embedded within relationships of linkage and exchange, embedded within a larger system that is shaped by culture, structures, priorities, and capacities. The linear models focus on engineering explanations, while the second and third focus on socio-organisational explanations.

Best and Holmes (2010) argued that there is not one best model for every circumstance. They did, however, argue that the systems model offers insight into the most complete set of factors.

1.1.7 Summing up the problem and implications for this research

This section showed that growing volumes of data are produced in the water service sector and beyond. There are doubts about the degree of actual data use, but documentation of this and robust studies into the factors enabling and hampering water supply data use, are rare. Better understanding of factors that enable and hamper data use is key to ensuring that produced data actually inform planning, decision-making, and learning (Caio et al., 2018). Insights from studies of knowledge, evidence, and data use beyond the water supply sector, where similar data use challenges have been observed, provide useful insights. However, the majority of these studies lack strong theoretical frameworks and little is known about how these myriad contextual factors interact with and influence one another (Turner and Coburn, 2012).

Building on factor typologies, this thesis suggests that factors for enabling and hampering data use can be viewed from the four perspectives:

- 1) **Linear perspective.** This perspective focuses on the characteristics and attributes of data and how these enable or hamper data use.
- 2) **Relationships perspective.** This perspective focuses on how the relationships between data producers and users enable or hamper data use.
- 3) **Behaviour systems perspective.** This perspective focuses on data user behaviour and how this is shaped by their motivations, capabilities, and context.
- 4) **Comprehensive perspective.** Similar to Best et al.'s systems model, this perspective takes a comprehensive view, considering various factors from perspectives 1, 2, and 3. It also considers how these factors interact with and influence one another.

Each perspective has the potential for (partially) explaining data use by providing different, but possibly complementary lenses. Combining lenses may provide a clearer picture of the factors that enable and hamper data use. A rare example of an application of a multi-perspective approach related to the use of monitoring data, De Kool (2007) applied three approaches, a rational approach, a political approach, and a cultural approach, in his study into monitoring as part of policy processes in the Netherlands. This multi-perspective view was inspired by Allison's influential 1971 analysis explaining the Cuban Missile Crisis using three different conceptual models: a rational actor model, an organisational process model, and a governmental (bureaucratic) politics model (Allison, 1971).

1.2 Scope and contribution of this thesis

This thesis focuses on data use in **water supply**. Although data use has been studied in several other sectors, including service provision sectors like health care and education, documentation of water supply data use has been limited. Also, there have not been many studies exploring the factors that enable and hamper use of data in the water supply sector. This thesis contributes to filling this gap.

This thesis focuses on data use in water supply in towns that fall between community-managed rural and utility-managed urban water supply. In the early 2000s, this middle ground was poorly understood and documented (WSP, 2002). Subsequently, interest and insight in town water supply has increased (Adank, 2014). Many expect that towns will grow in number, population, and importance (Collignon, 2002; Cranfield University et al., 2006; Foster, 2012; Gia et al., 2010; United Nations Human Settlements Programme, 2006). By focusing on town water supply, this thesis contributes to further understanding of this middle ground. This is especially relevant given the global demographic changes and observed utilisation processes.

This thesis focuses on data use in water supply in towns in Ethiopia. Ethiopia is a typical case of a low-income country with utility-managed town water supply. Since the late 2000s, the amount of water supply data produced in the country has increased substantially through several monitoring initiatives, including the national WASH Monitoring and Evaluation Management Information System (WASH M&E MIS), the Performance Indicators and Benchmarking (PI&BM) Initiative, and the benchmarking initiative by the Ethiopia Water Federation. Utility benchmarking data have also been observed to have been produced at regional level in some

regions, for example, in Tigray region. Limited documentation and analysis of data production and use processes in the water sector in Ethiopia exists. Welle's (2012) dissertation focused on performance monitoring in rural water supply in Ethiopia at a time when monitoring data were relatively limited compared to the present.

This thesis aims to contribute to the growing body of work on factors that enable and hamper data use. It does so by approaching data use from multiple theoretical perspectives to gain a comprehensive view of the enabling and hampering factors. While multiple authors (e.g. Best et al., 2008; Broadbent, 2012; Punton, 2016) identified different models and perspectives, multi-perspective approaches to gain synergetic clarity on data use, have rarely been applied. An exception is Van Buuren's (2006) thesis, which conceptualised knowledge in decision-making as three dynamic, sometimes unconnected, sometimes interwoven threads which are involved in decision-making processes: a thread for establishing facts, a thread for creating images or meanings (perceptions and interpretations), and a thread for reaching a consensus (van Buuren, 2006).

Most studies on data use have focused on use at a specific level, for example policy-making at national level, data use by teachers at local level, or by district staff at sub-national level. However, data in the water supply sector are produced and used at different institutional levels by different actors. This thesis takes a multi-level perspective to gain a thorough understanding of data use in water supply.

This thesis provides conceptual and practical recommendations for designing and implementing monitoring interventions, that emphasise meaningful data use, for Ethiopia and beyond. This includes identification of leverage points for enabling data use.

1.3 The research objective and questions

This thesis aims to provide insight into the rationality and reality of data use, factors that hamper and enable these processes, and what could be done to enable data use in town water supply in Ethiopia.

The central research question of this thesis is: 'How is monitoring data used in town water supply in Ethiopia, and what are the factors that enable or hamper this?'

To answer this overall question, it is broken down into the following research questions:

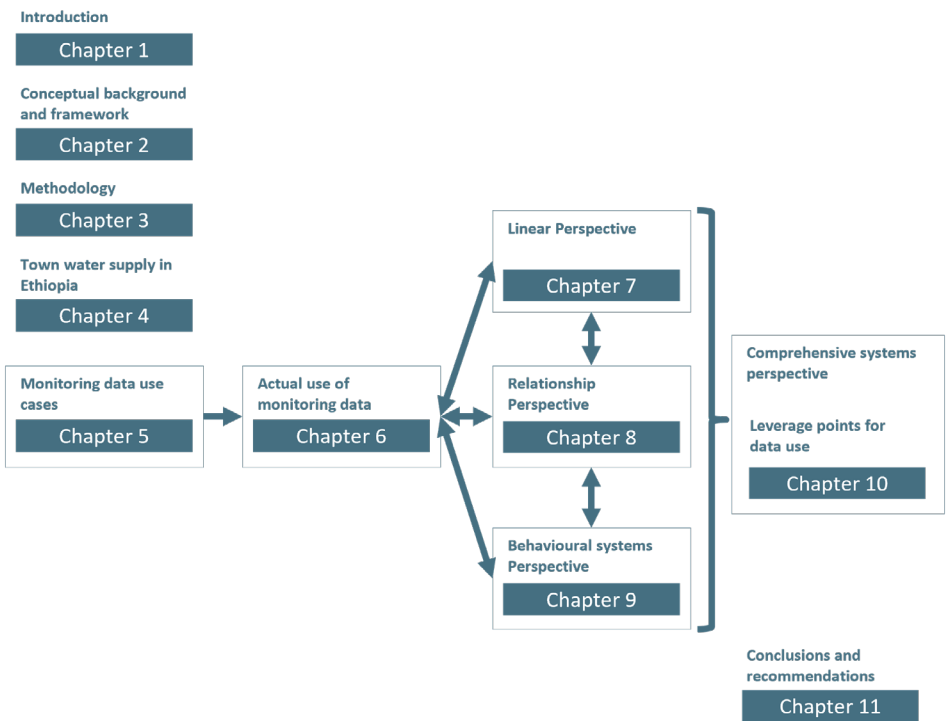
1. What are different use cases for town water supply monitoring data in Ethiopia? How have these been shaped?
2. How and to what degree are monitoring data actually used?
3. What factors enable or hamper actual monitoring data use? What conditions need to be in place to ensure use of monitoring data?
4. What are the leverage points for enabling monitoring data use?

This research approaches and explores factors that enable and hamper actual data use from the four theoretical perspectives: 1) Linear model, focusing on data characteristics and attributes; 2) Relationships model, focusing on the quality of relationships between data producers and users; 3) Data user behaviour perspective, focusing on motivations, capabilities and opportunities for data use; and 4) Comprehensive systems perspective, examining factor interactions and interdependence.

1.4 Outline of this thesis

Chapter 2 and 3 set out the conceptual and methodological framework respectively. Chapter 4 describes the context of town water supply in Ethiopia. Chapter 5 introduces the monitoring system in town water supply in Ethiopia and expected and potential data use cases, addressing research question 1. Chapter 6 describes and analyses actual use of monitoring data across institutional levels, addressing research question 2. Chapters 7, 8, 9, and 10 explore factors influencing the use of monitoring data, addressing research question 3. Each chapters takes a different theoretical perspective. Chapter 7 takes the linear model perspective, focusing on data characteristics and attributes. Chapter 8 takes the relationship perspective, focusing on the quality of relationships between data producers and users. Chapter 9 takes a behaviour systems perspective, focusing on individual capacities, motivations, and opportunities for data use. Chapter 10 examines factors interactions and interdependencies and how these directly and indirectly influence the use of monitoring data. This provides insights into the main leverage points for ensuring data use, addressing research question 4. Chapter 11 discusses the findings and presents the conclusions and recommendations. Figure 1-2 presents a readers' guide for this thesis.

Figure 1-2: Readers' guide



2 CONCEPTUAL BACKGROUND AND FRAMEWORK

This chapter introduces the conceptual background and framework guiding this thesis. The different sections in this chapter each cover the conceptual background related to one of the research questions. Section 2.4 presents the overall conceptual framework as a compilation of the concepts introduced in this chapter.

2.1 Monitoring and its place in service provision systems

As mentioned in Chapter 1, water supply is increasingly considered a complex adaptive system with monitoring as a fundamental building block. Systems theory can also be useful for understanding monitoring and data-use systems as complex processes in their own right (Van Gasse et al., 2021). This section presents the theoretical background of systems theory and thinking.

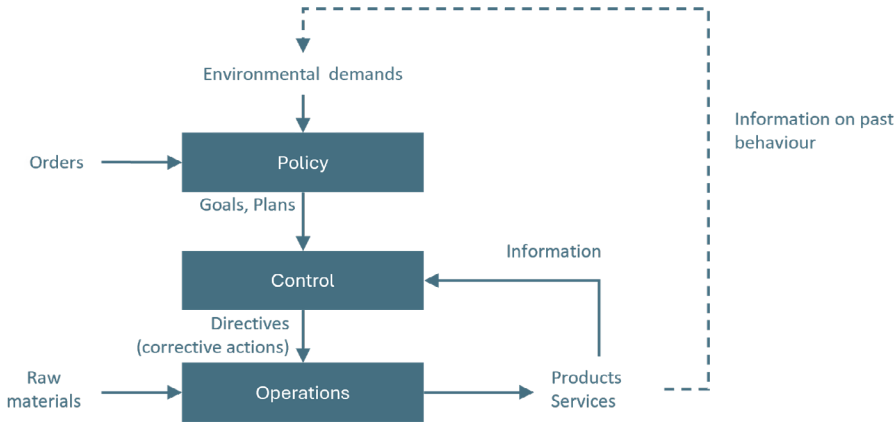
2.1.1 Introduction to systems theory

General Systems Theory emerged post-World War II as part of the search for a body of systemic theoretical constructs for discussing the general relationships of the empirical world (Boulding, 1956). Systems are defined as collections of parts that interact to function as a whole (Kauffman, 1980), in relation to their environment (Von Bertalanffy, 1972), with the whole (the system) being more than the sum of the parts (Klijn, 2008). The output of a system is the result of the dynamic behaviour of the whole system (Von Bertalanffy, 1950). Systems can be regarded as cybernetic systems, which include feedback loops, open systems, which consider systems elements in their environment, and complex adaptive systems.

The application of feedback models is arguably the most widely used concept from general systems theory (Von Bertalanffy 1972). Cybernetic systems are non-linear, self-regulating, and adaptive systems with negative and positive feedback loops (Rastogi, 1976). Transmission and interpretation of data and information are key characteristics of cybernetic systems (Boulding, 1956). Whenever there are feedback loops, the relationship is nonlinear (Miller et al., 2018).

From a cybernetic systems perspective, an organisation consists of operations, control, and policy centres, and flows between these centres (Swinth, 1974). The operations centre receives raw materials and produces products / services. The control centre monitors the performance of the operations centre, keeping outputs in line with goals set by the policy centre. It receives information from the operations centre, which it uses to inform directives and corrective actions (Scott, 1987; Scott and Davis, 2007). The policy centre sets goals for the system, based on demand and preferences from the environment (Scott and Davis, 2007).

Figure 2-1 presents a schematic overview of an organisation as a cybernetic system. It shows that information on products and services informs the directives and corrective actions at the control centre, and the setting of goals and plans at the policy centre.

Figure 2-1: Abstract model of an organisation as a cybernetic system

Source: Adapted from Swinth (1974) and Scott (1987)

Open systems are capable of self-maintenance (rather than just self-regulation) on the basis of throughput of resources from the environment (Scott, 1987). From an open system standpoint, there is a close connection between the condition of the environment and the characteristics of the systems within it. An open system is a cybernetic system (a non-linear, adaptive system with feedback loops) which interacts with its environment (Von Bertalanffy, 1972).

In the 1990s, inclusion of chaos and complexity theory led to conceptualisation of a new type of open system: the complex adaptive systems (CAS) (Dunn et al., 2017). Complex adaptive systems consist of multiple nested sub-systems and an environment with which they interact and co-evolve, and they are subject to feedback loops. Complexity results from the inter-relationship, non-linear interaction and inter-connectivity of elements within a system and between a system and its environment (Chan, 2001; Holden, 2005), which are not easily controlled or predictable (Paina and Peters, 2012). Where cybernetic systems are simple adaptive systems, adaptation in complex adaptive systems is more complex, because of the many parts and widely varying individual criteria for what a good outcome would be (Holland, 1992). CAS are dynamic systems able to adapt in and evolve with a changing environment (Chan, 2001). CAS are sensitive due to their dependence on initial conditions. Changes in the input characteristics or rules are not correlated in a linear fashion with outcomes. Small changes can have a surprisingly profound impact on overall behaviour, or vice-versa, a huge upset to the system may not affect it.

The production and use of monitoring data that inform the policy and control centres are important elements of cybernetic systems. However, using monitoring data is a complex process, highly influenced by its context, and is therefore in this thesis considered to be a complex adaptive system.

2.1.2 Sub-systems

General Systems Theory recognises hierarchy, in the form of clustering and levels, as a fundamental feature of complex systems (Scott, 1987). Within a system, sub-systems can be identified as different levels, with different actors fulfilling different roles. The boundaries between these sub-systems can delimit different social constructions, such as functional activities, political jurisdictions (e.g. nations), institutional and administrative levels (e.g. nation, state, district, town etc.), academic disciplines, and different types of knowledge (Cash et al., 2003). This section focuses on nested sub-systems at different institutional and administrative levels (2.1.2.1) and functional building blocks (2.1.2.2).

2.1.2.1 Nested (sub)systems and institutional levels

Recent decades have seen re-allocation of the governance roles of central governments to local governments through decentralisation processes, and to supra-national authorities, such as the European Union, AMCOW, the United Nations. This downward and upward dispersion of authority away from the central level is referred to as multi-level governance (Hooghe and Marks, 2002). As a result, service-oriented systems such as education, health services and water service systems consist of nested sub-systems at multiple governance levels, including the level where service provision takes place (schools, health care facilities, water schemes), the level that is supposed to provide oversight and support to service providers (e.g. school districts, health inspectors, local government and regulators), and the policy-making level (e.g. Ministry of Education, Ministry of Health, Ministry of Water).

Building on Lockwood and Smits (2011), Table 2-1 presents nested sub-systems based on water supply governance and administrative levels and functions. As shown in the table, service authority functions can be split over different institutional and administrative levels.

Table 2-1: Sub-systems based on institutional/ administrative levels and functions related to provision of water services

Institutional and administrative level	Functions
National level: Federal state level	Policy and normative functions: The enabling environment, where sector policy, norms and regulatory frameworks are set, service levels are defined, and macro-level planning and resource allocation take place.
Sub-national level (region, province, district)	Service authority functions: These include (decentralised) planning, coordination of the efforts of involved stakeholders, regulation and oversight of the service provider, and technical assistance to the service provider.
Local level (city, town, village, community, household)	Service provision functions: Day-to-day management of water schemes. These include operation, maintenance and management (development, repairs, rehabilitation) of assets.

Source: Author, based on (Lockwood and Smits, 2011)

These nested sub-systems relate closely to the operations, control and policy centres of cybernetic systems. National-level actors involved in setting policies, norms and targets can be regarded as the policy centre, actors involved in service authority functions as the control centres, and service providers as the operations centres.

2.1.2.2 Systems building blocks

Within systems, sub-systems can also be defined through demarcation of building blocks, as the fundamental components that make up the system. Huston and Moriarty (2018, p. 18) define building blocks as *recognisable (and widely recognised) sub-system[s] within the larger WASH system whose actors and factors work together to perform a key function.* Huston (2021) subsequently refers to the building blocks as 'windows', emphasising they can function as a way of reframing and looking at the system from different angles. Although the term 'building blocks' seems to imply completely separate entities that cannot overlap, this is the most commonly used term and will be applied as such in this thesis.

There are many ways in which systems can be subdivided into building blocks. For water, sanitation and hygiene systems, these include Sanitation and Water for All (SWA)'s five building blocks and IRC's nine building blocks (Huston and Moriarty, 2018), displayed in Figure 2-2.

Figure 2-2: WASH system building blocks



Source: Huston and Moriarty (2018)

Most building block frameworks include a monitoring building block. IRC's monitoring building block involves the capture, management and dissemination of data and information required to manage water services at all levels (Huston and Moriarty, 2018). In some frameworks, monitoring is combined with other building blocks. SWA, for example, groups monitoring together with planning and review as one of its five building blocks (Sanitation and Water for All (SWA), 2016).

Monitoring data can serve as inputs for informing processes in other building blocks, such as planning, regulation, learning and adaptive change and infrastructure development and management (Huston and Moriarty, 2018). Likewise, Nutley and Reynolds (2013) consider data from health information systems (HIS) as the foundation of the overall health system, which inform decision-making in each of the other building blocks in the system. As such, they consider data as a prerequisite for improving each of the five other building blocks of the health system. Building blocks usually span the different institutional levels, but can also be focused on a specific level. The policy and legislation building block as defined by Huston and Moriarty (2018), for example, mostly covers the national level. The monitoring building block spans all levels, with data being produced at all levels.

Information or monitoring systems can be regarded as systems in their own right (De Savigny and Adam, 2009; Huston and Moriarty, 2018; World Health Organization, 2007). The section that follows presents a conceptual framework for understanding monitoring systems, its components and its data use cases.

2.2 Monitoring systems

This section presents the conceptual background for addressing the first research question: *'What are the different use cases for town water supply monitoring data in Ethiopia? And how have these been shaped?'* It presents the components of monitoring systems, including its data use cases.

2.2.1 Monitoring systems components

There are various definitions of monitoring in the water supply sector (e.g. Shordt, 2000) and beyond (e.g. Brown (2000), Kuster and Batjes (2017)). These definitions all emphasise that monitoring is not a one-off activity, but an ongoing and continuous process. These definitions also emphasise the need for monitoring progress against set objectives, or the ideal or expected situation. A well-functioning water service monitoring system can be defined as one *intended to ensure the ongoing production, analysis, dissemination and use of reliable and timely data and information on various aspects of the systems, at different levels, against set targets or objectives*⁴.

Monitoring systems comprise various components. Nutley (2012) considers health information systems to be comprised of six components: health information system resources, indicators, data sources, data management, information products, and dissemination and use (Health Metrics Network, 2008). As part of a framework for assessing and strengthening national monitoring and evaluation systems, UNAIDS identified 12 components of monitoring systems (UNAIDS, 2009). This framework was adapted for the WASH sector (UNICEF et al., 2016).

4. This builds on WHO's (2007) often-quoted definition of a well-functioning health information system as a system "that ensures the production, analysis, dissemination and use of reliable and timely health information by decision makers at different levels of the health system."

Building on existing frameworks (Nutley, 2012; UNAIDS, 2009; UNICEF et al., 2016), this thesis considers monitoring systems to consist of the following six components:

1. Purpose, monitoring objectives and data use cases,
2. Indicator frameworks,
3. Data sources and data collection tools,
4. Procedures, institutional responsibilities and capacities for routine data collection, data cleaning, processing, aggregation and information production and dissemination,
5. Platforms and tools for data processing, storing and visualisation,
6. Financial frameworks for data collection and use, including required resources and funding flows.

Monitoring objectives are often explicitly stated and described in monitoring guidelines and manuals. For monitoring systems to produce data suitable for these objectives, the system components need to align with these. For example, indicators need to support the monitoring objectives, data tools need to facilitate data collection which can support the monitoring objectives, and ICT platforms can include or exclude certain actors from accessing and using data in line with monitoring objectives.

2.2.2 Data use cases

Performance management and development programme monitoring literature identifies the following two main monitoring objectives: 1) monitoring for improvement; and 2) monitoring for accountability (Binnendijk, 2001; Dooren et al., 2015; Hailey and Sorgenfrei, 2004; Harrison and Nutley, 2010a; Kuster and Batjes, 2017).

Some authors regard monitoring for steering and learning as a separate improvement objective (Dooren et al., 2015; Patton, 1997). Bird et al. (2005) distinguish the research (learning), managerial (steering), and democratic (accountability) role of monitoring. This thesis considers the learning or research role as part of using monitoring for improvement.

Monitoring for improvement involves the use of monitoring data for informing learning and decision-making for improved effectiveness and efficiency.

As mentioned by Schouten and Smits (2015), the purposes of monitoring water supply are manifold. Different actions in the water supply system have different data needs. Building on the common objectives for monitoring identified by Kuster and Batjes (2017) and on the nine building blocks for water service provision identified by Huston and Moriarty (2018), this thesis identifies the following uses of monitoring data for informing decision-making:

- Informing policy development and the setting of norms and standards
- Informing planning decisions, including planning decisions on asset development and management
- Informing operational decision-making, including corrective actions
- Informing regulatory decision-making
- Informing learning and adaptation

Monitoring for accountability or for rendering judgement (Patton, 1997) emphasises holding actors accountable for achieving planned results and transparent reporting of those results (Binnendijk, 2001a), against predefined deliverables (Kuster and Batjes, 2017) or targets. It provides legitimacy to management and governance processes.

Accountability is an elusive, complex and chameleon-like concept (Jordana et al., 2015; Mulgan, 2000). It refers to someone being held to account for their actions by an authority (Brinkerhoff, 2004; Mulgan, 2000). Accountable actors and authorities are referred to as 'power-holders' (Jordana et al., 2015) and 'overseeing actors' (Brinkerhoff, 2004); as 'duty bearers' and 'rights holders' (Albuquerque, 2014); or as 'agents' or 'service providers' and 'principals' (World Bank, 2004; Henig, 2012; Sandefur and Glassman, 2015). Rights holders can include ministers, parliament, auditors or other oversight agencies, customers, the general public (Binnendijk, 2001) and financiers. This thesis will hereafter refer to these actors as 'duty bearers' and 'rights holders'.

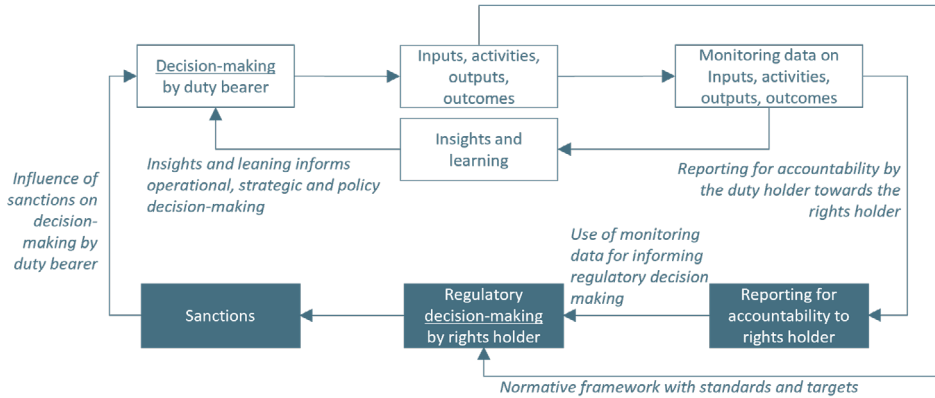
Literature distinguishes between upward, downward, and sideways accountability (Bianculli et al., 2015; Kuster and Batjes, 2017; Mulgan, 2011). Accountability of service providers to local government, and of local government to Ministries and/or financiers is directed upward. Sideways accountability involves accountability between actors at the same institutional level. Accountability of service providers or government bodies to intended customers, constituents or the general public is directed downward (Kuster and Batjes, 2017).

Accountability involves answerability and enforceability (Brinkerhoff, 2004; Jordana et al., 2015). In line with this, Mulgan (2011) considers information, discussion, and consequences as the three stages of a complete accountability relationship. When the consequences stage is omitted, accountability can be equated with transparency, falling short of full accountability (Brinkerhoff, 2004; Mulgan, 2011).

Consequences and sanctions are often based on regulatory power (Brinkerhoff, 2004) of agencies or contracts between rights holders and duty bearers. Citizens can exercise customer power over duty bearers through direct interactions (short route accountability), through politicians and policy makers (long route accountability) (World Bank, 2004). In addition to individual customers and citizens, civil society can play a role in holding duty bearers accountable (Dewachter et al., 2018).

The 'monitoring for improvement' and 'monitoring for accountability' objectives are often seen as different and possibly competing (Binnendijk, 2001), with tensions around 'accountability-learning dichotomy' (Hailey and Sorgenfrei, 2004). This thesis acknowledges this dichotomy, but also recognises the interconnections between the two objectives. Figure 2-3 illustrates monitoring for improvement, or for informing decision-making, in the small (light blue) loop, and monitoring for accountability in the wider loop. The main purpose of accountability is service delivery and management improvement, as stated by Brinkerhoff (2004). Full accountability involves the rights holder applying sanctions, which requires regulatory decision-making by the rights holder. These sanctions are expected to influence decision-making for improvement by the duty bearer. The setting of standards, an essential first step in regulation, involves policy-level decision-making.

Figure 2-3: Monitoring for decision-making and accountability



Source: Author

2.3 Actual use of monitoring data

This section presents the conceptual background for addressing the second research question: 'How and to what degree are monitoring data actually used?'. It presents a conceptualisation of how and to what degree monitoring data are actually used.

2.3.1 Types of actual use of monitoring data

The conceptualisation of knowledge utilisation is under continuous development (Landry et al., 2003). Research into knowledge utilisation gained momentum in the late 1970s. The resulting conceptualisation of knowledge use into instrumental, conceptual, and symbolic use was based on empirical studies on the use of social research in policy-making (Knorr, 1977; Rich, 1977; Weiss, 1979). It is still commonly applied in research related to use of knowledge, information and data use, knowledge to action, and data-based decision-making in education (Coburn et al., 2009; Weiss et al., 2005), health (Cambon et al., 2017) and environmental sciences (e.g. McKenzie et al., 2014). Although this conceptualisation of knowledge use is based on the use of research knowledge, this could be useful for exploring how monitoring data are actually used.

Instrumental use, or 'use for action' (Rich, 1977) is the use of information to find or select a solution to a problem and give direction to policy and practice. This type of information use assumes that the relationship between information and policy is unproblematic, linear and direct. The drive for the evidence-based approaches to policy and practice introduced in Chapter 1 has been based on this linear utilitarian view (Davoudi, 2006). Instrumental information use in decision-making can contribute to single-loop learning, in which information can lead to knowledge of how to do things better, without questioning the underlying assumptions (Pahl-Wostl et al., 2010). While pure instrumental use of research and evaluation findings is not common (Weiss et al., 2005), instrumental use of monitoring information may be more likely to occur.

Conceptual use, or 'use for understanding' (Rich, 1977) or 'enlightenment' (Davoudi, 2006; Weiss, 1979), provides decision makers with new ideas, new concepts, or new generalisations that

influence how they view the nature of the problem or make sense of the policy scene. The benefits of this role of information are indirect and can take longer to be realised (Davoudi, 2006). The emphasis of conceptual use is on knowledge generation (Patton, 1997) and on evidence-informed rather than evidence-based planning and policy, with information contributing to an informed discourse (Davoudi, 2006). Conceptual information use can lead to actors revisiting their assumptions (e.g. about cause–effect relationships) within a value-normative framework (Pahl-Wostl et al., 2010). This double-loop learning can result in decisions about doing things ‘differently’. Monitoring information is likely to play a mainly conceptual role in policy-making and strategic planning.

Symbolic use is also referred to as ‘strategic’ (McKenzie et al., 2014), ‘political’ (Weiss, 1979), or ‘persuasive’ use. This involves the use of information to justify or legitimise pre-existing preferences or action (Coburn et al., 2009; Knorr, 1977; Leviton and Hughes, 1981; Shadish et al., 1991; Weiss et al., 2005). McKenzie et al. (2014) observed that symbolic use is not necessarily ‘bad’ and can play an important role in gaining buy-in for policies and plans in politicized contexts and mediating power differences, by helping stakeholders reflect their values, beliefs, and interests in specific, quantitative ways.

In addition to the use of monitoring data, the monitoring process itself can influence decision-making. Patton (1997) referred to this as ‘process use’. Stakeholders actively involved in monitoring processes can increase their capacity to carry out self-assessments, and as a result, they can more effectively influence their own change processes and contribute to a particular development initiative on a timely basis (Kuster and Batjes, 2017).

This conceptualisation of knowledge use is mainly based on research utilisation literature. However, unlike research, monitoring data are not only intended to be used to ‘inform improvement’, but also for ensuring accountability. Duty bearers can report monitoring data to rights holders. Rights holders can use the reported monitoring data for holding duty bearers accountable for their actions and for informing (regulatory) decision-making.

In addition to the direct use of monitoring data for informing decision-making or accountability processes, indirect use can also take place, with monitoring data as input into research, policy analysis and evaluations, which can in turn inform decisions.

Various forms of non-use or misuse of data have also been identified, including passive use (reporting without action), perverse use (gaming and fraud) (Bird et al., 2005; McGinnes and Elandy, 2012; Moynihan, 2009; Perrin, 1998; Smith, 1995; Thiel and Leeuw, 2002), and rejection based on political or financial concerns (David, 1981).

2.3.2 Degree of data use

Landry et al. (2001) consider the conceptualisation of knowledge utilisation in terms of instrumental, conceptual and symbolic falling short of the conceptual complexity inherent to the idea of knowledge utilisation. They advocate for the use of the Knott and Wildavsky scale (Knott and Wildavsky, 1980), which consists of seven standards: 1) reception; 2) cognition; 3) reference; 4) effort; 5) adoption; 6) implementation; 7) impact. They slightly adapt this framework, referring to ‘transmission’ instead of ‘reception’, ‘influence’ instead of ‘adoption’, ‘application’ instead of ‘implementation’, and bringing the number of levels down to six, leaving out the impact level, which is also considered beyond the scope of this thesis.

2.3.3 Summing up conceptualising data use

Data use can be categorised by purpose (improvement vs. accountability), type (instrumental, conceptual, symbolic), and degree (from reception to implementation). Whether data are used depends on many factors, explored in the next section.

2.4 Enabling and hampering factors for data use in decision-making and accountability

This section presents the conceptual background for answering question 3: *‘What factors enable or hamper actual monitoring data use? What conditions need to be in place to ensure use of monitoring data?’*

As presented in Chapter 1, this thesis takes a multi-perspective approach to answering these questions. This section elaborates on each of the four perspectives for understanding data use, each focused on a specific set of enabling and hampering factors.

2.4.1 The linear perspective

The linear model for data use describes a one-way process of information transmission: data are produced, disseminated to decision makers, and then incorporated into practice and policy (Best et al., 2009; Crona and Parker, 2011). The degree of data use under linear models is a function of effective packaging of the information (Best et al., 2009).

2.4.1.1 Linear models as rational models

Linear models assume rational decision-making, which assumes there is a one-to-one relationship between information acquisition and use. All available information is assumed to be gathered from different sources so that decision makers are completely informed. Information is assumed to be disseminated, used and will have impact, as long as it is precise, reliable, and relevant (Hezri and Hasan, 2004; Rich and Oh, 2000).

Rationalism has dominated Western thinking about decision-making since the Renaissance. In the mid-1950s, the rationalist paradigm became increasingly contested, through the notion that rational decision-making is not feasible in real life (Alexander, 1984). Hurdles to rational decision-making include time, information and cognitive constraints (Simon, 1955). Information needed to evaluate all possible alternatives is too vast (Hezri and Hasan, 2004). Furthermore, decision makers may not always be free to consider all possible options for political reasons. Rational models can therefore be seen as utopian, as the model represents a planner’s dream, rather than reality (Smith and May, 2013). Nevertheless, linear models can play a role in, at least partially, explaining use of monitoring data or lack thereof.

From a rational perspective, data use in decision-making processes can be viewed as a cybernetic system: a system capable of self-regulation in terms of some externally prescribed targets or criterion (Scott, 1987; Scott and Davis, 2007), in which transmission and interpretation of information play a key role (Boulding, 1956).

2.4.1.2 Linear models for explaining data use

Landry et al. (2001) identify three types of linear models: a science-push model, a demand-pull model, and a dissemination model, each with their own main independent variables related to

knowledge use. They also identify the non-linear 'interaction model', under which knowledge utilisation depends on various disorderly interactions between researchers and users. This interaction model is discussed in more detail under the relationship perspective.

Under the science-push model, researchers are the producers and suppliers of knowledge and users are simply the receptacles (Landry et al., 2001). Within the context of monitoring water supply, with data mainly produced by practitioners and dedicated data collectors and processors, this could rather be regarded as a 'data-push model' than a 'science-push model', with data being produced at the discretion of the data producers, with the expectation that this will be used by decision makers and practitioners. Under this model, decision makers are expected to behave like customers served by producers of data, who behave like contractors. The main factors of interest under these models include the amount of research produced, the extent to which researchers have taken into account the needs of users, and the context factors surrounding research, e.g. the source of funding for research (Landry et al., 2001).

The demand-pull model aligns with the most common model for conceptualising decision-making processes, the phase model (Teisman, 2000). Phase models include an identification or intelligence phase, an alternative solutions identification phase, and an alternative solutions choice phase (Simon, 1960; Brim et al., 1962; Dewey, 1978; Mintzberg et al., 1976). These models imply rational decision-making, with data and information playing a strong role. Main factors influencing knowledge use under these models include relevance, credibility and timeliness of the knowledge for the knowledge users (Landry et al., 2001).

The dissemination model stresses the importance of data processing and development and dissemination of information products.

Monitoring involves the production and use of different 'products' along the data-information-knowledge-wisdom (DIKW) hierarchy, as conceptualised by Zeleny (1987), Ackoff (1989) and many others since. Monitoring produces data on variables⁵ and indicators⁶. Data on these parameters⁷ can be processed into data on indicators.

Collected and organised data can be converted into *information* through a process of analysis, summarising and packaging. Monitoring information consists of the processed monitoring data presented in the form of information products with graphs, maps and summary tables. However, Henig (2012) observed that raw data can be perceived in theory, but in practice, even relatively unadorned descriptive information is framed by interpretation.

Knowledge is the collection of information deemed useful to guide action (Light et al., 2004). Information can be converted into *actionable knowledge* through a process of prioritisation and synthesis and dissemination and internalisation of the information (Mandinach et al., 2006). The conversion of information into knowledge is generally regarded as an expected outcome of a well-functioning information system (Davies, 1994).

5. A variable is a factor or characteristic that can change over time and can be measured.

6. A monitoring indicator is a quantitative metric that provides information to monitor performance, measure achievement and determine accountability (UNAIDS, 2010)

7. Parameters are the variables that make up the indicator (Schouten and Smits, 2015b)

Commonly, different actors at different levels, with different functions and with varying levels of understanding of each other's job, are involved in different parts of this data use results chain (Nutley, 2012).

2.4.1.3 Factors that enable and hamper data use according to linear models

Linear models emphasise data characteristics as the main factors influencing data use. Building on literature from social science, and science, technology, and policy, and their own empirical work in the area of sustainable development, Cash et al. (2003) developed a framework of knowledge production and use that focuses on the following information attributes: credibility, salience/relevance, and legitimacy. Since the development of this framework, also referred to as CRELE (credibility, relevance, and legitimacy), it has been applied in environmental science (Dunn and Laing, 2017; Kunseler et al., 2015; McNie, 2007; van Voorn et al., 2016), but also in areas of water resource management (e.g. White, 2001) and the impact of transdisciplinary research (Hansson and Polk, 2018).

Cash et al. (2003) refer to relevance as 'the relevance of information for an actor's decision choices, or for the choices that affect a given stakeholder'. Salience (or relevance) is a broad concept and can include many elements (Dunn and Laing, 2017), including content and context-sensitivity of information, the timeliness of the information, in terms of when it is produced and made available, and the scale of the information (Leviton and Hughes, 1981; McKenzie et al., 2014). Required data frequency and scale depend on what the data are used for (Bird et al., 2005; Caio et al., 2018), with local planning requiring data collected on a frequent basis, but only covering a limited area, while national-level planning requires data collected on a less frequent basis, but at a scale that allows for representative data for comparing sub-national levels. Relevance can also relate to how data are processed and information communicated, presented and disseminated (Landry et al., 2001; Leviton and Hughes, 1981). Furthermore, relevant information considers regulatory and legal constraints; the values and beliefs of stakeholders; and the political landscape (McNie, 2007).

Credibility of information in research use relates to whether information is perceived as meeting standards of scientific plausibility and technical adequacy (Cash et al., 2003). In evaluation use, it relates to the credibility of the information producer and the information itself, compared to other sources of information (Leviton and Hughes, 1981). In this thesis, data credibility is considered to be a combination of technical accuracy and perceived credibility by data users.

Legitimacy refers to actor perceptions of the data production process and whether these are perceived as unbiased and meeting standards of political and procedural fairness. This is based on who participated in data production and who did not, the processes for making those choices, and how data are produced, vetted, and disseminated (Cash et al., 2003). McNie (2007) proposes that legitimacy can also be thought of in terms of social capital, in terms of trust, respect and cooperation between data producers and users. This thesis considers this under the second perspective (relationship perspective).

Dunn and Laing (2017) argue that the CRELE framework mainly reflects the science-push perspective, rather than the needs and considerations of users of information. Based on over seventy semi-structured interviews with policy-makers in the urban water sector, they suggest

that applicability, comprehensiveness, timing and accessibility (ACTA) better summarises the most important aspects of research influencing decision-making. Applicability aligns with the relevance component of CRELE. Data timeliness is especially a concern for application of findings from applied research and for instrumental use (Beyer and Trice, 1982) and thus highly relevant for this thesis on the use of monitoring data. Therefore, it is considered an additional data attribute.

From the demand-pull perspective, decision makers need comprehensive information that accounts for a broad range of variables (Dunn and Laing, 2017). However, McGinnes and Elandy (2012) observe that ‘The information age truism that knowledge is power does not seamlessly scale into ‘more knowledge is more power’. Availability of large quantities of information can also be a hindrance to the actual use of this information in decision-making and accountability processes (Schildkamp et al., 2014). Davies (1994) argues that those who receive information first in decision-making structures (generally members lower down the hierarchy) have the task of selecting information to pass up, so as to avoid decision makers being swamped with too much information. If this selection process is inadequate, decision makers will not receive the information they need.

Information needs to be accessible to potential users (Dunn and Laing, 2017). In addition to ‘physical’ accessibility of information, the discoverability and the degree of information processing and the way in which information is presented (Leviton and Hughes, 1981), readable and intelligible to its audience and users (Dunn and Laing, 2017), can influence data use.

The CRELE and ACTA frameworks both present factors related to data and information, which are believed to play a role in enabling or hampering the use of data. The data attributes presented in these frameworks (relevance, credibility, legitimacy, timeliness, comprehensiveness, and accessibility) are subjective, involving actor-specific judgements using different criteria and standards (Cash et al., 2003). However, these judgements are, at least partially, shaped by the observable data characteristics. For example, the scale at which data are representative will impact the relevance of the data from the perspective of different users, with nationally representative data considered relevant for policy-making by national government, but not for informing planning by local decision makers.

Table 2-2 presents a compilation of these data attributes based on the CRELE and ACTA frameworks, and their related characteristics.

The linear perspective introduced in this section emphasises the data characteristics and attributes presented in Table 2-2 as the main factors enabling or hampering data use.

Table 2-2: Data factors

Data attributes	Observable data characteristics	Data attribute descriptions
Relevance	Content of the data	Relevance of the data regarding the content, scale, frequency of the data for a specific use
	Frequency with which data are available	
	Scale in terms of number of units of observation	
	Scale in terms of unit of analysis	
Credibility	Data accuracy	Credibility of data by a specific data user
Timeliness	Data processing time	Timeliness of the data for a specific use
Comprehensiveness	Number of variables and indicators	Data comprehensiveness for a specific use
	Number of units of observation	
Accessibility	Accessibility, in terms of physical accessibility of the data	Data accessibility in terms of physical accessibility to a specific data user
	Discoverability of the data	
	Level of data processing	Data accessibility in terms of accessible and appropriate information products and formats to a specific data user
	Level of information product	

Source: Author

2.4.2 Relationship perspective

The second perspective focuses on quality of the relationships between data producers and users, considered by many as one of the most important factors for enabling or hampering data use (Daly, 2012), evaluations (Høydal, 2020; Cousins and Leithwood, 1986; Johnson et al., 2009) and research (Court and Young, 2006; Innvaer et al., 2002; Landry et al., 2007; Lomas, 2007; S. Nutley et al., 2007; Nutley and Reynolds, 2013; Nutley, 2012; Oliver et al., 2014). Oliver et al. (2014), for example, found that such relationships were considered a major facilitator of evidence use in over two-thirds of the 145 studies on barriers and enablers of evidence-use in policy-making they reviewed. Although the nature of the interactions between data producers and (potential) users has especially been a prime area of study within the research utilisation paradigm (Huberman, 1990), insights from this literature are expected to be relevant for the exploration of the use of monitoring data.

2.4.2.1 Models of interaction and co-production

Focus on the relationship between data producers and users goes beyond the demand-pull, data-push and dissemination models related to the linear perspective focused on data attributes. Criticism of these linear models included the lack of recognition of research users' involvement in research production and its focus on instrumental use. Responding to this criticism, Landry, Amara and Lamari (2001) introduced the interaction model. Under interaction models, knowledge utilisation is believed to depend on the relationships and interactions between knowledge producers and users, with collaborative or cooperative data production assumed to be more likely to lead to the production of relevant, useable knowledge (Heinsch et al., 2016).

According to the interaction model, knowledge utilisation depends on various disorderly interactions between data producers and users, rather than on linear sequences beginning with the needs of the producers or the needs of the users. The streams model for decision-making

provides a useful alternative to linear phase models presented under the linear perspective, as it emphasises the role of multiple stakeholders in the decision-making process. The *streams model* was initially developed by Cohen, March and Olsen (1972) and refined by Kingdon (1984). Under this model, a decision is an outcome or interpretation of several independent streams within an organisation: problems, solutions, and participants. These three horizontal streams are mostly independent from each other, each with their own development path, dynamics and rules (Kingdon, 1984) and therefore not linked in any temporal sequence (Teisman, 2000). Decisions occur when the streams come together. This causes uncertainty and unpredictability as decisions emerge from interaction between stakeholders, each with their own preferences, perspectives and strategies, leading to various (overlapping) rounds of decision-making (Teisman, 2000).

Landry, Amara, and Lamari (2001) observed that supporters of the interaction model can be divided into two camps: 1) the supporters of the 'two-communities theory', focused on the divide between researchers (as data producers) and policy makers (as data users), and 2) supporters of models focused on interactions and collaboration between data producers and users.

By the end of the 1970s, the two-communities theory was observed to be the most prevalent theory in literature for explaining non-utilisation of research in policy-making (Caplan, 1979a). The argument was that *'social scientists and policy makers live in separate worlds with different and often conflicting values, different reward systems, and different languages.'* (Caplan, 1979).

However, since then, there has been a move to look beyond the two-community perspective, resulting in the blurring, and even dissolving, of boundaries between research and practice (Heinsch et al., 2016; Høydal, 2020). Scholars in this second camp predict that more sustained and intense interactions between researchers and users (Landry et al., 2001), and more resources invested in linkages between researchers and practitioners, (Heinsch et al., 2016), will lead to utilisation. They do not draw clear distinctions between knowledge (and data) producers and users, but recognise their mutual influence in, what Jasanoff (2004), building on Latour (1993), labels 'co-production' of knowledge. Co-production of knowledge acknowledges that the research and policy systems produce knowledge together, with policy being part of knowledge production in the same way as knowledge production being part of policy (Høydal, 2020).

The two-community and co-production theories provide useful insights into data producer and user interactions, but do not provide comprehensive insight into the quality of relations. The concept of social capital provides a potentially useful framework for addressing this.

2.4.2.2 Quality of relationships and social capital

The social capital concept intends to provide insights into why certain people and organisations perform better than others (Burt, 2000). Social capital has become a core concept in business, political science, economics, organisational science, and sociology (Abbasi et al., 2014; Burt, 2005, 2000; Durlauf and Fafchamps, 2004; Lin et al., 2017).

Aspects of social capital, in terms of the qualities that define successful relationships between data producers and users, have been identified by many researchers as a prerequisite for using information in decision-making (McNie, 2007). Literature recognises that increasing the quality of a trusted relationship by creating more social capital between stakeholders can have a positive effect on information and knowledge sharing (Nahapiet and Ghoshal,

1998; Willem and Scarbrough, 2006), that it can produce more effective interactions between scientists and policy makers (Guston, 2001; McNie, 2007a; Pretty, 2003) and that it could foster the collection, dissemination, and usability of performance data (Tantardini and Kroll, 2015). Social capital can explain and facilitate the flow of information (Lin et al, 2017). Social capital can also play a role in hampering data use, though literature on risks of social capital is considerably more limited than literature on its benefits. Power benefits may, for example, in some cases trade off against information benefits (Adler and Kwon, 2002). However, Tantardini and Kroll (2015) observed that empirical proof for this is scarce and that the concept of social capital has been neglected in explaining variations in data use.

The various definitions of social capital in literature (e.g. Burt, 2005; Coleman, 1988; Lin et al., 2017; Putnam, 2000; Woolcock and Narayan, 2000) imply that social capital is an attribute of individuals or groups, determined through relations within their social network. As social capital has its roots in social networks and relations, social network analysis metrics could be applied in assessing social capital (Abbasi et al., 2014). This thesis focuses on the use of social network theory and analysis related to (structural) social capital in relationships between data producers and users and their influence on data use within data-use systems.

2.4.2.3 Social networks

Network theory has been applied in studies of knowledge transfer and use in education (Daly, 2012; Huberman, 1990), health (Oliver, 2013), infrastructure planning (Bogadi, 2019) and the water resource sector, but not the water supply sector.

Social network analysis is a collection of concepts, measures, and techniques for relational analysis (Scott, 2012). It involves the mapping and measuring of relationships and flows between nodes of a social network. It can provide visual (in the form of sociograms, with points or nodes representing actors, and lines or edges representing relationships between the points / nodes) and mathematical analysis of human relationships (Abbasi et al., 2014; Freeman, 1978; Scott, 2012; Wasserman and Faust, 1994). Social network research focuses on how outcomes are influenced not just by the attributes of the nodes (the actors in the network, and their capacities and motivations), but also by the ties (visualised by lines or edges) connecting nodes to each other. Social network analysis thus focuses on the type, quality, and intensity of interactions among individuals (Crona and Parker, 2011), and can be useful for better understanding relationships between data producers and users and the influence of links between them on data-use (as an outcome).

Social (network) ties between actors are the foundational element in social networks (Daly, 2012) and an important element of structural social capital (Nahapiet and Ghoshal, 1998; Tantardini and Kroll, 2015). A typology of ties suggested by Borgatti, Mehra, Brass, and Labianca (2009) includes social relations, interactions, and flows. Social relations can describe the type of relationship between actors, including accountability relationships. Interactions are the individual events that may be quantified and are facilitated by, and may occur within, a social relationship and vice versa. Flows represent both tangible and intangible resources that are transmitted through these interactions (Tantardini and Kroll, 2015), including data and information, financial resources, support etc. Network ties within a group can strengthen bonds within a network, which can facilitate information exchange between actors in a group.

A bridge is a network tie between two otherwise unconnected groups. The resulting bonding and bridging social capital is discussed in more detail below.

Social networks can be perceived at different scales: the ego-network, which can help describe and analyse individuals or groups (actors) within a social system; dyadic relationships, focused on the links (ties) between individual actors; and a whole social system, focused on the structure of these links within the network (Oliver, 2013). As this thesis is mainly interested in the relationships between data producers and users, ego-networks and dyadic relationships are of most interest under the relationship perspective.

Network configuration describes the pattern of linkages in terms of social network terms such as network density, connectivity, and hierarchy (Claridge, 2018; Nahapiet and Ghoshal, 1998). Tantardini and Kroll (2015) identified network configurations and network ties as important elements of structural social capital which can facilitate timely information exchange. Quantitative social network analysis approaches focus on structural social capital. They are limited in considering the content, quality, and meaning of relationships (Bonney et al., 2023). However, it is not just the presence (and quantity) of relationships (structural social capital), but also quality of social ties (relational and cognitive social capital) that are important for creating an enabling environment for data use to take place (Daly, 2012). Qualitative network approaches are especially useful for understanding the concrete acts, practices, interactions and communication patterns in light of the respective context in which they occur (Hollstein, 2011). As such, they can provide better insight into the relational and cognitive social capital.

2.4.2.4 Types of social capital in social networks

A commonly made distinction in social capital, based on social network theory, is the distinction between bonding and bridging social capital. Bonding social capital refers to inter-community ties, between people with similar characteristics, such as demographic and socio-economic characteristics (Adler and Kwon, 2002; Claridge, 2018; Woolcock and Narayan, 2000). Bonding social capital implies high density networks (Claridge, 2018). Bridging social capital focuses on external relationships. This builds on Granovetter's (1973) concept of a bridge as a line in a network which provides the only line between points, connecting two otherwise unconnected high density networks. It focuses on social capital as a resource that inheres in the social network tying a specific actor to another (Adler and Kwon, 2002). In addition to bonding and bridging social capital, 'linking' social capital has been identified as an additional type of social capital, mainly as a sub-set of bridging social capital, focused on vertical links between individuals or groups at different hierarchical positions (e.g. based on power, social status or wealth). Bridging and linking can especially play a role in ensuring data flows between data producers and users.

Another common social capital differentiation, focused on sources, rather than on consequences of social capital (Abbasi et al., 2014) is Nahapiet and Ghoshal's (1998) conceptualisation of three (interrelated) dimensions of social capital: 1) structural social capital, 2) relational social capital, 3) cognitive social capital. This is in line with Putnam's (1993) concept of networks, trust and norms as features of social organisation related to social capital, and Pretty's (2003) four important features of social capital (connectedness in networks and groups; relations of trust; reciprocity and exchanges; common rules, norms, and sanctions). The three dimensions are highly interrelated (Claridge, 2018). Empirical studies have found that differences in professional

goals (cognitive social capital) between data producers and users cause tension and mistrust (relational social capital) between them (Hemsley-Brown and Sharp, 2003).

Structural social capital refers to the overall patterns of connections between actors (Nahapiet and Ghoshal, 1998). Structural social capital is tangible and can be observed by the existence of network ties discussed above, as well as roles, rules, precedents, and procedures (Claridge, 2018). Data producers are often far removed from those who could ultimately use these data in decision-making (Custer and Sethi, 2017). The wider the gap between data producers and users, the greater the risk of a mismatch between data supply and demand (Custer et al., 2016a, b), especially in terms of their relevance, credibility, and comprehensiveness. This is possibly especially prevalent in research use, where Saul Feldman, in Lomas (2000), compared researchers and practitioners to 'strangers in the night, dimly aware of each other's presence', but could also play a role in the use of monitoring data at different levels.

Relational social capital refers to the degree of trust and reciprocity. It describes the kind of personal relationships actors have developed through a history of interactions, that influence their behaviour (Nahapiet and Ghoshal, 1998). This social capital dimension is intangible, as it is about what and how people think and feel (Claridge, 2018). There is surprisingly little literature in public administration, public management and policy science on trust (Edelenbos and Klijn, 2007) and its role in governance networks (Klijn et al., 2010). Where the concept of trust has been applied, it concerns mostly trust of citizens in public actors, rather than trust between public and other actors in decision-making networks (Edelenbos and Klijn, 2007). Exploring existing definitions on trust, Edelenbos and Klijn (2007) concluded that trust refers to a more-or-less stable perception of actors about the intentions of other actors, with the assumption that they would refrain from opportunistic behaviour. Literature mainly distinguishes two types of trust: particularised trust and generalised trust (Freitag and Traunmüller, 2009; Patulny, 2004; Patulny and Lind Haase Svendsen, 2007; Uslaner, 1999; Uslaner and Brown, 2005), with particularised trust building on the economic conception of rational choice, based on availability of information about actors as the basis of trust, and generalised trust based on the sociological conception of trust based on morals and faith, rather than information (Patulny, 2004; Patulny and Lind Haase Svendsen, 2007). Bonding social capital is based on rational-process particularised trust, while bridging social capital is based on moral-normative generalised trust (Patulny, 2004).

Daly (2012) recognised that measuring relational quality of exchanges between actors through network methods may provide additional analytic insights in the use of data for improvement. Recognising that trust is a key element in this, he suggests that quality of social interactions could be indicated in network terms through reciprocated relationships. A reciprocated tie is one in which actors have a symmetric or mutual tie (Daly, 2012) with simultaneous exchanges of goods and knowledge of roughly equal value (Pretty, 2003). Reciprocity increases trust and contributes to the development of long-term obligations between people (Pretty, 2003). Reciprocated relationships provide opportunities for mutual exchange of resources and the creation of norms (cognitive social capital) between actors (Daly, 2012).

Relations of trust facilitate cooperation between actors, reducing transaction costs between them (Pretty, 2003). This can thus strengthen relations between data producers and users and the flows between them. However, trust and reciprocated relations in decision-making networks

between decision makers and actors other than the data producers, can possibly hamper data use. A study by Cross (2001) cited in Daly (2012) suggested that individuals tend to seek data from trusted colleagues with whom they have a reciprocated relationship, rather than from those individuals who are recognised as experts. In cases of high relational capital between decision makers and actors other than data producers, this relationship could thus actually hamper data use by the decision maker.

Cognitive social capital refers to the resources providing shared representations, interpretations, and systems of meaning among actors (Nahapiet and Ghoshal, 1998). It is the degree to which actors have and use the same goals, values and language / definitions. Common rules, norms, and sanctions can give individuals the confidence to invest in the collective good. These are mutually agreed upon or handed-down drivers of behaviour that ensure group interests are complementary with those of individuals (Pretty, 2003). Different language and perceptions, including on relevance, credibility and legitimacy can impede communication and coordination across boundaries (Cash et al., 2003). Lack of common language can play a role in communication challenges between data producers and users as described in the 'two-communities theory'. This theory gives insight into possible challenges in communication between data producers and users, and hence data utilisation, caused by differences in culture and knowledge (Caplan, 1979). Edelenbos et al. (2011) recognised that a variety of actors can be involved in production and use of knowledge and that the knowledge differs in terms of both content and orientation and emerges within different institutional and social contexts. They identify three types of knowledge in decision-making processes (scientific, bureaucratic and actor knowledge), each with their own language, norms and values, systems and warrants, rules of the game, procedures and criteria.

The relationship perspective presented in this section emphasises that the quality of relationships between data producers and users - in terms of structural, relational, and cognitive social capital - is crucial for enabling data use.

2.4.3 Behaviour systems perspective: Capacities, motivations and opportunities for data use

The third perspective for explaining actual data use takes the individual (potential) data users and their context as the entry point. As mentioned by Beyer and Trice (1982), *'utilisation is a complex behavioural process. Conceptual frameworks that fail to reflect this ignore some parts of the phenomenon.'* Therefore, the third perspective takes a behaviour systems perspective, going beyond the purely rational decision-making of the linear perspective, providing space for bounded rational and incremental decision-making.

The incrementalist view of decision-making sees decision-making as an inescapably political activity into which perceptions and interests of individual actors enter at all stages (Hezri and Hasan, 2004). The incrementalist approach to decision-making, spearheaded by Lindblom (1959), features policy processes characterised by bargaining and compromise strategies among individual actors. This form of decision-making tends to focus on remedying ills, rather than seeking positive goals, and on incremental change or change at the margins. Only a restricted number of alternatives is reviewed and a limited number of consequences

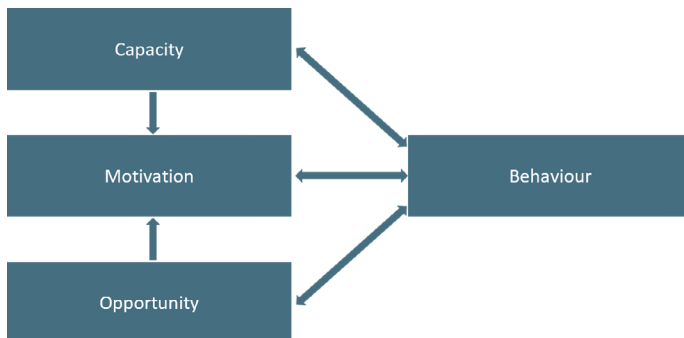
is envisaged and evaluated for any given alternative (Hezri and Hasan, 2004; Smith and May, 2013). The role of information in informing incremental decision-making processes is limited. In general the incrementalist view of ‘muddling through’ seems to be more in line with observations of real political processes, as opposed to the rationalist view, which seems to present more of a utopian view, as mentioned above. However, ‘good decisions’ are assessed not by the ranking on some objective evaluative criterion but simply by their acceptability in a particular situation. This tends to favour interests of the most powerful and can be undemocratic. In addition, incrementalism tends to undermine the search for promising new alternatives by discouraging systematic analysis and planning (Howlett and Ramesh, 2003). In the long run, choosing a sub-optimal solution can prove to be more costly than doing a thorough analysis of alternative options, which yields the optimal solution (Smith and May, 2013).

Bounded rationality takes a less radical view and considers a higher role for data in informing policy and practice. It acknowledges the limitations of humans when it comes to processing information as well as to time and cost constraints. In bounded rationality, informed decision makers seek to select satisfactory and sufficient alternatives, rather than the best alternative in objective terms (Simon, 1955). In that respect, it differs from comprehensive rationality under which a decision maker seeks to maximise through the collection and evaluation of all information about all alternatives.

The COM-B model, developed by Michie et al. (2011), following their review of existing behaviour change frameworks, proposes that behaviour (B) arises from the interactions of capabilities (C), opportunities (O) and motivations (M) within behaviour systems, which in turn influence these factors. This framework may provide insight into the factors that enable and push (or hamper) actors to use data in decision-making and accountability processes.

Under the COM-B model, capability is defined as an individual's psychological and physical capacity, including the necessary knowledge and skills, to engage in the activity concerned. Motivation is defined as the brain processes that energise and direct behaviour of an individual. Opportunity is defined as all the factors that lie outside the individual that make the behaviour possible or prompt it (Michie et al., 2011).

Figure 2-4: COM-B model



Source: Michie, van Stralen, and West, 2011

2.4.3.1 Individual capacity

Capabilities and capacities of data users (understanding, skills and experience to collect, analyse, interpret and use data) have indeed often been mentioned in literature as factors influencing actual data use (Caio et al., 2018; Harrison and Nutley, 2010; Li et al., 2018). In their study into enablers and barriers to data use in schools in five European countries, Schildkamp et al. (2014) found that training in the use of data was likely to be the most important factor accounting for differences in data use between countries.

2.4.3.2 Individual motivation

Motivation is also recognised as an important factor that can enable or hamper use of data for decision-making, in terms of personal interest (Wickremasinghe et al., 2016), willingness (Caio et al., 2018), commitment and motivation (Li et al., 2018) to use data for decision-making and the intrinsic desire to evaluate and improve one's practice and performance (Marsh et al., 2006). Potential data users will be more likely to use data when the data supports their interest, and more likely to disregard or reject data when this is not the case (Beyer and Trice, 1982).

2.4.3.3 Opportunities

Different factors related to opportunities for data use have been identified in literature on knowledge, research and data use. These have enabled and prompted data use, either directly, and/or indirectly, by stimulating motivation for data use. These opportunity factors include organisational culture and capacity for data use, the sectoral context, and the general context related to political economy and culture related to data use.

Organisational opportunities for data use: Information culture is manifested in the organisation's practices, values, and norms that have an impact on how information is perceived, created and used (Choo et al., 2008). Key components of positive information culture include individual, organisational and institutional capacity, but also a clear vision and explicit expectations for data use; a focus on continuous improvement; and leadership that models and supports data use (Lasater et al., 2020).

Farley-Ripple and Buttram (2015) observed that in addition to the individual capacity lens introduced in Section 2.4.3.1, capacity in data use research is often understood as the organisational conditions to support or enable data. Organisational capacity factors which have been identified to play a role in enabling or hampering data use include 1) Human resources and time availability to collect, analyse and interpret data (Marsh, Pane, and Hamilton, 2006); 2) Financial capacity (Caio, Coppard, and Dodd, 2018; Viswanathan, Karthykeyan, and Williams, 2021) and budget allocation (Li et al., 2018) for production and use of data and analysis; and 3) Technical capacity for production, analysis and use of data, related to the presence of information systems and decision support tools (Caio et al., 2018; Li et al., 2018; Schildkamp et al., 2014).

Sectoral opportunities for data use: These include the presence and strength of data-use systems, including the national policy-making, planning, regulatory and accountability, infrastructure management, and learning and adaptation (sub)systems (or systems building blocks). Strong data-use systems are characterised by clear guidelines, mechanisms and incentives for data use. Incentives can enable or prompt data use (Caio et al., 2018; Mackay, 2006; Viswanathan et al., 2021). For example, development partners can play a role in setting

clear incentives for inclusive, multi-stakeholder approaches and for support to the production, sharing and use of data (Caio et al., 2018). They can provide pressure for evidence-informed policy and programme decisions, which can facilitate better data use (Li et al., 2018). Incentives can be formal or informal and can involve material incentives, with material reward; solidarity incentives, with intangible rewards derived from the act of association (e.g. status, identification); or purposive incentives, with intangible rewards related to the goals of the organisations (e.g. work satisfaction) (Clark and Wilson, 1961).

Contextual opportunities for data use: There is growing acknowledgement that the political context (Court and Young, 2006; Crewe and Young, 2002; Jones et al., 2013) and the political economy influence data use in water supply (WaterAid, 2019) and beyond (Caio et al., 2018; Porter and Feinstein, 2014; Turner and Coburn, 2012).

The relationship between the nature of the political (economy) system and the importance given to knowledge in policy processes is very complex (Jones et al., 2009). Politics is often framed as a barrier to rational data-based decision-making (Smith, 2013). For example, Henig (2012), who views politics as a matter of ideology, partisanship, and systemic and personal powers, observed that ideology can lead to selective data use when data are not in line with the ideology; partisanship can lead to elected leaders promoting agendas based on what can get them re-elected, rather than based on data; and systemic and personal powers can be used to manipulate data to support specific interests. However, he suggests that rather than viewing politics as a threat to data use to be avoided, it is a reality that needs to be understood and taken into account as an important factor influencing data use. Smith (2013) also argues that politics should not be seen as a barrier, but that there is a need to explore how data production, ethics, politics, values, and democratic ideas are intertwined.

The political context for data use includes political and economic structures and interests, systems of innovation, institutional pressures, cultural differences, preference for incremental vs radical change, and so on (Court and Young, 2006).

The political economy of a country is about how a country is managed or governed, taking into account both political and economic factors (Veseth and Balaam, 2025). It is about the interplay between political and economic systems: how political institutions, processes, and power influence economic outcomes, and how economic structures influence power dynamics. WaterAid (2019) perceives the political economy of decision-making as the institutions, incentives, and ideas that shape the behaviour of key decision makers. Porter and Feinstein (2014) suggest that when there is an active demand for data and when there is a supply of good quality data that works within the conditions of the political economy, data are likely to be used.

This thesis has already considered some of the political economy elements mentioned above, such as institutions and incentives, as sectoral opportunities for data use. Therefore, this thesis considers that a political economy that provides opportunities for data use involves power relations, vision, and political leadership that create favourable conditions for data use.

Culture can also be a contextual opportunity for data use as it can affect how data are perceived and used (Firestone and González, 2007; Harrison and Nutley, 2010; Lasater et al., 2020; Li et al., 2018; Marsh et al., 2006; Viswanathan et al., 2021; Voogt and Pieters, 2019). Without an enabling culture in which evidence can be actively and safely sought out, openly

discussed, correctly appraised, and acted on, data will not lead to evidence-based decision-making (Caio et al., 2018). Based on models and definitions from sociology and anthropology, with their long tradition of studying culture, Schein and Schein (2017, p. 6) defined the culture of a group as *‘the accumulated shared learning of that group as it solves its problems of external adaptation and internal integration; which has worked well enough to be considered valid and, therefore, to be taught to new members as the correct way to perceive, think, feel, and behave in relation to those problems.’* This includes macro-cultures (including nations, ethnic and religious groups and global occupations), organisational cultures, and subcultures and microcultures (Schein, 2010).

In their influential work on national cultural dimensions, Hofstede et al. (2010) identify six dimensions of national culture on which they score national cultures on a low to high continuum. Table 2-3 gives an overview of these dimensions and of the characteristics of high and low scoring cultures. These cultural characteristics can play a role in enabling or hampering data use, as also indicated in the table.

Table 2-3: National culture dimensions and data use

National culture dimension	Data use related characteristics	
	Low score	High score
Power distance	Managers rely on own experience and on subordinates; Subordinates expect to be consulted. Likely to enable data use.	Managers rely on superiors and formal rules; Subordinates expect to be told what to do. Likely to hamper data use, except for reporting for upward accountability, and possibly regulatory decision-making.
Individualism	Social network is source of information; Hiring and promotion takes employee's group into account; In-group consumers get better treatment; Relationship prevails over task. Likely to hamper data use (for operational decision-making and performance regulation).	Media is source of information; Hiring and promotion based on skills and rules only; All customers get same treatment; Task prevails over relationship. Likely to enable data use.
Motivation towards achievement and success		Likely to enable use of KPIs for regulator
Uncertainty avoidance	Top managers are concerned with strategy; Focus on decision process; Change of law if they cannot be respected; Citizens are competent towards authority. Likely to enable data use for policy-making, strategic planning, reporting for downward accountability.	Top managers are concerned with operations Focus on decision content; Laws are needed, even if they cannot be respected; Citizens are incompetent towards authority. Likely to enable data use for operational decision-making and planning of short-term solutions

National culture dimension	Data use related characteristics	
	Low score	High score
Long-term orientation	Efforts should produce quick results; Work values: freedom, rights, achievement, thinking of self; Priority to abstract rationality. Likely to enable data use for operational decision-making and planning of short-term solutions.	Sustained efforts towards slow results; Work values: learning, honesty, adaptiveness, accountability, self-discipline; Priority to common sense. Likely to enable data use for reporting for accountability, and learning and adaptation.
Indulgence	Likely to enable data use for reporting (for upward accountability).	

Source: Hofstede et al. (2010); The Culture Factor Group (n.d.). Statements in bold by author.

The political economy and national culture are related to and influence each other. Hofstede et al. (2010) observed that especially cultural norms regarding power distance and uncertainty avoidance influence who has decision power in organisations.

The behaviour systems perspective introduced in this section emphasises that individual capacities and motivations for data use, combined with external opportunities including organisational capacity, incentives, and sectoral (systems strength) and general context factors (power, politics and national culture), determine whether data will actually be used.

2.4.4 Comprehensive systems perspective

The previous three perspectives on data use each put emphasis on different factors that are believed to play a role in enabling (or hampering) actual data use. The fourth perspective brings these different factors together and focuses on how the factors influence each other.

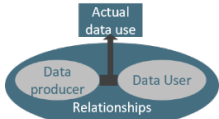
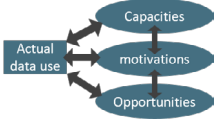
Larsen (1980, p. 424) recognised that *‘Knowledge utilisation is a complex process involving political, organisational, socioeconomic, and attitudinal components in addition to the specific information or knowledge.’* While Crewe and Young (2002) considered the three clusters of factors as reasonably independent, systems models for data use recognise that these factors can interact with the (use of) data, as well as with each other, so that the constantly emerging process transforms the terms of the interaction as it progresses (Smith, 1977). The use of data is affected by a complex set of factors, which do not lend themselves easily to causal analysis (Rich and Oh, 2000). As observed by Turner and Coburn (2012) little is known about how the different factors interact with one another. When trying to understand the use of monitoring data, one needs to be cognizant of the contribution, or intrusion of such factors to the eventual use of data.

The comprehensive systems perspective recognises that data use depends on complex interactions between data attributes, relationships between data producers and users, and individual capacity, motivation and opportunities for data use.

2.4.5 Overview of the four perspectives for data use

Table 2-4 summarises the four perspectives of data use introduced in this chapter.

Table 2-4: Overview of the four perspectives

	Linear perspective	Relationship perspective	Behaviour systems perspective	Comprehensive systems perspective
Decision-making paradigm	Rational decision-making	Two-community / co-production	Bounded rationalism and incrementalism	Bounded rationalism
Decision-making model	Phase model	Stream / round model	Behaviour systems model	System models
Data-use model	Science/data-push	Interactive	Demand-pull	Combination
Explanatory variables	Engineering	Socio-organisational	Socio-organisational	Engineering and socio-organisational
Main focus	Data	Relationships between data producers and users	Individual data users in context	Relationships between factors
Main factors of interest	Data characteristics and attributes	Quality of relationship between data users and producers, in terms of structural, relationship and cognitive social capital.	Individual motivation, capacity, and opportunities (organisational capacity, incentives, context) for data use	All previously mentioned factors and the influence of factors on each other
Schematic overview				

Source: Author

These perspectives have different ontological backgrounds and relate to different epistemological traditions. The linear perspective relates to the positivist tradition (Comte, Durkheim, Ayer), which assumes value-free knowledge can be obtained. The relationship perspective relates to the social constructivist tradition (Berger and Luckmann, Bloor), which assumes that knowledge is not objective, but subjective, and the result of social interaction. The third perspective considers decision makers in their organisational, institutional, and political economy and cultural context. This relates to the critical theory tradition (Horkheimer, Adorno, Marcuse) which assumes knowledge is inseparable from power and interests. Systems thinking, the focus of the fourth perspective, has been linked to different epistemological traditions over time, including those related to the first three perspectives. At its conception, General Systems Theory was framed in the positivist tradition, seeking universal laws applicable to all systems. Later, systems thinking diverged into multiple epistemological streams, including the positivist hard systems thinking stream, the constructivist soft systems thinking stream, and the critical systems thinking stream. Nowadays, systems thinking is generally no longer considered to be epistemologically monolithic. Therefore, the comprehensive systems perspective has the potential to integrate the factors enabling and hampering data use from the linear, relationship, and behaviour systems perspectives.

2.5 Leverage points

This section presents the conceptual background for answering part of question 4: *‘What are the leverage points for enabling monitoring data use?’*

Complex adaptive systems generally have the property that a small input can produce major, predictable, directed change through an amplifier effect (Holland, 2006; Meadows, 1999; Valcourt et al., 2020b). Identifying where these leverage points are located in a system and understanding how they can be adjusted to lead to more favourable outcomes is an essential element of effectively strengthening complex systems (Valcourt et al., 2020b). However, leverage points are not intuitive and there are no quick and easy formulas for finding them (Meadows, 1999). Leverage points are not to be confused with root causes. In complex adaptive systems, many factors are interlinked and there is no central control mechanism of the system (Burns and Worsley, 2015). Systems analysis is useful for identifying such leverage (tipping) points for systems change (De Savigny and Adam, 2009).

The combination of the different factors explored under the first three perspectives and their interrelations can provide insight into the leverage points for ensuring actual data use.

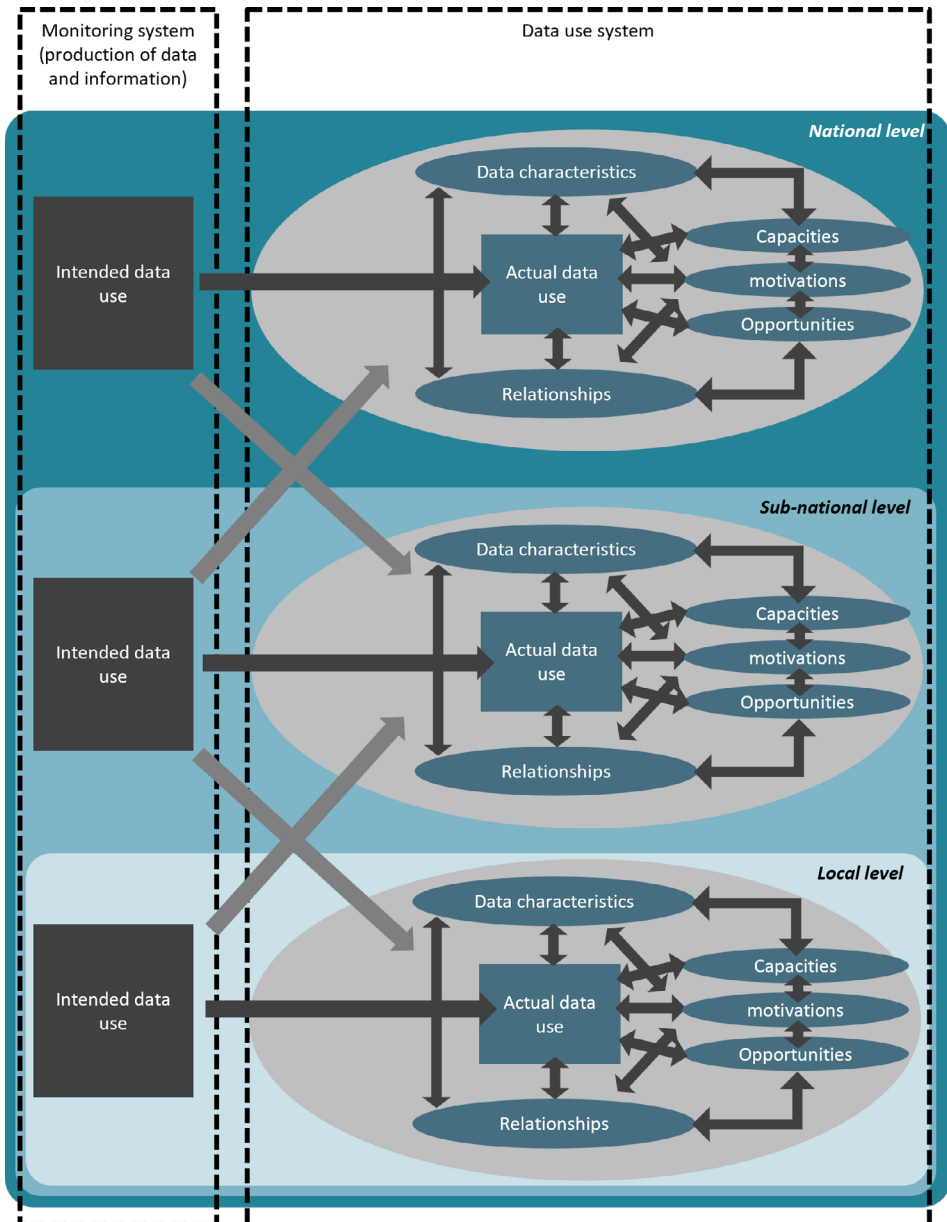
2.6 Conceptual framework

This section presents the conceptual framework used in this thesis which brings together the concepts related to the intended and actual use of monitoring data, and the factors that enable or hamper actual data use from different perspectives introduced in the previous sections of this chapter. This framework is visualised in Figure 2-5.

The conceptual framework recognises three nested and linked governance levels at which data use is intended to take place in line with the objectives of the monitoring system, and at which actual data use for informing decision-making and accountability take place within the data-use system. These levels are the national level, the sub-national level, and the local level. As introduced in Section 2.1, intended use of monitoring data is stated as part of the objectives of the monitoring system, both explicitly expressed in guidelines and manuals and implicitly expressed in monitoring system components, such as indicator frameworks, data collection tools, processes and roles and responsibilities etc. The intended use influences the actual level of (instrumental, conceptual) data use, from level 1 to 6 as described in Section 2.3. Furthermore, actual data use is expected to depend on a variety of factors, explored through four different perspectives: the linear perspective focusing on data characteristics and attributes (Section 2.4.1); the relationship perspective, focusing on interactions and the quality of relationships between data producers and users (Section 2.4.2); the behaviour systems perspective, focusing on capacities, motivations, and opportunities for data use (Section 2.4.3); and the comprehensive systems perspective, combining the different factors, and focusing on how they influence each other (Section 2.4.4).

This conceptual framework provides the foundation for analysing the use of monitoring data across multiple levels and perspectives and the complex factors that influence data use in practice.

Figure 2-5: Conceptual framework



3 METHODOLOGY

This chapter presents the methodological approach and framework. It introduces the study approach, the variables, assessment methods, detailed research questions, and data collection methods. It closes with an overview of the methodological framework of this thesis.

3.1 Study approach

Many studies on data and evidence use focus on quantitative, survey-based approaches, capturing decision makers' attitudes and perceptions (Honig and Venkateswaran, 2012; Innvaer et al., 2002; Kroll, 2015; Verboom and Baumann, 2022). However, due to their complexity and systemic nature, the study of data- and evidence-use processes calls for more in-depth, qualitative case study approaches, with greater use of more direct methods of observing such processes (Molloy, 2010; Nutley, 2012; Verboom and Baumann, 2022), including interviews and document analysis (Innvaer et al., 2002). Interpretive qualitative methods are commonly considered most appropriate (Verboom and Baumann, 2022). Contandriopoulos et al. (2010) found case study methods to be ontologically better suited for studies into evidence use in decision-making than any other method.

The use of case studies has the potential to bridge the gap between the positivist, rationalistic ideal of data use in decision-making and the more incrementalistic and messy reality. Therefore, this thesis takes a case study approach that is focused on qualitative data collection and analysis, to answer the first three research questions. This approach is elaborated in Section 3.1.1.

To answer the fourth research question on leverage points for enabling data use, the thesis goes beyond a case study approach. It applies a structural analysis of the network of enabling and hampering factors and identifies possible leverage factors accordingly. This approach is elaborated in Section 3.1.2.

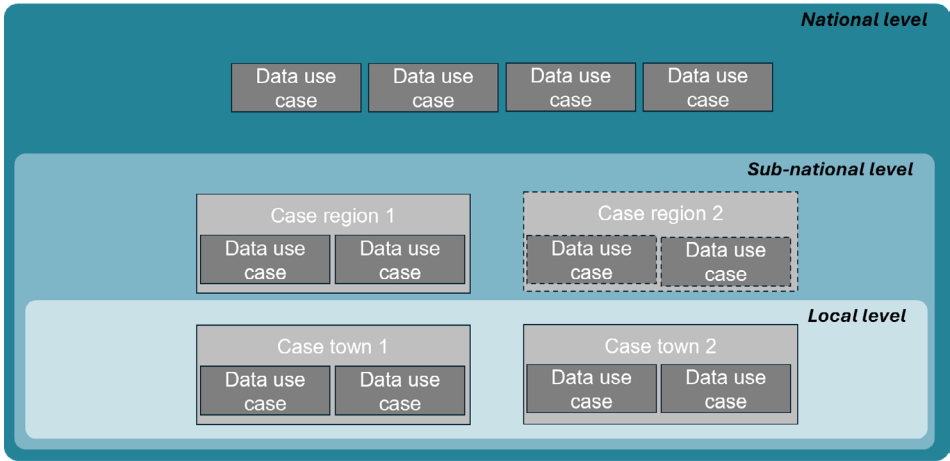
3.1.1 Case study approach

Yin (2009) defines a case study as *'an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident'*. Defining the main unit of analysis is the first step in case study design (Yin, 2012). A case can be an integrated system (Stake, 2005), a bounded system (Merriam, 1998) or a phenomenon that occurs in a bounded context (Miles and Huberman, 1994). Case study design can involve single or multiple case studies with single or multiple embedded cases (Yin, 2012).

This thesis focuses on a single overall case study, the phenomenon of the use of monitoring data in town water supply, with multiple nested data use cases at different institutional levels. Data use cases at the local level are primarily focused on two selected case study towns, while sub-national data use cases focus on the regions of the case study towns.

Each data use cases concerns a specific data-use-focused phenomenon (e.g., data use for policy-making, planning, operational, regulatory decision-making, or reporting for upward, sideways or downward accountability) and a specific user of these data (a decision maker or duty bearer reporting for accountability to a rights holder). Figure 3-1 presents an overview of the nested cases.

Figure 3-1: Nested cases



Source: Author

This thesis applies the three different types of case studies identified by Yin (2012): exploratory, descriptive, and explanatory case studies. Each of these case study types is used to answer one of the first three research questions. An exploratory case study is applied to identify and explore the relevant data use cases nested within the Ethiopia town water supply case, answering research question 1. Actual observed data uses in the different identified data use cases are described and assessed in terms of the type and degree of use, answering research question 2. Explanatory case studies explain the observed data use, or lack thereof, answering research question 3 about enabling and hampering factors. Four explanatory theories are used for doing so, each from one of the first four theoretical perspectives presented in Chapter 1 and 2, each with a focus on a specific set of explanatory variables. The linear perspective focuses on data characteristics and attributes, the relationship perspective focuses on the relationships between data producers and users, and the behaviour systems perspective focuses on motivations, capacities and opportunities for data use. Pattern matching analysis, comparing the hypothetical theoretical influence of the different factors with the actual course of events (Yin, 2012) between the various data use cases, is applied to get insight into the explanatory strength of the factors under the different perspectives.

3.1.2 Case selection

Ethiopia provides a typical case of a resource-constrained country where multiple national, sub-national and local initiatives involving different actors (including government, development partners

and utilities) have resulted in the development of different water supply monitoring systems, with various, often overlapping, objectives. Therefore, Ethiopia was selected as the main case study. In addition, this was informed by practical reasons like the author's experience and knowledge of the Ethiopian water supply sector, the ease of access to national actors due to existing relationships, and availability of logistics, linked to the author's involvement in several projects in the country.

Two case study towns were selected to get local-level insights. These were purposefully selected based on the following criteria:

- Presence of a functional water service scheme
- Presence of a functional monitoring system
- Ease of access to local actors and access to facilitating logistics

Based on these selection criteria, Jinka in South Omo Zone in Southern Nations and Nationalities Peoples' Region (SNNPR), and Wukro in Tigray Region were selected as case towns. Table 3-1 presents several characteristics of the two towns, their context and their water supply schemes.

Table 3-1: Characteristics of the case study towns (2018)

Characteristics	Jinka	Wukro
Region	SNNPR	Tigray Region
Establishment	SNNPR proclamations 170/2017	Tigray proclamation 257/2014
Estimated (projected 2023) population	56,881	67,069
Production (m3/year)	358,088	649,675
Production (litre per capita per day)	24	37
Number of connections	3,082	7,073
Number of staff	32	79

The regions in which the towns are located were selected as regional-level cases. However, as no systems were reported to be in place for using utility data at the regional level in SNNPR, this thesis focused on data use cases in Tigray Region.

3.1.3 Structural analysis using the MICMAC approach

This thesis applies structural analysis to explore the relationships between the various factors enabling and hampering data use from the first three theoretical perspectives. This comprehensive systems perspective is the fourth theoretical perspective explored in this thesis. This does not only contribute to answering research question 3, on the enabling and hampering factors, but also provides insight into possible leverage factors, answering research question 4.

Structural analysis involves the description of a system by using a matrix which interconnects all the system factors. It allows the detection of mutual influence and relationships between the factors of studied systems and identification of main driving variables (Godet et al., 1994; Nazarko et al., 2017). The advantage of structural analysis is its ability to identify the ties between factors, whose mutual influences are not obvious and may remain unrecognised even by experts in the field (Nazarko et al., 2017). Since its emergence in the 1960s (Gordon and Hayward, 1968), it has been widely applied in identification of main driving factors in complex systems to inform decision-making (Arantes and Ferreira, 2023; Arcade et al., 1999; Godet et al., 1994). This has, for example, included the construction sector (Arantes and Ferreira, 2023;

Hussain et al., 2023), the health sector (Bashini and Suresh, 2018), the ICT sector (Gupta and Singh, 2023), logistics management (Pfohl et al., 2011), and rural water service sustainability (Valcourt et al., 2020b; Walters et al., 2017).

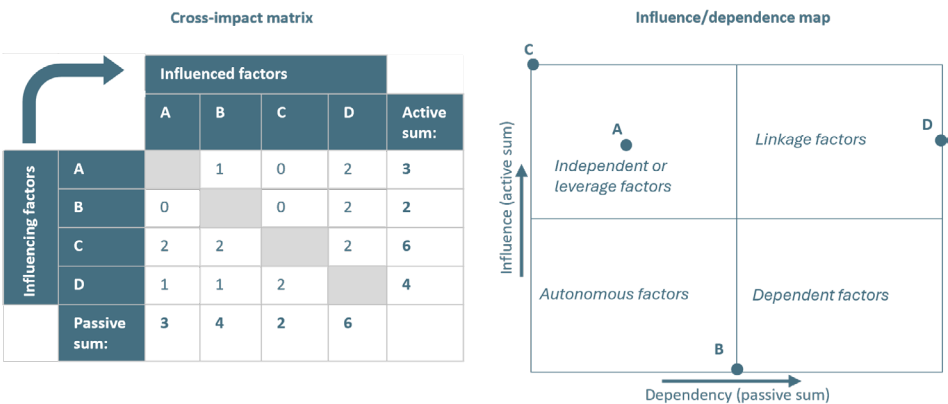
The MICMAC (Matrice d'Impacts Croisés-Multiplication Appliquée à un Classement, or Cross-Impact Matrix Multiplication Applied to Classification) approach, developed by Godet and Duperrin, presents an operational method to rank factors and assess the factors with the highest driving power within a system.

As a first step of the approach, all internal and external factors that characterise the system are identified. This is commonly done through group brainstorming, but can also be fed by key informant interviews and literature (Godet et al., 1994).

In step 2, the relationships between the factors are quantified in terms of the influence the factors are perceived to have on each other. A factor influence score of 0 (no influence) to 3 (high influence) is assigned. This is done by setting up a cross-impact matrix, as shown in Figure 3-2. For each factor the question is asked: 'if variable A changed, what would be its direct impact on variable B?' (Asan et al., 2004; Godet et al., 1994).

In step 3, the factors are plotted on an influence/dependence map, based on their dependence (passive sum, plotted on the x-axis) and their influence power (active sum, plotted on the y-axis). Based on their relative dependency and influence on each other, visualised by their position in the influence/dependence map, factors are categorised as autonomous, dependent, linkage or independent/leverage factors (Attri et al., 2013; Manjunatheshwara and Vinodh, 2018), as shown in Figure 3-2. Linkage factors are unstable, outcome-dependent factors. Any action on these factors will have an effect on other factors and a feedback effect on themselves (Attri et al., 2013). These are factors that need to be protected, but are unlikely to function as leverage factors (Walters et al., 2017). Autonomous factors are factors with low significance in the system, with relatively low influence and dependency. Dependent factors are highly sensitive to other factors. Independent factors, which are highly influential but with low dependency on other factors, could be the leverage factors referred to in Chapter 2 and the answer to research question 4.

Figure 3-2: Cross-impact matrix and influence/ dependency map example



Source: Author, based on Walters et al. (2017)

In addition to assessing the direct impact, based on the active and passive sums, MICMAC considers the indirect relationships between factors, e.g. when factor A directly influences factor B ($A \rightarrow B$), but also indirectly influences factor B through influencing factor C ($A \rightarrow C \rightarrow B$). A system of matrix multiplications is applied to the cross-impact matrix, based on the classical properties of Boolean matrices (Godet et al., 1994). This allows for assessing the diffusion of impacts through reaction paths and loops. Comparison of direct and indirect influence maps can provide insight into how the influence and dependency of factors may evolve over time, based on their direct or indirect interaction (Walters et al., 2017).

3.2 Variables, assessment methods and detailed research questions

This thesis describes data use cases (research question 1) and actual use of different monitoring data sets in the town water supply sector in Ethiopia (research question 2), and aims to explain the degree of observed actual data use through a variety of factors (research question 3). Furthermore, it explores which factors have the highest leveraging power (research question 4). The main dependent variable of interest for this thesis is the degree of actual use of monitoring data and the factors enabling and hampering data use are the explanatory variables. This section presents the assessment and analysis methods and detailed research questions for each of the four research questions.

3.2.1 Research question 1

The first research question of this thesis is *'What are the different use cases for town water supply monitoring data in Ethiopia? And how have these been shaped?'*. To answer this question, the monitoring landscape in Ethiopia and its components are explored and described. This includes an exploration of the purpose and objectives of the monitoring system which give insight into the *intended* data use cases. These are generally expressed in manuals and guidelines. Whether monitoring data have the *potential* to be used in line with the explicitly expressed data use cases depends on the other components of the monitoring system, including the indicator framework, data collection and processing tools and procedures, ICT platforms, and financial resources and flows, as set out in Section 2.2. These components are explored as well, based on which an assessment is made of the potential data use. The case study also explores what drove and shaped the development of the monitoring system.

Research question 1 is thus broken down into the following sub-questions:

1. What are the intended monitoring data use cases, explicitly expressed in the monitoring manuals and guidelines?
2. What are the potential monitoring data use cases, implicitly expressed in the monitoring system components?
3. What has driven the design of the monitoring system and its data use cases?

3.2.2 Research question 2

To answer the second research question of this thesis, *'How and to what degree are monitoring data actually used?'*, observed actual data use cases are described according to the purpose of the use (the 'what') and the type of use (the 'how'). Types of data use (the 'how') include: no use, conceptual use, instrumental use, symbolic use, process use and use for accountability (see Chapter 2).

For each data use case, the degree of use is assessed as well. The degree of actual data use is rated using the scale adapted from Knott and Wildavsky (1980), introduced in Chapter 2. At the first level, the potential data user receives data, but does not engage with them. At the second level, the potential user does engage with and understand the data, but does not actually refer to or use them. At this level, the potential user can still ignore or even reject the data (Larsen and Wemer, 1981). Decisions are then made based on other factors. For example, in her study into whether or not local education staff use the results of programme evaluations, David (1981) found that the majority of decisions were made based on political or financial concerns, or on 'subjective information' such as impressions and anecdotal information, rather than on the evaluation findings. At the third level, research (or data) is referenced in reports, studies and strategies developed by potential data users (Landry et al., 2001). At the adoption / influence level, research influences the decisions by decision makers (Landry et al., 2001).

The scale adapted for this thesis on monitoring data use distinguishes between data use for decision-making and for reporting for accountability, as presented in Table 3-2. This table presents the different data use degrees and their scores. It differentiates between different degrees of data use within the adoption/influence level, depending on whether or not a decision is primarily informed by the data, or whether other factors play a role as well.

Table 3-2: Scale for assessing actual levels of use of monitoring data

Data use		Score	Data use for decision-making	Data use for reporting for accountability
No use	No availability	0	Data are not available to potential users	
	Transmission /Reception	1	Data are available to the decision maker(s) / duty bearer, but they do not engage with the data or do not understand them	
	Cognition	2	Decision makers / duty bearers have engaged with and understand the data, but do not refer to them or use them.	
	Reference /reporting	3	Decision makers refer to the data, e.g. in policy, strategy or planning documents, but the data does not influence decision-making	Duty bearers refer to data in their reports to rights holders, but rights holders do not use the data to keep duty bearers accountable accordingly
	Process use		Not the data, but the presence of the monitoring system and process have influenced decision-making	NA
Data use	Influence	4 Low influence	Decision makers have made use of data for informing decisions, but these decisions are mainly informed by other factors than the data	Rights holders have used data for holding the duty bearer accountable, but to a low degree
		5 Moderate influence	Decision makers have made use of data for informing decisions, but these decisions are to some degree been informed by other factors than the data	Rights holders have used data for holding the duty bearer accountable to a moderate degree
		6 High influence	Decision makers have made use of data for informing decisions, mainly depending on the data for informing their decision	Rights holders have used data for holding the duty bearer accountable to a high degree

The sub-questions to be answered are:

1. How and to what degree have monitoring data produced by the different monitoring systems been actually used to inform decision-making and accountability at different levels?
2. Has this been in line with the intended and potential use?

3.2.3 Research question 3

The third research question presented in Chapter 1 ‘What factors enable or hamper actual monitoring data use? What conditions need to be in place to ensure use of monitoring data?’ is approached through the four theoretical perspectives introduced in Chapter 2.

While several authors who explore factors that influence data use differentiate between enabling and hampering factors (Clar et al., 2011; Innvaer et al., 2002; Oliver et al., 2014; Punton, 2016), this thesis does not consider this differentiation as useful. It argues that whether or not a factor enables or hampers data use will depend on the strength of the factor. For example, considering capacity for data use as a factor, strong capacity for data use can enable, whereas low capacity can hamper actual data use.

3.2.3.1 linear model

The linear perspective focuses on data characteristics and attributes as explanatory factors for the degree of data use. Chapter 2 presented an overview of data characteristics and attributes which are believed to play an enabling or hampering role. Table 3-3 presents an overview of the data characteristics and attributes based on the CRELE and ACTA frameworks. Data attributes are rated as high, moderate or low based on the criteria presented in the table.

For each data use case, data attribute ratings are compared with the degree of actual data use. This is expected to provide insight into the explanatory power of these factors under the linear perspective.

The sub-questions which concern the linear perspective are:

1. What are the characteristics of data produced under different monitoring systems?
What are the attributes of these data, in terms of relevance, credibility, timeliness, comprehensiveness and accessibility vis-à-vis potential use?
2. How have the data attributes been shaped?
3. What role have the data attributes played in enabling or hampering the actual use of these data, and to what extent can they explain the actual use of these data or lack thereof?

Table 3-3: Data factors

Descriptive data characteristics	Data attribute rating
Content of the data: Data on (spatial) coverage; Data on utility performance; asset data; operational data Frequency with which data are available: real-time data, monthly data, annual data, etc. Scale in terms of number of units of observation, e.g. single unit of observation, sample, census Scale in terms of unit of analysis, e.g. nationally aggregated, regionally aggregated, aggregated at town level, single unit Data quality, based on accuracy of data as a result of the collection, cleaning and processing tools and processes	Relevance: <i>High:</i> Content, scale and frequency in line with required content, scale and frequency for the use <i>Moderate:</i> Content, scale <u>or</u> frequency if <u>not fully</u> in line with required content, scale and frequency for the use <i>Low:</i> Content, scale and frequency <u>not</u> in line with required content, scale and frequency for the use
Data processing time: Time between data collection and data (and information) publication	Credibility: <i>High:</i> The data user considers the data highly credible, based on high level of data quality <i>Moderate:</i> The data use considers the data as credible <i>Low:</i> The data user does not consider the data as credible
Number of variables and indicators Number of units of observation Comprehensiveness, in terms of intended units of observation, variables and indicators with data	Timeliness: <i>High:</i> Usable data are available at the time of the data use process <i>Moderate:</i> Data are not directly available at the time of the data use, but is made available to enable use <i>Low:</i> Usable data not available at the time of the data use process, or is too outdated to be used Comprehensiveness: <i>High:</i> Data are available on the majority (at least 90%) of variables, indicators or units of observation to enable data use <i>Moderate:</i> Data are available on at least 50% of the variables, indicators or units of observation <i>Low:</i> Data are available on less than 50% of variables, indicators or units of observation to enable data use
Physical accessibility, in terms of physical accessibility of the data, either in hard-or soft copy format.	Data accessibility: <i>High:</i> Data are easily and without considerable effort accessible to the data user <i>Moderate:</i> Data are accessible to data users, with some effort <i>Low:</i> Data are <u>not</u> accessible to the data user
Level of data processing in terms of proportion of data, which is actually processed into usable data, e.g. on indicators Level of information product development, going from raw data, to tables, maps and graphs, and to summary reports and briefing notes with clear recommendations	Data accessibility in appropriate formats: <i>High:</i> The data have been processed as suitable information products. <i>Moderate:</i> The data have not been processed to a high level, but the format of the data or information product is appropriate for enabling data use by the data user. <i>Low:</i> The format of the data or information product is <u>not</u> suitable for enabling data use by the data user.

Source: author

3.2.3.2 Relationship perspective

The relationship perspective focuses on the relationship between data producers and users. To get insight into whether relationships between data producers and users influence actual data use, several data use cases with different degrees of data use are studied in detail. For each data use case, the social network of actors involved in data production and use is visualised with a sociogram. The sociogram depicts the data producers and decision makers and their social ties, and other actors with their social ties to these actors. The quality of the relationship between the different actors in the network is assessed, in terms of their structural, relational and cognitive social capital. Observations are then made per case on the influence of the quality of the relationship between data producers and users (and the quality of relationships between other actors in the data-use network) on the observed data use.

The quality of the relationship between data producers and users is rated based on the combination of their structural, cognitive and relational social capital:

- Structural social capital:
 - Mapping and assessment of social ties between actors in the decision-making network:
 - Social relations: Types of linkages, including accountability links, in terms of the level of formality of the relationship
 - Interactions: Occurrence and nature of interactions
 - Flows: Flow of data, information and knowledge and other resources (e.g. funding) through the social ties
 - Reflection on network structure, based on shape of the network and obvious differences in degree, closeness and betweenness centrality between data producers, users and other actors in the decision-making network
- Relational social capital:
 - Level of trust between actors
 - Level of reciprocity between actors
- Cognitive social capital:
 - Level of common goals, culture, and language between actors.

The level of structural, relational, and cognitive social capital between actors is rated as low, medium or high. The quality of the relationship is rated as low if there is low structural, relational and cognitive social capital; high if there is high structural, relational and cognitive social capital; and moderate if there is moderate or low structural, relational or cognitive social capital.

Ratings of the quality of relationships between data producers and users are compared with the degree of actual data use. Comparison between data use cases with different degrees of alignment between relationship rating and degree of actual use is expected to provide insight into the explanatory power of the relationship perspective.

The sub-research questions which concern the relationship perspective are:

1. What is the quality of relationships between data producers and users in different data use cases, based on their structural, relational, and cognitive social capital?
2. Does the quality of relationships between data producers and users influence actual use of monitoring data?

3.2.3.3 Behaviour systems perspective

The behaviour systems perspective focuses on (groups of) individual data users. The thesis assesses the capacity, motivation and opportunities for data use of the main intended (groups of) individual data users. Table 3-4 presents factors and their definitions for assessing individual capacity, motivation and the opportunities for data use⁸. The factors are assessed as high, moderate or low, based on observations of the factor characteristics.

Table 3-4: Scoring of capacity, motivation and opportunities for data use

Factor			Factor characteristics
Individual capacity			Level of data user's understanding, skills and experience to analyse, interpret and use data
Motivation			Level of data user's interest in data use
Opportunities	Organisational opportunities	HR capacity	Availability of human research and time to analyse, interpret and use data
		Financial capacity	Availability of financial resources to act on data
		Decision Support Tools (DSTs)	Presence of information systems and decision support tools for facilitating data use
	Sectoral opportunities	Presence and strength of relevant data-use systems	Clear guidelines and strong mechanisms and incentives for data use
	Contextual opportunities	Political economy	Level to which power relations, vision and political leadership are in place that enable and stimulate data use
		National culture	Level to which the national culture (assessed through Hofstede's cultural dimensions) enables data use

Following the assessment of capacities, motivations and opportunities, an assessment is made of whether these have enabled or hampered actual data use by the data users, by looking at alignment between factor rates and degree of actual data use. Comparing the presence or absence of this alignment between data use cases can provide insight into the explanatory power of the factors under the behaviour systems perspective.

The sub-questions which concern the behaviour systems perspective are:

- What is the level of capacity, motivation and opportunities for data use in decision-making by different intended data users?
- How have these capacities, motivations and opportunities to use data enabled or hampered actual use of data in decision-making?

3.2.4 The comprehensive systems perspective and research question 4

The comprehensive systems perspective combines factors from perspectives 1, 2 and 3. It considers these factors as part of a complex adaptive data-use system and focuses on the interplay between the different factors, and how this enables or hampers data use. By

8. Although this thesis recognises the importance of organisation and information culture related to data use, it perceives the manifestation of organisational data culture to be mainly expressed in organisational practices and the capacities which have been put in place accordingly, as presented in chapter 2. Therefore, this factor is not included in the methodological framework.

exploring how the factors both directly and indirectly influence the degree of actual data use, this perspective also provides insight into possible leverage points for stimulating data use and hence for answering research question 4: *'What are the leverage points for enabling monitoring data use in decision-making and accountability processes?'*.

In this thesis, different factors were identified based on literature, presented in Chapter 2. These include data attributes (linear perspective), the relationships between data producers and users (relationship perspective), and individual capacity, individual motivation and organisational, sectoral and contextual opportunities (behaviour systems perspective).

Assessment of the factor influence scores is done by a single person (the author), based on and justified by the observations from the data use cases presented in this thesis, rather than through a participatory assessment by a group of stakeholders. Open access MICMAC software ('MICMAC,' 2004) as well as MS Excel are used for the direct and indirect influence/dependency mapping.

The sub-questions to be answered are:

- How do the different factors identified under perspectives 1-3 relate to each other? How do they influence and depend on each other?
- What are the possible leverage factors which have the largest potential influence on enabling data use?

3.3 Data collection methods

This research employs various, mostly qualitative data collection methods.

Literature review: A literature review informed the identification of potential factors that enable and hamper data use. This resulted in the identification of a variety of factors under four theoretical perspectives, as presented in Chapter 2. The literature review included literature on the use of different types of data (research, evaluation, performance monitoring) and from different sectors (health, education, environmental management, etc.), sourced from Google scholar and citation chaining.

Review of grey literature and sector documents: The water supply sector in Ethiopia has a large number of unpublished sector documents (pers. comm. Butterworth, 2018), which can nevertheless have considerable influence on the sector. These include studies, guidelines, manuals, draft policies, strategies etc. A useful repository of grey literature for the Ethiopian water supply sector, is the 'Resources' page of the Community Managed Project (CMP) website, a product of the Ethiopian-Finnish COWASH project (English - CMP CoWASH Ethiopia). Furthermore, grey literature was obtained from interviewees. Grey literature informed the description of the monitoring systems and their various components. It also informed the description of actual data use cases and the assessment of data characteristics and attributes, relationships, and motivations, capacities and opportunities for data use.

Review of monitoring data: Monitoring data sets were obtained from different sources, including the internet (JMP and IBNET data), password-protected government databases, and from interviewees (regional data sets). These data were mainly reviewed and assessed to inform the description of data characteristics and assessment of data attributes.

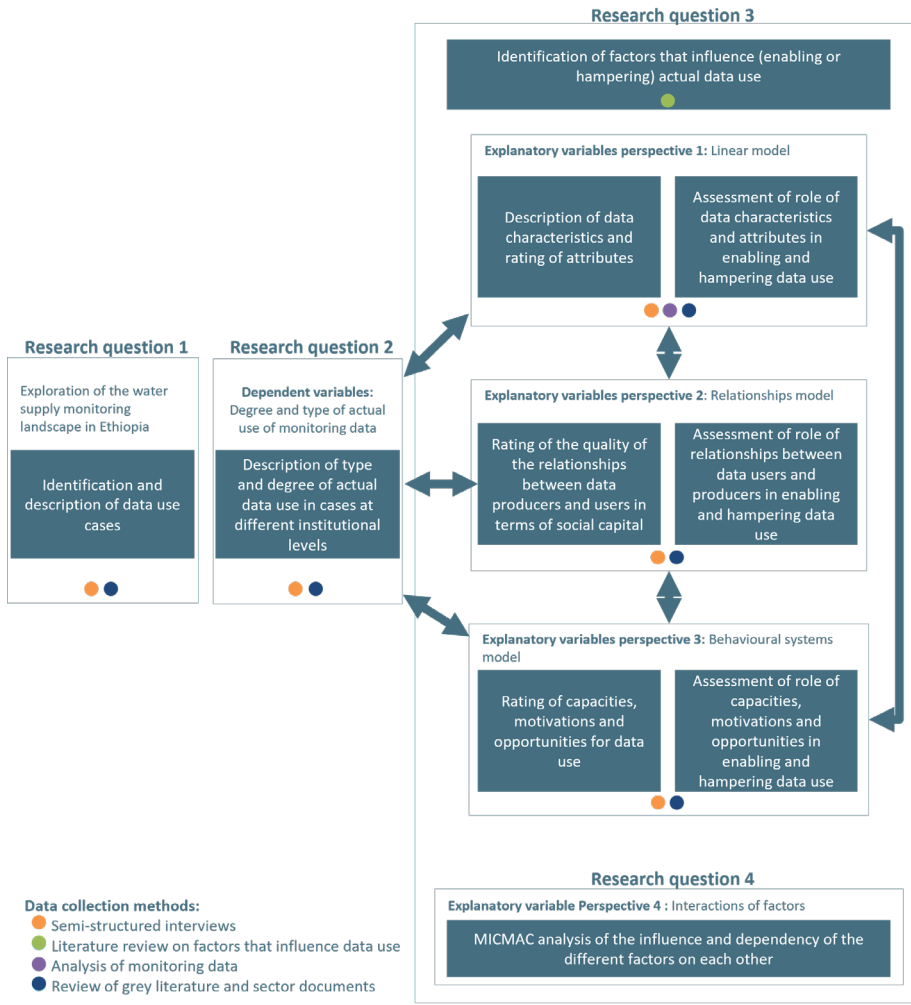
Semi-structured interviews: A series of semi-structured interviews with national, sub-national and local stakeholders was conducted in 2018, 2020 and 2022. These interviews

covered various aspects of the thesis, including exploration of data sets and data use cases, actual data use, and factors that enable or hamper data use. The interview guide was informed by the (early) conceptual and methodological framework. Interviewees were informed of the purpose of the interviews and given the opportunity to participate anonymously. Where needed, translation was provided. Interviews were digitally recorded (with permission of the interviewees) and transcribed. A list of interviewees and the interview checklist are provided in Annex 2 and 3 respectively.

3.4 Methodological framework

Figure 3-3 gives an overview of the methodological framework. It shows how the research questions relate to each other and presents the variables, data collection methods and assessment methods for each research question.

Figure 3-3: Overview of research methodology



4 TOWN WATER SUPPLY IN ETHIOPIA

This chapter introduces the background of the main case study for this thesis: the town water supply sector in Ethiopia. Ethiopia is a landlocked country in the Horn of Africa. It is the continent's second most populated country, with a total population estimated to amount to 123 million in 2022 (World Bank, 2024)⁹. The per capita GDP was 1,028 USD in 2022 (World Bank, 2024). Ethiopia remains predominantly rural (77% in 2022), but is urbanising rapidly at 4.4% annually. The majority of the urban population has access to improved water services: 97.3% according to 2022 JMP data and 85.3% according to government data. The urban population with access to safely managed water services is, however, considerably lower at 39% in 2022 (JMP, 2024).

As this thesis takes a systems perspective to water supply, it is important to understand the system in its context. Understanding the political, cultural and sectoral context is especially relevant for Chapter 9, which looks at water supply data use from a behaviour systems perspective. This chapter describes the country's recent political economy development (4.1) and its cultural context (4.2), followed by an introduction to Ethiopia's town water system, the actors involved and the building blocks that are most relevant for this thesis on data use (4.3).

4.1 Political economy background

4.1.1 Political and administrative developments

The unification of Ethiopia as a state mainly took place under Emperor Tewodros II (1855-1868) and was expanded under Emperor Menelik II (1889-1913). In 1974, the country's last emperor Haile Selassie was overthrown by the communist military committee known as the 'Dergue'. The Dergue favoured central economic planning and banned private ownership (Mengesha and Common, 2007). With the decline of the Soviet Union, the Dergue lost its international ideological, financial and military support, which enabled the Ethiopian People's Revolutionary Democratic Front (EPRDF), a coalition of various resistance movements¹⁰ (primarily led by the Tigrayan People's Liberation Front (TPLF)), to overthrow the Dergue and assume power in 1991 after a 14-year civil war (Fantini and Puddu, 2021; Lie et al., 2018).

A new federal constitution was promulgated by the Transitional Government of Ethiopia in December 1994 and the country's first elections were held in 1995 (Lie et al., 2018), with the EPRDF and its allies winning 471 of the 547 parliamentary seats (86%).

9. The Ethiopian Statistical Services (ESS) estimated the 2022 population to amount to 105 million people, based on projections from the 2007 census.

10. Tigray People's Liberation Front (TPLF), Amhara Democratic Party (ADP), Oromo Democratic Party (ODP) and Southern Ethiopian People's Democratic Movement (SEPDM).

The EPRDF inherited a professional bureaucratic apparatus with strong presence at all levels, from the capital Addis Ababa to kebele (village) level, which originated from imperial times and had been maintained under the Dergue (Meester et al., 2022). However, core public management systems at the federal and regional levels were hampered by various structural weaknesses. These included outdated civil service legislation, lack of medium-term planning and budgeting frameworks, ineffective financial and personnel management controls; inadequate wages and inappropriate grading systems, poor strategic decision-making capacity at cabinet-level, and insufficient focus on modern service delivery approaches (Mengesha and Common, 2007). This prompted the EPRDF government to embark on a comprehensive Civil Service Reform Program (CSRPF) in 1996, influenced by international NPM trends. This was also a loan condition from financial institutions attached to the Structural Adjustment Programmes in the 1990s (Mengesha and Common, 2007).

The reforms included introducing the idea of 'ethnic self-determination', with devolution of political, fiscal and administrative powers through an ethnic federalist system. As a result, Ethiopia became a federal democratic republic with nine regional states¹¹ and two administrative councils (the cities of Addis Ababa and Dire Dawa) with the ratification of its constitution in 1995 (World Bank, 2018). This first phase of the decentralisation allowed regions some degree of autonomy in creating constitutions and policies. In 2003, as part of the second decentralisation phase, a total of 805 woredas were created as the primary unit of local government in Ethiopia, with decentralised sectoral departments (Pichon, 2019).

While the decentralisation process was ongoing, the EPRDF built a local administrative structure heavily dependent on the party apparatus, with political appointees by the federal government at strategic sub-national levels, which has assisted the central government in consolidating its power and administrative control over the periphery (Lie et al., 2018). This has resulted in what Lie et al. (2018) refer to as a developmental party state: the party is the state.

Government adopted the Democratic Development State doctrine to ensure socio-economic transformation (Debela and Troupin, 2016; Meester et al., 2022), leading to the development of its Growth and Transformation plans (GTP) in 2010 and 2015 (Debela and Troupin, 2016).

The elections of 2005 saw an unexpected loss of seats for the ruling EPRDF party, from 481 of the 547 seats in 2000 (88%) to 327 (60%). Following the 2005 elections, the government enacted restrictive laws and regulations related to political opposition, the press, and civil society (Fantini and Puddu, 2021). Since then, the EPRDF (and the Prosperity Party since 2021) has managed to win the vast majority of seats in government. As the power of political opposition parties is marginal, they cannot play a role in monitoring and regulating the government (Lie et al., 2018).

Years of social unrest caused by dissatisfaction with EPRDF policy and Tigray People's Liberation Front (TPLF) control contributed to considerable changes in EPRDF leadership

11. In 2020, Southern Nations, Nationalities, and Peoples' Region (SNNPR)'s Sidama zone became an independent region. This was followed by the creation of Southwest Ethiopia Region in 2021 and South Ethiopia Regional State (where Jinka is located) in 2023. The remaining territory was reconstituted as the Central Ethiopia Regional State. However, as this thesis mainly covers developments in the time period 2006-2021, the thesis refers to SNNRP, rather than to the new regional states set up after 2020.

(Meester et al., 2022), resulting in the resignation of Prime Minister Hailemariam Desalegn in 2018, followed by the election of Abiy Ahmed from the Oromo Democratic Party as the leader of the EPRDF and his inauguration as Prime Minister. In 2019, the EPRDF was dissolved and succeeded by the Prosperity Party, which excluded the TPLF.

Meester, Lanfranchi and Negash Gebregziabher (2022) observed that post 2018 there has been a professionalisation drive within the Ethiopian government, with party officials in technical and business roles being replaced by experienced and appropriately educated professionals. As a result, office holders increasingly move within, rather than between sectors. Nevertheless, the hierarchical and autocratic political culture has remained strong, and true political decentralisation has not yet emerged (Debela, 2017). As observed by Pichon (2019), regional policies tend to be highly influenced by national targets and priorities, and local governments are often compelled to follow higher-level directives and help meet nationally-set targets.

Ethnic-based social unrest and violence have continued, including the war in Tigray region from 3 November 2020 to 3 November 2022 and conflicts in Amhara, Oromia and other regions.

4.1.2 Power of development partners

Meester, Lanfranchi and Negash Gebregziabher (2022) regard the Ethiopian federal state as an old, strong, and value-infused institution, rather than a product influenced by donor-driven state-building and democratisation projects. International donors have generally encountered greater resistance in implementing their agenda than in other Sub-Saharan African countries, especially where these are not aligned with those of the Ethiopian government (Lie et al., 2018). However, this does not mean development partners have not had a role, stake and influence in Ethiopia. Post 1991, Ethiopia has been among the largest recipients of international development aid, receiving some 26 billion USD between 1991 and 2011 and some 3 billion USD per year in the late 2000s and early 2010s, which amounted to more than a third of its annual budget (Feyissa, 2011; Peterson, 2015). For drinking water supply, the proportion of funding from external sources is likely to be much higher. According to Debela (2017), the MDG needs assessment report, for example, assumed 69 percent of required resources would be obtained from foreign aid and loans.

Development partners have been engaging with the Ethiopian government, increasing development aid, in spite of its authoritarian and 'one party-state' character, which generally does not meet the aid conditionality strategies linking official development assistance (ODA) to recipient countries' performance on good governance and democracy (Fantini and Puddu, 2021). Reasons that have been offered for this include the ability of the Ethiopian government to manipulate development discourse and steer ODA to fulfil its political priorities, donor naiveté or ignorance, Western geopolitical priorities (with Ethiopia as a relatively stable, strategic ally in the region), Ethiopia as a showcase for aid effectiveness, and the country's humanitarian challenges (Fantini and Puddu, 2021; Feyissa, 2011; Lie et al., 2018).

4.2 National culture

Table 4-1 presents Ethiopia's scores on Hofstede's national cultural dimensions, introduced in Chapter 2.

Table 4-1: National culture

Hofstede's national cultural dimension	Score	Interpretation
Power distance index	70	High score
Individualism	7	Low score
Motivation towards achievement and success	65	Moderately high score
Uncertainty avoidance	55	Moderate score
Long term orientation	14	Low score
Indulgence	46	Moderate score

Source: Adapted from Hofstede et al. (2010)

The relatively high score on the power distance index indicates that the national culture involves managers relying on superiors and formal rules, with subordinates expected to do what they are told. This could hamper data use, except for reporting on upward accountability and possibly regulatory decision-making. The low score on the individualism dimension implies a national culture in which social networks are the main source of information, with hiring and promotion taking the employee's group into account, and with in-group consumers getting better treatment, and relationship prevailing over task. This can hamper data use, especially for operational decision-making and performance regulation. The relatively low score on the long-term orientation dimension implies top managers are mainly concerned with operations, and the focus is on decision content. Laws are considered necessary, even if they cannot be respected. Citizens are incompetent towards authority. This is likely to mainly enable data use for operational decision-making and planning of short-term solutions, rather than more strategic and long-term planning.

4.3 Town water supply

This section presents an overview of the building blocks of the town water service systems, as introduced in Chapter 2: institutions, policy and legislation, planning, finance, infrastructure development and management, learning and adaptation, regulation and reporting for accountability. This section does not provide a detailed introduction to the monitoring systems, as that is the focus of Chapter 5.

4.3.1 Administrative set-up of towns

Ethiopia has been undergoing rapid urbanisation. Every settlement with a population above 2,000 and any settlement where the woreda (district) administration office resides is considered to be a 'town' by the Ministry of Urban Development and Construction (MOUDC) (Tesfaye et al., 2021). While only around 22% of the population lived in towns in 2021, there is considerable urban growth. The number of people living in towns is expected to increase from 15.2 million (18% of the total population) in 2012 to 42.3 million (31% of the total population) by 2037 (Central Statistical Agency (CSA), 2013).

The vast majority of the 973 towns in the country (855, or 88%) were small (2,000-20,000 population), with 82 (8%) medium (20,000-50,000 population), 19 (2%) large (50,000-100,000 population), 16 (1.6%) mega towns (100,000-1 million population) and 1 metropolis (Addis Ababa) with a population of over 1 million (Tesfaye, 2021). Based on the 2007 census and population projections, CSA estimated that about 37.6% of the urban population resides in small towns, with 14.9 % residing in medium, 10.3% in large, 15.6% in mega, and 21.7% in Addis Ababa in 2020.

Towns with a population of more than 17,500 have their own council and manage their economic and social affairs autonomously, while towns with fewer than 17,500 are organised under woreda councils and only manage municipal affairs, with other socio-economic development issues being the responsibility of the woreda council. The Ministry of Urban Development and Housing decides on the organisation of towns (Defere, 2017, unpublished). Town administrations are created through regional statutes (Fenta, 2014).

4.3.2 Actors involved in town water supply

Urban water supply is defined in Ethiopia as water supply managed by legally proclaimed utilities with autonomous Water Boards. All other water supply facilities are considered and treated as rural water supply facilities (GoE, 2008).

4.3.2.1 Local level

Town Water Utilities, also referred to as Water and Sewerage Enterprises, Services, or Authorities (hereafter referred to as 'utilities') are responsible for providing adequate, safe, good quality potable water at a reasonable cost and serving their consumers in a prompt and courteous manner in Ethiopia (Ministry of Water and Energy, 2013a, 2013b, 2013c). Unlike countries with a single (main) national water utility (like Ghana, Burkina Faso, Uganda), or with a relatively small number of regional utilities (e.g. England, the Netherlands), there are about 500 autonomous utilities in the country, each constituted independently in each town, commonly managing a single town scheme, and providing services to an urban core and surrounding rural settlements (Frade, 2019; Tesfaye et al., 2021).

Utilities are established under regional proclamations. Water Boards are responsible for directing and supervising the activities of the water utility. Water Boards are commonly established by and accountable to town or woreda administrations, though in some regions bigger towns can be established by and accountable to the zonal water officer or Regional Water Bureau. Regional proclamations prescribe the membership, functions and frequency of meetings of Water Boards. Generally, gender-balanced Water Boards should consist of six to 10 members, including the utility manager as a non-voting member and secretary, two representatives from the user community (one male, one female) and a number of representatives from local government offices (Ministry of Water and Energy, 2013d) as prescribed by the regional proclamation.

The proclamations set out the main roles and responsibilities of Water Boards, which include review of short-, medium- and long-term plans and budgets and recommending these for approval by the council, appointment of the utility manager, and setting and approving utility staff salaries and allowances (National Regional State of Tigray, 2014).

4.3.2.2 Sub-national level

Regional offices of the centralised Water Supply and Sewerage Authority under the National Water Resource Commission were established in 1981. These were dissolved after the fall of the Dergue in 1991 and replaced by decentralised Regional Water Bureaus, established in 1995 under the Regional States. Each regional state has a Regional Water Bureau, which is the executive body responsible for the implementation of federal policies, strategies and action plans by adapting them to the specific conditions of the region. In addition, Water Bureaus exercise regulatory duties delegated to them by the Ministry (Arsano et al., 2010). The Regional Water Bureaus are accountable to the Regional State Council (Federal Democratic Republic of Ethiopia, 2011).

Regional Water Bureaus are responsible for ensuring that water services are provided in line with national and regional policies and laws, coordinating loans and grants from government and non-governmental parties, and providing guidelines and technical support to Water Boards and utilities (National Regional State of Tigray, 2014).

4.3.2.3 National level

In 1995, a dedicated ministry was established for Water Resources. Since then, the Ministry has undergone many restructurings and name changes as shown in Table 4-2.

Table 4-2: Ministry name changes

Year	Proclamation	Name of Unit
1995	4/1995	Ministry of Water Resources
2005		Ministry of Water and Energy
2010	691/2010	Ministry of Water and Energy
2013	803/2013	Ministry of Water, Irrigation and Energy
2015	916/2015	Ministry of Water, Irrigation and Electricity
2018	1097/2018	Ministry of Water, Irrigation and Energy
2022	1263/2021	Ministry of Water and Energy

Source: Compiled by author

In spite of its frequent, often politically inspired (pers. comm. Gossa, 2018) restructuring, many actors have continuously been involved in the Ministry, either as staff members, or as national consultants. The Minister leading the Ministry from 2016 to 2021, one of the few ministers without a clear party background, was not replaced in 2018 after the election of the new government, unlike many other ministers (Meester et al., 2022). Because of many the changes, the ministry responsible for water supply will be referred to in the rest of this thesis simply as 'the Ministry'.

A 2018 proclamation stated that the jurisdictions of ministries include 1) formulation of policies; 2) preparation of plans and budgets; 3) Undertaking capacity building activities; 4) providing, where necessary, assistance and advice to Regional States. It also specifies that other powers and duties of the Ministry include 1) determining and monitoring water quality standards; and 2) establishment of systems that facilitate the expansion of water service coverage and follow-up implementation.

In 2018, the Water Development Commission (WDC) was established by the Council of Ministers through regulation 442/2018. The powers and duties of the Water Development Commission included 1) the coordination and undertaking of studies and designs for water infrastructure, including provision of support to regions for infrastructure development, follow-up and monitoring of infrastructure development projects, and preparation, dissemination and follow-up of the implementation of national potable water supply and sanitation study, design, construction and utility management criteria, guidelines, standards and manuals; 2) preparation, dissemination and follow-up of utility management criteria, guidelines, standards and manual; 3) policy formulation; 4) preparation of long-, medium-, and short-term national sector plans and follow-up of its implementation; 5) development, analysis, dissemination and updating of the national water supply and sanitation database system; 6) planning of activities that enhance the implementation capacity of the sector (Council of Ministers, 2018). During the latest restructuring of the Ministry in 2022, the WDC was abolished.

In 2002, the Ethiopian Water Resources Development Fund (WRDF) Office was established by government through proclamation 265/2002, for providing low-interest, long-term loans to utilities and irrigation water user associations (MoWIE, 2021). It started operations in 2004 (Federal Democratic Republic of Ethiopia, 2013a). The fund channels financing asset construction and expansion in medium towns under the CWA and under the World Bank's Second Water and Sanitation Program focused on Addis Ababa and 20 secondary towns. The WRDF has been supported with technical assistance from an international consultant, funded by the EIB. The main sources of funding for the Fund come from: Government of Ethiopia, World Bank, DFID, AfDB, EIB, AfD (Government of France), IDC (Government of Italy), BADEA, Kuwait Fund and UNICEF (Frade, 2019). The WRDF office consisted of a Board which was supposed to meet every three months, a general manager appointed by government on recommendations of the Board, and staff. The Office was directly accountable to the Minister (Federal Democratic Republic of Ethiopia, 2002). In 2023, the WRDF was dissolved as an autonomous organisation and became an executive unit under the Ministry.

The Ethiopian Urban Water Federation was established in April 2018 and registered as a legal entity by the Ministry of Water, Irrigation, and Energy (MoWIE). It has over 500 member utilities across the country and acts as an umbrella organisation for all Ethiopian utilities. Its mission is to improve the enabling environment for member utilities to provide sustainable, efficient, and effective water and sewerage services through advocacy, networking, partnerships, capacity building, and best practices (Ethiopian Water Federation and Vitens Evides International, 2022).

Development partners are responsible for more than half of the sector's annual expenditure. According to Debela (2017), the MDG needs assessment report even assumed 69% of required resources would be obtained from foreign aid and loans. Key development partners in the urban water sector over the past two decades have included the World Bank, Italian Development Corporation, UNICEF (with funding from different sources, including DFID/UKAID), WaterAid, French Development Aid (AFD), African Development Bank (AfDB) and Government of the Netherlands. Following the signing of the Paris Declaration on Aid Effectiveness in 2005, an EU-funded programme facilitated harmonisation and alignment by establishing a process of multi-stakeholder forums and annual joint sector reviews. Since the first edition in 2006, the MSFs

have been bringing more than 200 stakeholders together from government, civil society, private sector, academia and development partners on an approximately annual basis. However, as observed by Pichon (2019), follow-up from these meetings is often lacking, which reduces their policy influence.

The One WASH National Programme (OWNP) was established in 2013 as a sector-wide approach programme with the ambition of having one plan, one budget (the Consolidated WASH Account (CWA)) and one report (through the National WASH M&E MIS) for the WASH sector. Urban water and sanitation is one of the components of the programme. The National WASH Coordination Office (NWCO) is responsible for coordinating the planning and implementation of OWNP at federal level, including preparing a consolidated annual WASH plan, budget and periodic reports. The main contributors to the CWA, which finances (part of) the OWNP, have been the African Development Bank (AfDB), DFID, UNICEF and the World Bank. At the time of writing, some 10 development partner programmes were supporting town water supply in a total of some 137 towns in the country (based on an overview compiled by the Urban Working Group in 2022).

4.3.3 Policy and legislation

The Ministry developed and published the Ethiopian Water Resources Management Policy in 1999 (Ministry of Water and Energy, 1999). It includes the drinking water policy, which covers issues such as planning parameters and standards (stating that these need to be developed), finance and tariffs (prescribing the need for site-specific tariffs, with progressive tariffs based on full cost recovery in urban areas), and the enabling environment (mainly indicating the need to develop frameworks, guidelines and standards, rather than actually providing these). The updating of the policy was ongoing at the time of writing.

The policy was complemented by the 2001 national water sector strategy. This strategy provides some guidance for implementation of the policy, but still refers frequently to the need to develop national standards, procedures, processes, manuals and guidelines, etc. It reiterates the point the policy made about site-specific water tariffs, based on financial, economic, and social equality considerations, with urban tariffs aiming for total cost recovery over time, including covering operation and maintenance costs, depreciation, and debt servicing (Ministry of Water Resources, 2001). Based on the policy, each region has developed regional proclamations for the set-up and management of town water utilities, detailing roles and responsibilities of the service provider and authorities.

Service level norms and standards have been mainly defined as part of multi-annual development plans, as described below.

4.3.4 Planning

In addition to global goals such as the MDGs and SDGs, the government of Ethiopia has set national development goals and targets as part of national multi-sector and sectoral development plans. An overview of these plans is provided in Table 4-3.

Table 4-3: Overview of national level multi-annual plans

Name of plan	Time period	Source
National multi-sector development plans		
Plan for Accelerated and Sustained Development to End Poverty (PASDEP)	2005/06 - 2009/10	
First Growth and Transformation Plan (GTP)	2010/11 - 2014/15	MFED (2010)
Second Growth and Transformation Plan (GTP2)	2015/16 - 2019/20	NPC (2016)
National sectoral development plans		
Universal Access plan (UAP)	2005-2012	
Urban focused Urban water supply (U-UAP)	2011-2015	Ministry of Water and Energy (2011)
Water Supply and Sanitation Sub-Sector GTP2	2015/16 – 2019/20	Ministry of Water Resources, Irrigation and Electricity (2015)
One WASH National Programme (OWNP)	phase I: 2013/14-2014/15	Federal Democratic Republic of Ethiopia (2013)
	phase II: 2018-2020	Federal Democratic Republic of Ethiopia (2018)
Ministry of Water and Energy ten-year Strategic Plan	2021-2030	

The PASDEP, UAP, the first GTP and OOWNP phase I were conceived in the MDG-era. Goals and targets under these plans were focused on coverage and asset development. The Water Supply and Sanitation Sub-Sector part of the GTP2, developed at the start of the SDG era, included goals and targets on coverage and study, design and construction of schemes as well (goal 1.2), but also on utility performance, under its good governance (objective 3) and sub-sector capacity building (objective 4) objectives. The goals, indicators and targets related to urban water supply presented in the OOWNP phase II strategic action plan, were fully in line with the GTP II goals. The Ministry's ten-year Strategic Plan includes targets on coverage and reducing non-revenue water (NRW), but not on other utility performance indicators.

Although several of these multi-annual strategic plans include targets on coverage and utility performance, they do not include details on how to achieve the utility performance targets or ensure equitable and sustainable service delivery. The linkage of these targets to budgeting is also weak (Defere, 2017).

At regional level, strategic and annual planning related to town water supply is the responsibility of the Regional Water Bureau. They set regional targets and performance targets for utilities, and develop medium-term and annual plans accordingly.

At local level, utilities are responsible for developing multi-annual business plans and annual operational plans. However, there is limited capacity at town level to actually develop such strategic long-term plans (Defere, 2017). At the time of writing of this thesis, there were no (national) guidelines in place for guiding multi-annual planning and business planning by town water utilities in Ethiopia. A business plan guideline for rural piped systems had been developed, as part of a set of technical guidelines developed by the Ministry, with technical and financial assistance from the Finnish-financed COWASH Project (Ministry of Water, Irrigation and Electricity, 2016). However, although the guidelines could broadly apply to town water utilities as well, these guidelines are not widely known nor used.

4.3.5 Infrastructure development and management

The One WASH National Programme document and the Program Operational Manual (POM) outline infrastructure development and procurement processes, which are supposed to be followed by the partners of the OWNPN. Other financiers follow similar processes with minor adjustments. However, even though there are mechanisms for oversight and quality control over infrastructure development and procurement processes, these are not fully practiced due to limited capacities at different levels (Defere, 2017).

A set of guidelines for urban water supply was produced by the Ministry in 2013. In 2023, the Utility Federation produced an updated set. These included guidelines related to the set-up of utilities and Water Boards, operation and maintenance, tariff setting, etc. A full list of the guidelines can be found in Annex 4.

There is general clarity on urban water asset ownership, with urban water supply assets defined as public assets by national proclamation, and these assets are defined as property of town councils through regional proclamations. However, clear roles and responsibilities, mechanisms, tools and capacities for asset management were not in place (Defere, 2017).

4.3.6 Regulation and accountability

At the time of writing, there was no independent national-level agency responsible for water quality regulation, economic regulation (including tariff approval), and performance regulation (in terms of rewarding well-performing utilities and penalising poorly performing ones). This has been a point of concern and discussion in the sector. The establishment of a regulatory body was included as one of the water supply goals of GTP2 (Ministry of Water Resources, Irrigation and Electricity (MOWIE), 2015) and was proposed as one of the focus areas for the second phase of the OWNPN (July 2016-June 2020) (National WASH Coordination Office, 2018).

Exploration of the development of an independent regulator started around 2014 with support from UNICEF's (DFID-funded) ONEWASH Plus Project. This included south-south cooperation with Brazil, including exchange visits. However, little progress was made on the conceptualisation and establishment of a regulatory body, reportedly (at least partially) because of the ongoing restructuring of the Ministry at the time (Osterwalder et al., 2020).

In 2018, a study was commissioned by WDC to develop an urban water supply and sanitation regulatory framework for Ethiopia, to be undertaken by a team of national consultants with funding and technical support from the World Bank and UNICEF, and technical support from (VEI) and SIWI (Tesfaye et al., 2021). A draft report, describing the current situation and with five recommended options for the establishment of a regulatory framework and bodies, was presented to the Ministry in 2021 (Tesfaye et al., 2021), but its approval and follow-up was delayed because of another restructuring of the Ministry (pers. comm. Tesfaye, 2022), and was still pending at the time of writing. The preferred recommended option was the establishment of an umbrella regulatory body at federal level with branches in the regions, with key performance indicators that would be reported by utilities to the regulator on an annual basis (pers. comm. Tesfaye, 2022).

In the absence of an official national regulatory body, several regulatory functions, including tariff approval and performance regulation, were taken up by the Regional Water Bureaus, town councils and Water Boards, in line with proclamations and regulations (World Bank, 2018).

4.3.7 Finance

The budgeting procedures are focused on budgeting for asset development and improvement. Development partners are an important source of funding for these costs, channelled through the Consolidated WASH Account (CWA). Government also provides funding for both investment and recurrent costs through block grants channelled from federal to regional level. Investments by NGOs do not flow through government channels and are therefore considered 'off-budget'.

The Ministry of Finance and Economic Development (MoFED) is responsible for the GoE and CWA funds. It has developed detailed budgeting, funding and financial monitoring mechanisms which are followed by the water sector. These funding flows are well monitored. However, these only capture part of the investments, and focus exclusively on capital investments (Defere, 2017).

Between 2004 and 2023, the WRDF provided loans for asset development and grants for capacity building activities to utilities. In order to qualify for a loan, utilities had to contribute at least 20% of the total costs from their own resources (Federal Democratic Republic of Ethiopia, 2013) and were required to demonstrate ability to repay the loan (Frade, 2019). To be eligible, utilities needed to have a functional Water Board and a business plan, and needed to have completed preliminary rehabilitation works and detailed studies for water scheme expansion (Italian Development Cooperation, 2010). Loans were provided at a 3% interest rate, for a typical period of 15 to 25 years. The Regional Water Bureaus or towns could submit loan request proposals to the WRDF. These were screened by the WRDF board committee members based on criteria, including size of population, access coverage, and regional equity (Frade, 2019). By 2019, WRDF had provided loans to 104 utilities, covering more than 7.5 million people. However, only 37 projects had been completed by 2019. At the time, 580 million ETB (about 18 million USD) had been reimbursed (MoWIE, 2021). Poor performance and low tariffs of many utilities affected their creditworthiness and ability to access the WRDF concessional loans (Frade, 2019).

As mentioned above, cost recovery through tariffs is part of the national policy and strategy. However, in reality, utilities struggle to cover their operational costs through tariffs and no utility in the country has achieved full cost recovery (Defere, 2017). Tariff setting is in principle guided by the 2013 and 2023 national guidelines.

4.3.8 Learning and adaptation

At national level, there is an urban water sector group which brings together representatives from the Ministry and development partners. Although the group facilitates learning and sharing between government and development partners, it mainly serves as a platform for facilitating relationships between government and development partners and ensuring coordination of efforts. As mentioned above, the MSF brings together a wide variety of sector stakeholders, especially from national and regional levels, to share and learn from each other on an approximately annual basis. However, participation of representatives from utilities tends to be limited. Representatives from utilities typically come together to learn and share with each other in the Utility Forum organised by the Ethiopian Water Utility Federation. At regional level, Regional Water Bureaus conduct review meetings with utilities, but they are focused more on administrative issues rather than on learning and adaptation (Defere, 2017).

5 MONITORING DATA USE CASES IN ETHIOPIAN TOWN WATER SUPPLY

5.1 Introduction

Chapter 4 introduced Ethiopia's town water supply sector and its context. It described the different building blocks involved in the use of monitoring data. This Chapter focuses on the monitoring building block and addresses the first research question of this thesis: *'What are the different use cases for town water supply monitoring data in Ethiopia and how have these been shaped?'* and its sub-questions introduced in Chapter 3:

1. What are the intended monitoring data use cases, explicitly expressed in the monitoring manuals and guidelines?
2. What are the potential monitoring data use cases, implicitly expressed in the monitoring system components?
3. What has driven the design of the monitoring system and its data use cases?

Section 5.2 provides an overview of the town water supply monitoring landscape and its development between 2007 and 2022. It shows that the monitoring system consists of several monitoring systems at different institutional levels. Subsequent Sections examine each system individually. Each Section describes the system's development, its intended data use as explicitly stated in guidelines and manuals, other monitoring system components, and their alignment with the intended data use cases. As set out in Chapter 2, monitoring system components are: indicators, monitoring tools and procedures, ICT platforms, and financial resources and flows.. The Chapter closes with summary observations. A summary overview of the components of the different monitoring systems can be found in Annex 5.

5.2 The town water supply monitoring landscape in Ethiopia

The water supply monitoring system in Ethiopia consists of several systems at different institutional levels, each with its own, but often overlapping objectives.

Asset and operational data are primarily produced at local level by utilities. These utilities, including those in case study towns Wukro and Jinka, compile and process data for their own use, and for reporting to their Water Board and Regional Water Bureau. This thesis refers to utility-level mechanisms and systems for producing, managing, and using asset, operational, and utility performance data as the Utility Management Information System, or 'Utility MIS'.

The SNNPR Regional Water Bureau was observed to hardly compile or process reported data. The Tigray Regional Water Bureau on the other hand, was found to have a system in place for compiling and benchmarking utility performance data. This thesis refers to this monitoring system as the Tigray Utility Monitoring System (TUMS). Section 5.4 explores TUMS.

At national level, several monitoring initiatives were involved in compiling and producing utility performance data during the 2007 to 2022 period. Development of the national Water,

Sanitation and Hygiene Monitoring and Evaluation Management Information System (hereafter referred to as the WASH M&E MIS) started in 2006 and was ongoing at the time of writing. This system is supposed to bring together asset and performance data from all utilities in the country. The WASH M&E MIS is explored in Section 5.5

In parallel with the WASH M&E MIS development, the Ministry, with support from the World Bank, initiated Performance Indicators and Benchmarking (hereafter referred to as PI&BM) around 2012. This system is explored in Section 5.6.

More recently, since around 2022, the benchmarking initiative by the Ethiopia Water Federation, with support from VEI and UNICEF, has gained traction. However, as this development falls outside the timespan of interest for this thesis, this system and its data use cases are not explored in this chapter, nor in the rest of this thesis.

Coverage data are produced through various nationally representative household surveys. Since 1990, the Joint Monitoring Programme (JMP) of UNICEF and the World Health Organization (WHO) has used various national coverage data sets to produce and publish inferred national, regional, and global coverage data. This is explored in Section 5.7.

The Ministry also produces national and regional coverage data, mainly by combining asset and (projected) population data, as explored in Section 5.8.

5.3 Utility MIS

The Ministry produced guidelines for directing utility water supply in 2013. More recently, in 2023, the Federation updated these guidelines. A complete overview of these guidelines can be found in Annex 4. According to these guidelines, Utility MIS is expected to produce:

- Asset and operational data intended to inform:
 - Asset management and operational decision-making;
 - Strategic decision-making related to asset development, maintenance, rehabilitation, and renewal; and
 - Tariff setting by utilities.
- Utility performance data, compiling and processing asset and operational data based on performance indicators, intended to:
 - Inform the utility's reporting for accountability to its Water Board;
 - Inform regulatory decisions by the Water Board; and
 - Inform tariff setting by utilities.

The guidelines did not include directions on utility reporting for accountability beyond the Water Board. Regional proclamations for the set-up and management of utilities did that state utilities were required to report to Regional Water Bureaus.

This section explores the components of Utility MIS and their alignment with these intended data use cases.

5.3.1 Monitoring tools and procedures

Utilities have different tools and procedures for producing asset, operational, and utility performance data.

Asset data tools and procedures: The 2023 asset management guide recommends that utilities keep complete and up-to-date asset inventories of all assets, including sources, reservoirs, electro-mechanical equipment, pipelines, etc. Asset data should at a minimum include the age, location, condition, criticality, probability of failure, consequence of failure and remaining useful life of each asset (Ethiopian Urban Water and Sanitation Federation, 2023). However, few utilities in Ethiopia have asset management systems in place. Neither Wukro nor Jinka utility had tools and processes for asset management in place at the time of study. Overall, only 16% of the 261 utilities in Tigray and Amhara regions had asset management systems in place around 2018 (source: NWI2 regional data compiled by author).

Operational monitoring data tools and procedures: The 2013 O&M manual (Ministry of Water and Energy, 2013a) includes 23 forms for record keeping and reporting. However, utilities generally design their own tools and processes for tracking operational data. These include tools and procedures for customer administration, financial management, human resource management, water production and consumption, and customer complaints and actions. Both Wukro and Jinka utilities had such tools and procedures in place. Some utilities apply off-the-shelf solutions, especially for billing and financial record keeping. Wukro Utility, for example, uses Peach Tree software, mainly for its financial data management. Many utilities, including Jinka Utility, mainly use simple MS Excel spreadsheets or ledgers. Utilities often lack tools and procedures for water production and measurement of leakages.

According to the Ethiopian Standards Agency, monthly water quality samples should be taken from water distribution systems to examine possible bacteriological contamination (1 sample for utilities serving fewer than 5,000 people and 1 sample per 5,000 people for utilities serving 5,000 to 100,000 people). Furthermore, samples should be taken twice a year (wet and dry season) to examine physical and chemical characteristics (ESA, 2013). However, no systems and mechanisms are in place to regulate and enforce these standards, and utilities generally lack tools and mechanisms for producing water quality data. Water quality data are occasionally collected by Regional Water Bureaus or by external entities, mostly to serve project reporting, rather than operational decision-making or regulation. For example, in Wukro, during the ONEWASH Plus Project (2014-2020), water quality testing was undertaken on an approximately annual basis by consultants responsible, mainly to serve project monitoring.

Utility performance data tools and procedures: Regional proclamations prescribe reporting obligations to Water Boards and Regional Water Bureaus, but formats for doing so are mostly designed by utilities themselves. Although the national guidelines decree that performance agreements should be in place between utilities and their authorities or regulatory bodies, these are not in place in practice. Therefore, unclear processes for reporting on performance indicators generally prevail.

Utility department heads and the utility manager (supported by the head of the planning department, where in place) compile selected operational and performance data into monthly, quarterly, and annual reports for reporting to and informing decision-making by utility

management, the Water Board, the town administration and the Regional (and, where relevant, Zonal) Water Bureau.

In Wukro, a mismatch was observed between the indicators set out in the five-year strategic plan and the data that the utility actually collects and keeps. For example, although there were indicators on user satisfaction, the utility did not have mechanisms in place for measuring this.

5.3.2 Indicators

The 2013 national guidelines do not provide consistent guidance on the indicators to be tracked and reported by utilities (see annex 6). The 2023 guidelines suggested 21 utility performance indicators, in line with the indicators suggested by the Federation in collaboration with VEI under the Dutch-funded WaterWorX project (see Annex 6).

However, utilities have set their own performance indicators. At the time of this study, Jinka did not have a long-term strategic plan with utility performance indicators. A ten-years (2020-2030) Strategic Business Plan does not include performance indicators or targets (Jinka City Water and Sewage Service Company, 2024). Rather, the utility developed indicators related to its annual plans.

Quarterly performance reports of Jinka Utility included indicators on 1) production, distribution, NRW, awareness creation, and pipe construction; 2) water quality control and monitoring; 3) maintenance activities; 4) water meters; 5) procurement, finance, and asset management (including revenues, amount deposited, and expenditure); and 6) human resource management (Jinka City Water and Sewage Service Company, 2017). These were mostly reported in terms of completed activities and outputs achieved against set targets.

The Wukro five-year strategic plan (2015-2020) included 16 weighted performance indicators on 1) coverage and user satisfaction; 2) finance; 3) internal processes, including NRW and water production; and 4) learning and development, including number of staff and employee satisfaction (Wukro Water Services Office, 2016). In both cases, progress on indicators was reported against targets set in annual plans.

5.3.3 ICT platforms

The 2023 asset management guidelines suggest that there can be various options for asset inventory data storage and management, including commercially available software for asset inventory, generic database software (e.g. MS Access), spreadsheet software (e.g. MS Excel) or even handwritten inventories, with specifically designed asset management software programmes as the preferred option (Ethiopian Urban Water and Sanitation Federation, 2023). The 2013 and 2023 guidelines do not prescribe specific ICT systems for utility operational and performance data production and management.

The 2018 National WASH Inventory (NWI) found that in Tigray Region, only 17 (38%) of the 45 assessed utilities reported having ICT systems in place. All large (category 2 and 3) and three-quarters of the category 4 towns reported to have ICT systems in place, while only 11% of the 28 small (category 5) utilities has as well. This is being addressed through different programmes, such as the World Bank's Second Urban Water and Sanitation Program, supporting the development of Utility MIS in 22 towns (pers. comm. Belete, 2022), UNICEF's utility systems

strengthening programme in 10 towns, and the DFID-funded ONEWASH Plus Programme of UNICEF in eight towns (2014-2020).

Although comprehensive ICT systems were not in place in either Wukro or Jinka, Wukro's ICT systems were found to be stronger than those in Jinka. The Wukro Utility had commercially available software (Peach Tree) for accounting and financial management, but the Jinka Utility billing was done manually, and financial records were kept on the only computer available to the finance team. Data are mainly stored in hard copy format. Where digital data systems are available, such as in Wukro's finance department, soft copies are available on computer hard drives. Utility monitoring data are not readily accessible to stakeholders such as customers or water users, NGOs, or researchers, but could be provided on request.

5.3.4 Financial framework

The costs related to the production and use of data are covered by revenues from utility customers. Utilities are often supported, technically and financially, by government (especially Regional Water Bureaus) and their development partners for the development and implementation of Utility MIS system components, including the design of indicators, tools, procedures, and ICT systems.

5.3.5 Summing-up

Although national guidelines have been developed for guiding monitoring data production and use by utilities, design of actual Utility MIS has mainly been driven by utilities themselves, often supported by projects funded and implemented by development partners.

Utility MIS components for production and use of asset data were generally lacking at the time of this assessment.

Alignment of Utility MIS components with intended uses was found to be stronger, with utilities generally having tools, procedures, and financial resources in place for this.

The utility performance indicators as defined by the Jinka and Wukro utilities were suitable for reporting for accountability purposes and regulatory decision-making by the Water Board. However, tools and procedures for tracking progress and for informing planning were found to be weak or not aligned with the indicators.

5.4 The Tigray Utility Monitoring System

Between 2015 and 2020, the Tigray Monitoring, Support and Maintenance Sub-Process (MSMSP) of the Tigray Bureau of Water Resources operated a system for monitoring and benchmarking utility performance. This system is referred to in this thesis as 'Tigray Utility Monitoring System' (TUMS). It was discontinued during the armed conflict in Tigray Region (November 2020 to November 2022). Post-conflict efforts have focused on reconstruction of the water supply infrastructure, 75% of which was destroyed or damaged during the conflict, with (understandably) little emphasis on monitoring utility performance (pers. comm. Zeruu Haile, 2024). The TUMS had not regained operation status yet at the time of writing. This thesis therefore focuses on the system as observed during the 2018 data collection.

Development of the regional monitoring system was mostly driven by staff of the MSMSP of the Tigray Regional Water Bureau to mitigate the perceived inadequacy of monitoring and regulation of utilities by Water Boards. This process was also driven by the increased focus on utility performance indicators introduced under GTP2. Around 2015, the amount of utility performance data available to the Regional Water Bureaus on indicators such as non-revenue water and operational cost recovery was limited. MSMSP undertook utility performance assessments to inform the baseline and target setting for the regional GTP2.

Subsequently, it started using utility performance data to rank utilities according to their performance on an annual basis. Development of the utility ranking was inspired by the monitoring system introduced by WaterAid's 20-Town programme, applied to three towns in the region between 2014 and 2019. This included weighted average scores on specific performance indicators and ranking of utilities accordingly.

Documentation on the TUMS and its intended data use was not available. According to the head of the MSMSP, the main purpose of the TUMS was to:

1. Inform regulation of utilities;
2. Enable peer learning for improving operational and strategic decision-making;
3. Inform provision of technical support by the Regional Water Bureau (pers. comm. Zeruu Haile, 2018);
4. Inform reporting to the Regional Water Bureau head (pers. comm. Zeruu Haile, 2024).

This section explores the components of TUMS and their alignment with these intended data use cases.

5.4.1 Indicators

The Tigray Regional Water Bureau's MSMSP included a set of indicators which varied from year to year. An overview of the indicators can be found in Annex 6. The amount of water produced and sold, the resulting non-revenue water, and revenues were consistently applied. The 2008 EC¹² (2015/16) and 2010 EC (2017/18) KPIs also included utility coverage as an indicator. The 2009 EC (2016/17) indicators included three additional activity indicators (submission of plans; submission of reports; auditing practices). A user satisfaction indicator was included in 2009 EC and 2010 EC.

Water quality indicators were only included in the 2008 EC indicator framework. However, these were not based on water quality testing data, but rather on activity variables related to presence of water quality monitoring and chlorination practices. Water quality was not considered an issue (Monitoring, Support and Maintenance Subprocesses, Drinking water supply process, Tigray Bureau of Water Resources, 2015). This may have contributed to it not being included in the 2009 EC and 2010 EC monitoring frameworks.

The national KPIs related to service continuity and operational cost recovery (based on revenues and expenditure) were not included in any of the years.

Performance of utilities was assessed in terms of actual values on these indicators as

12. EC=Ethiopia Calander. The Ethiopian year starts on 11 September in the Gregorian calendar and is 7-8 years behind the Gregorian calendar.

percentage of the target values. Utilities were ranked based on weighted indicator scores against the set target. Utilities were thus not ranked in terms of comparative performance on the KPIs, but rather on the extent to which they managed to achieve the set target. Performance on the revenue indicator was weighted highest, contributing 25% of the overall score.

5.4.2 Monitoring tools and processes

The MSMSP developed forms and checklists to be completed and submitted by the utilities on monthly, quarterly, and annual bases. These forms were reviewed and revised by the team on an annual basis. These checklists included a relatively large set of variables (for example, about 32 variables in 2009 EC and some 49 variables in 2010 EC). Not all variables included in the data collection tools were directly linked to the indicators. The 2009 EC data collection tools included 12 variables (out of the 32 variables, so 38%) directly related to the eight indicators, while in 2010 EC, only 15 out of the 61 variables (25%) were directly related to the six utility performance indicators.

Utilities were benchmarked and ranked on an annual basis in July, in line with the end of the Ethiopian fiscal calendar, which runs from 1 July to 30 June (pers. comm. Zeruu Haile, 2024).

5.4.3 ICT platform and financial framework

No specific ICT platforms were used for collection, processing, and compilation of the data, other than MS Excel on the laptop of the head of the MSMSP.

Compilation of the KPI data was done by the MSMSP as part of routine activities, and mainly funded through government transfers.

5.4.4 Summing-up

The Tigray regional monitoring indicators, tools and processes, ICT platform and financial resources were aligned with the intended data uses: to inform regulation of utilities by the Regional Water Bureau, to stimulate performance improvement by utilities, and to direct support from the Regional Water Bureau to utilities.

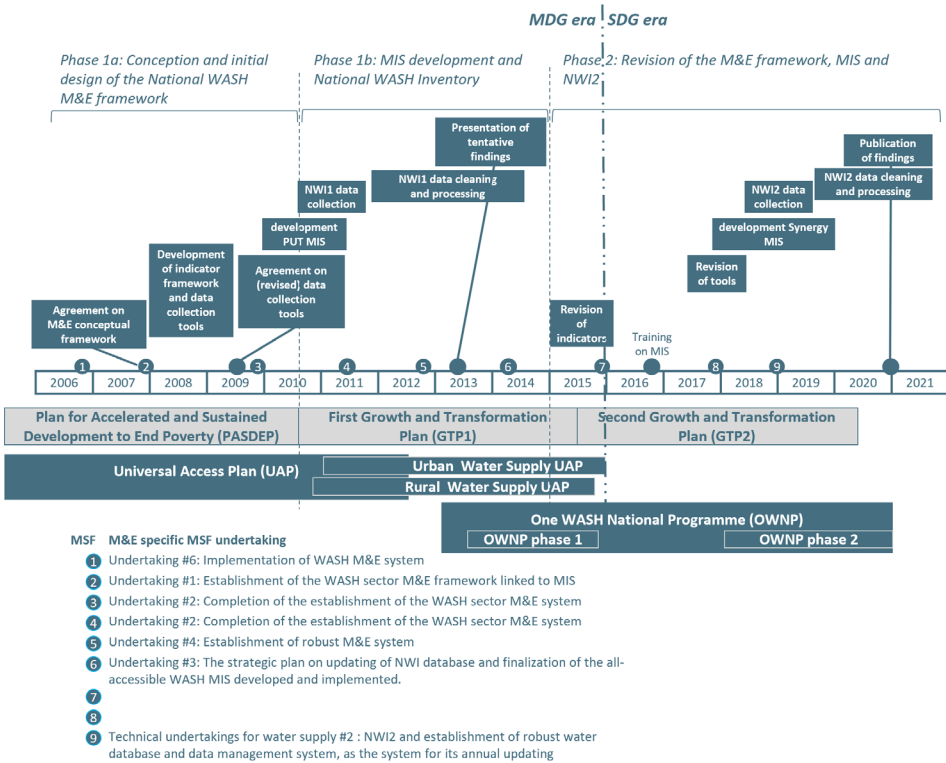
5.5 The National Water, Sanitation and Hygiene Monitoring and Evaluation Management Information System (WASH M&E MIS)

This thesis divides the development of the national Water, Sanitation and Hygiene Monitoring and Evaluation Management Information System (WASH M&E MIS) into two main phases, with phase 1 mainly taking place in the MDG era, and with phase 2 starting at the onset of the SDG era. The first phase is divided into two sub-phases, as shown in Figure 5-1.

Phase 1a (2006-2009) covers the conceptualisation and initial design of the framework.

Phase 1b (2010-2015) covers the operationalisation of the monitoring framework through development and implementation of the NWI for collecting, and the ICT platform for storing and presenting data. Phase 2 (2015-2022) covers the re-design of the system and the second NWI. This section presents the data use cases in the three phases, as explicitly stated in sector documents, followed by an exploration of the (shaping of) the system components and their alignment with the data use cases.

Figure 5-1: Timeline of development of the National WASH M&E MIS in Ethiopia



Source: Author

5.5.1 WASH M&E MIS system components, Phase 1a

The conception of the WASH M&E MIS was driven by sector harmonisation involving multiple ministries (Water, Health, Education and Finance) and development partners, and the introduction of a Joint Sector Review (JSR) process and Multi-Stakeholder Forum (MSF). At the 2006 MSF, more than 200 sector stakeholders agreed to improve information flows and reporting mechanisms between local (woreda and town), regional, and federal administration. They identified strengthening of monitoring systems as a priority for the year ahead (EUWI, 2006). The National WASH Technical Team (NWTT), in coordination with WSP, was to establish an M&E Thematic Working Group responsible for development of the national monitoring framework and MIS. By the third MSF in 2009, a WASH sector performance report was expected to be produced (EUWI, 2008). However, this proved overambitious. Development of the WASH M&E MIS would be the most commonly addressed issue in subsequent MSFs (COWASH, 2019), with regular explicit mentions of monitoring in the MSF undertakings, as shown in Figure 5-2.

Explicitly stated data use cases: The objective of the WASH M&E MIS was first defined in the 2008 conceptual M&E framework and manual, developed by the National WASH Coordination

Office of the MoWR, with technical assistance from the World Bank's Water and Sanitation Program (WSP), to:

1. Complement the JMP data in providing insight into progress made towards achieving the sector's Universal Access Plan coverage targets; and
2. Help guide national and sub-national planning and equitable allocation of investments to maintain this progress (National WASH Coordination Office, 2008).

Indicators: The 2008 framework set out the design of the system, in terms of indicators and monitoring tools and procedures. The key performance indicators include an urban coverage indicator and an indicator on the urban population newly served during the past year. These aligned with the data use cases to track progress on the main national sector plans at the time, the UAP and GTP1, and to inform planning and resource allocation.

The framework also included three utility performance indicators: on Non-Revenue Water (NRW), supply continuity, and operational and full cost recovery (for a complete overview of indicators, see Annex 6). These indicators were based on indicators developed under WSP's International Benchmarking Network (IBNET). However, as the UAP and GTP1 did not include targets on utility performance, the indicators were not in line with tracking progress on these national plans.

Arguably, the utility performance indicators were suitable for directing planning related to support for utilities. However, as the UAP focused on increasing coverage through asset development, rather than on improving service quality and utility performance, inclusion of these utility performance indicators went beyond the explicitly stated data use cases.

A task force consisting of some 5-6 national consultants and Ministry staff developed the KPI algorithms, which were reviewed and approved by the World Bank, as the main financier and supporter of the process at the time (pers. comm. Defere, 2018).

Tools and procedures: The proposed data collection tools included two instruments: a one-time report that describes the design of the scheme (in the base year), and an annual report that describes both improvement to (expansion, rehabilitation, etc.) and performance of the utility. The purpose of the one-time report was to: 1) assess technical performance of water source and scheme; 2) support the Water Board in planning and decision-making processes; and 3) identify governance and management issues such as Board elections, meetings with the community, how tariff changes are made, audits etc.

The purpose of the annual urban water supply report was to inform '*national, sub-national and town/ city level decision-making regarding policy-making, planning and resource allocation.*' The annual report was expected to support utilities in reviewing their own performance and to signal to Regional Water Bureaus any support they would require (NWCO, 2008).

The one-off report format included 26 variables, mainly related to utility assets and non-KPI-related utility performance. The annual urban reports format included some 42 variables, including asset variables and variables for assessing the KPIs. Overall, 26% of the variables in the two reports were directly aligned with the urban water KPIs. The coverage KPI was to be informed by the most recent nationally representative household survey, with a comparison of the two sets of figures and an analysis of reasons for disparities (NWCO, 2008).

The proposed monitoring procedure involved data collection by the regional technical team visiting the utility, in coordination with the town WASH team. The team would meet with

the Water Board, collect and review data, make observations and inspections, and discuss the need for technical support. The team would complete the reports and disseminate copies to the utility, Water Board, town administration, Regional Water Bureau, and Ministry. It would also enter the data into the ICT platform. Utilities would compile data for annual reports.

ICT platform: In December 2009, the Ministry signed a contract with PUT (Professionals Unite Together) PLC, in collaboration with Addis Ababa University, for the development of an SQL-based ICT platform for managing and storing national WASH M&E data. The MIS was developed in line with the KPIs and data collection tools. It considered utility managers and the Regional Water Bureaus as main users of the raw data, and national stakeholders as main users of KPI data. The MIS would provide access to the data for inquiry and reporting, produce aggregate one-time and annual inventory reports, and KPI data, chart, graph, table, map, and combinations of these, presenting progress against national and international targets (Professionals Unite Together (PUT), 2010).

Financial framework: WSP covered a considerable part of the costs of the initial conception and design of the WASH M&E MIS. Data on these costs were not readily available. The 2008 monitoring framework did not provide a financial framework for operationalisation of the WASH M&E MIS, but seemed to assume that monitoring activities would become part of routine activities performed by the utility, Regional Water Bureau and Ministry staff.

Summing-up: The emphasis of the explicitly stated data use cases was on tracking progress on coverage and informing planning and resource allocation decisions in line with the focus of UAP and GTP1. Nevertheless, the main donor (World Bank) pushed for the design of indicators, tools, and procedures beyond this, intending to make data suitable as well for informing reporting and decision-making related to utility performance.

5.5.2 WASH M&E MIS system components, Phase 1b

This phase saw the operationalisation of the WASH M&E MIS, including the first National WASH Inventory and the further development of the ICT platform.

Explicitly stated data use cases: In line with the above-presented explicit monitoring objectives for the National WASH M&E system, the data use cases of the NWI were:

1. To provide baseline data for monitoring progress; and
2. To inform planning (Hailu Debela, 2013).

This period aligned with the last five years of the coverage-data-focused MDG period and the Universal Action Plan, leading to considerable national level interest in coverage figures.

Tools: The monitoring tools and processes described in the 2008 framework were not put into practice. Instead, in 2009, the Ministry established a National WASH Inventory Project Office (NWIPO) to organise a National WASH Inventory to operationalise the National WASH M&E MIS and populate it with data. Data collection tools were reviewed in a consultative meeting in May 2009 involving UNICEF, SNV, the RiPPLE Project and the SNNPR Water Bureau (No author, 2009). The experience and interest of these actors was mainly in monitoring rural water and sanitation, focused on coverage and functionality data for informing woreda level planning and resource allocation decisions related to asset development for rural water supply. The Water and Sanitation Program of the World Bank (WSP), which had been instrumental in

the development of the 2018 monitoring framework, took a backseat in this process. UNICEF's plan to scale up its woreda inventory initiative from eight (2007-2010) to 78 woredas, was considered a good opportunity for operationalising the national M&E MIS (pers. comm. Gossa, 2018). National WASH Inventory instruments subsequently built on the UNICEF survey tools (Welle et al., 2012), rather than on the instruments presented in the 2008 manual, developed with support from WSP.

Indicators: As the new data collection tools did not fully align with the original indicators, the indicators were adjusted, resulting in an indicator set which included eight utility KPIs. These included four indicators on utility coverage, in line with the focus on coverage data, which had emerged from the Minister's desire to compare its coverage data with JMP data. The KPIs on non-revenue water and cost recovery remained, but the output and continuity indicators were removed (as data collection tools did not include variables for these indicators), and two additional utility performance indicators (on adequacy of water supply and on staffing) were added. Together the data collection tools included 62 variables, with a relatively high proportion (65%) directly linked to utility KPIs. In addition, a relatively large part of the data collection tools was related to asset variables (32%).

Procedures: The NWI was conducted from October 2010 to October 2011, as a nationwide (with the exception of Somali Region) data collection process. It involved almost 70,000 data collectors, including teachers and health extension workers, in addition to staff of the Woreda Water Offices, supervised by Zonal Water Offices. Data collection was paper-based and required a time-consuming data entry process at regional level.

The design of the NWI was focused on data collection, and less on processing and analysis. Only in May 2011, with the data collection process in full swing, the NWIPO wrote a briefing note urging the establishment of a data management and analysis team (National WASH Inventory Project Office, 2011a). Woreda report cards displaying WASH access data in pie charts and graphs, were to be produced to provide easy access to the data in accessible formats (Butterworth et al., 2010). However, these never materialised and in spite of the effort, time and resources that had gone into the NWI, no major information product presenting its results was produced.

The NWI was mainly organised as a one-off data collection exercise. NWIPO set out its NWI sustainability strategy in a briefing note produced in May 2011, suggesting that regions, woredas and kebeles should work together to update the data, using several of the data collection forms, on a half-yearly basis, adding additional facilities, and where needed, noting changes to existing facilities. It also recommended updating the data every 2.5 years by deploying enumerators to all community schemes, schools, and HCFs (National WASH Inventory Project Office, 2011b). This would, however, not include updating of the utility performance data, on which the strategy remained silent. Also, the strategy lacked details on required institutional and financial mechanisms for this.

ICT platform: The design and development of the ICT platform was still underway at the start of the NWI. Therefore, Hawassa University and SNV, with financial support from UNICEF, developed a simple MS Access 'Interim Data Capture system' for interim data input and storage. Eventually, the Ministry transferred the data into the PUT MIS, which had originally been set up to accommodate data aligned with the 2008 annual and one-off data collection forms. There

was a mismatch between the variables in the MIS and the NWI data collection forms, with some 30 variables in the MIS not in the data collection tools. The MIS was adjusted to better align with the new variables and KPIs. The resulting PUT MIS was designed to include data on 69 variables and eight KPIs.

Financial framework: The NWIPO estimated the required budget of the NWI to amount to some 123 million ETB, or some 7.3 million USD (National WASH Inventory Project Office, 2011c, 2010a). The first OOWNP document estimated that the total costs of the NWI actually amounted to about 200 million ETB (Federal Democratic Republic of Ethiopia, 2013), or almost 12 million USD (some 0.13 USD per (2011) inhabitant). The majority of these costs were covered by development partners with an interest in sector harmonisation (who would at a later stage also be instrumental in the development of the OOWNP), including UNICEF, AfDB, World Bank and DfID. NGOs and local government also contributed with time and logistics.

Summing-up: The re-design of the monitoring tools and procedures, and some of the indicators in this phase, were driven by development partner funding for a considerable part of the initiative (UNICEF).

Although data were intended to be used at different institutional levels, because of the *'clear bias in both the design and implementation of the NWI process towards interests at the central level, namely sector donors'* (Welle et al., 2012), the designed monitoring procedure and ICT system were not aligned with this, focusing rather on national-level data use.

5.5.3 WASH M&E MIS system components, Phase 2

The government's 2015 GTP2 introduced higher and more diverse water supply goals and targets. This triggered the revision of the WASH M&E MIS indicator framework and ICT platform. Data had not been updated since the 2011 NWI and were outdated. The revision of the WASH M&E MIS was also driven by the 2013 introduction of the One WASH National Programme (OOWNP), with the ambition of having one WASH sector plan, budget and report. As an active contributor to the OOWNP, DfID funded a programme to support strengthening the WASH M&E MIS, expecting that a functional system would enable assessing and reporting progress on the OOWNP. Coffey International was contracted to execute the project.

Explicitly stated data use cases: The Terms of Reference of the WASH M&E MIS strengthening programme mentioned that the programme intended to operationalise and strengthen the WASH M&E MIS, so it could ensure *'that reliable, timely and strategic information are generated at all levels of administration (i.e., federal, regional and Woreda) to facilitate evidence-based decisions'*.

However, it mentioned the main target audience for the data and reports as 'policymakers at the WASH sector Ministries [...] and their experts and professionals, regional bureaus, the pooled fund (CWA) contributing partners and other OOWNP partners', so focusing on national and to some degree on regional level decision makers. Like in phase 1, the dual monitoring objective of intended data use for tracking progress and informing planning at different levels remained, but now with a focus on tracking progress on the OOWNP (as a means to implement the GTPs) and informing evidence-based decision-making related to its implementation.

Indicators: In 2015, GTP2 was launched, which, unlike the UAP and GTP1, included utility performance goals related to NRW, service continuity, cost recovery, water quality monitoring

and water safety planning, and involvement of private sector (see Chapter 4). Indicators needed to be revised to align with these new goals and targets. As part of the monitoring system strengthening initiative funded by DFID, indicators were reviewed and revised by the consultant team, with feedback provided by national stakeholders. The resulting indicator set included seven KPIs, six supplementary indicators (SI) and four regional SIs related to urban water supply. Also, two supplementary indicators related to the presence and performance of water authorities (Water Boards and consumer platforms) had been added (MoWIE and Coffey, July 2018). However, the indicators did not fully align with the GTP2 goals, with only five of the 13 urban water indicators aligned with the GTP2 goals and without indicators related to the GTP2 targets on presence of water quality monitoring systems and involvement of private sector in O&M of urban water supply utilities.

Data collection tools: Coffey introduced a mobile phone application for data collection under NWI2: the custom built COSMOS (Coffey Spatial Mobile Solution) survey tool (Coffey, 2018). The Ministry and its consultants designed new data collection surveys accordingly (pers. comm. Asmamaw Molla, 2018). The use of COSMOS enabled more elaborate survey design with more conditional variables. Also, as manual data entry was no longer required, there was less incentive to limit the number of variables to be included in the survey. This, together with the increased number of indicators, is likely to have resulted in the large number of variables: 83 common variables and an additional 47 conditional ones.

As shown in Table 5-1, only 18 (22%) variables were directly related to the KPIs or SIs, with a considerable number of asset variables and utility performance variables unrelated to KPIs or SIs.

Table 5-1: Number of variables as part of urban water supply data collection tools

Variable group	Phase 1 a*	Phase 1b**	Phase 2***
Asset variables	18 (26%)	20 (32%)	23 (28%)
Variables for assessing coverage	6 (9%)	9 (15%)	4 (5%)
Variables for assessing service provider performance KPIs and SI	18 (26%)	31 (50%)	18 (22%)
Variables related to service provider performance (non KPIs)	20 (29%)	2 (3%)	34 (41%)
Variables for assessing service authority KPIs	0	0	2 (2%)
Variables related to service authorities (non KPIs)	4 (6%)	0	0
Total	68	62	At least 83

Source: *2008 manual annual and one-off report format;

** NWI1 data collector formats; *** NWI2 data collection survey

Although there were no KPIs on GTP2 goals related to groundwater level monitoring and involvement of private sector, variables related to these goals had been included in the surveys. Only one KPI, three SIs and three regional SIs had aligning variables (see Annex 7).

Procedure: Testing of the survey started in September 2018, and data were collected from late December 2018 to early March 2019. Some 150 representatives from national, regional, and zonal levels participated in a Training of Trainers, with subsequent training of some 3,379 local level data collectors and 430 zonal supervisors. This was considerably fewer than the 70,000 data collectors engaged in NWI1. This was mainly due to the abolishing of the household survey that had been included in NWI1. In addition, the use of mobile-data collection technology facilitated and speeded up data collection, requiring less time and fewer people involved.

Post-data collection, Coffey provided the data in MS Excel format for cleaning and verification by national and regional level task force members (Water Development Commission, 2021). In October 2019, the head of the WDC and several national consultants jointly worked for two weeks on calculating the coverage figures based on the NWI2 data, using and comparing three different calculation methods. The results were presented to the Minister, who decided which method would be used and presented in the NWI2 report.

In January 2021, the Draft Report on National WaSH Inventory-II & MIS was made available online on the Community Management Project Approach website, the de facto repository of documents in the WASH sector in Ethiopia. The report focuses primarily on coverage findings and does not include results on the utility KPIs.

According to the NWI2 data collection guidelines, the Urban Water Supply and Sewerage Inventory data were expected to be updated annually by utilities enumerators, supervised by Zonal Water Offices (Coffey, 2018). However, recognising the challenges of doing a national inventory from an economic and a value-addition point of view, Asmamaw (2021) proposed undertaking a national inventory every five years.

ICT platform: The DFID-funded national WASH M&E MIS strengthening programme did not intend to further develop the ICT system; instead it expected the PUT MIS developed under phase 1 to be used and enhanced. This proved difficult, both technically and contractually. Therefore, DFID provided an additional 'critical gap fund' of about 1 million GBP for the development of a new MIS by Coffey in 2017. Coffey sub-contracted this task to Synergy International Systems Inc, a USA-based IT and consulting company, which provides web-based software to international development agencies, country governments, NGOs and private sector partners. The resulting MIS was aligned with Coffey's COSMOS data collection system. Its main objective was to *'provide MoWIE with a unified platform for monitoring the progress and evaluating the effectiveness of Ethiopia's One WASH National Programme to improve the provision of safe water and sanitation throughout the country. [...] The MIS is an accountability mechanism, a performance monitoring tool, and an information management tool that coordinates the One WASH National Programme implementation at the federal level. It enables supervising and monitoring the implementation activities carried out by the WASH Programme Management Units (WPMUs) in the Ministries of Water, Irrigation and Electricity, Health, Education, and Finance and Economic Development.'* (Synergy International Systems, n.d.).

The platform would provide standard dashboards and enable users to create their own dashboards, displaying relevant data in tables, graphs and maps. It would allow users to view data on indicator performance, including the baseline and target (Synergy International Systems, n.d.). The Ministry (and its consultants) provided the algorithms and population data needed to calculate the KPIs (pers. comm. Asmamaw Molla, 2022).

On 25 December 2019, provisional operational acceptance of the resulting 'One WaSH National Management Information System (One WaSH National MIS)' was provided (Asmamaw, 2021). This started an 18-month warranty period, during which the Ministry was expected to procure servers for migrating the data and the MIS. AfDB was willing to support the procurement of the Ministry's servers. However, due to the Ministry's internal procurement process challenges and delays due to restructuring of the Ministry, procurement was stalled,

and after an additional six-month extension period, Synergy could no longer permit access to the MIS as from November 2021 (pers. comm. Asmamaw Molla, 2022). At the time of writing, the MIS was therefore (still) not functional.

Financial framework: Like in phase 1, the development of the WASH M&E MIS in phase 2 lacked the development of clear financial frameworks for ongoing data collection, processing, and use, which is a clear challenge for its operationalisation and sustainability. The budget for the DFID-funded programme to strengthen the WASH M&E system, including the second NWI in phase 2, amounted to 3 million GBP. In addition, this phase included national monitoring system development, which amounted to an additional 1 million GBP for MIS development, bringing the total to some 4 million GBP, or some 5.4 million USD. In addition, 3,924 tablets used for the NWI2 were procured with financial support from AfDB (Water Development Commission, 2021), which may have costed as least an additional 0.8 million USD. The total of 6.2 million USD amounts to almost 0.06 USD per (2018) inhabitant and 1.3% of the estimated 475 million USD per year that was spent in the sector, as estimated in 2017 by the Water Sector Working Group Secretariat and UNICEF (National WASH Coordination Office, 2018).

Summing-up: Like phase 1, phase 2 was driven by national-level actors, especially development partners, from a desire for a common monitoring system for the OWNP.

Intended data use was explicitly stated to include use for tracking progress on utility performance and for reporting on progress towards GTP2 goals. However, indicators and data collection tools were not entirely suitable for this purpose.

5.5.4 Summing-up

As described above, development partners have played a key role in the development of the WASH M&E MIS, both in phase 1 (World Bank and UNICEF) and phase 2 (DFID).

In both phases, there was some level of misalignment of the explicitly stated intended data use, and the systems components.

The data use potential for tracking and improving utility performance, as expressed in the original design of the monitoring systems components included in phase 1a, was considerably less evident in the re-designed indicators, tools and procedures of phase 2. Rather, the objectives implicitly built into the monitoring system, focused more on data use for informing planning and resource allocation, are arguably more in line with the explicitly expressed monitoring objectives.

Despite increased attention to utility performance in the sector, expressed through inclusion of standards, targets and KPIs in GTP2 and OWNP, the national WASH M&E MIS has remained very focused on producing coverage data to inform macro-level planning related to asset development, rather than on producing utility performance data for tracking progress on performance KPIs and regulating and improving service provision.

5.6 National utility performance indicators and benchmarking

In parallel with the WASH M&E MIS development, benchmarking of utility performance was introduced in Ethiopia in August 2011, with a workshop organised by the Ministry. This resulted in the Adama Declaration on the development of performance indicators for Ethiopian Water Utilities. This workshop was followed by another one in March 2012, where representatives from the Ministry,

Regional Water Bureaus, World Bank, and 150 utilities agreed to adopt the IBNET methodology and tools to make comparable utility performance data available to all actors (Ministry of Water and Energy, 2012; Tadesse, 2020). The World Bank was an important driver and facilitator of the development and implementation of utility performance benchmarking using IBNET in Ethiopia.

In Ethiopia, utilities and government and its development partners are expected to be the main users of PI&BM data (Birhane and Tesfaye, 2015; Ministry of Water and Energy, 2012a). The main data use cases for performance benchmarking data in Ethiopia, as expressed in the 2012 utility performance indicator and benchmarking training manual and a 2015 MSF presentation, can be summarised as:

1. To enable peer learning and utility capacity building, intended to improve utility performance efficiency and effectiveness;
2. To guide planning, prioritisation, and allocation of available capital finance (loan and grant) by government and development partners;
3. To enable the public to hold their utility accountable for provided services (Birhane and Tesfaye, 2015; Ministry of Water and Energy, 2012).

The training manual furthermore states that performance monitoring can be used by the Ministry to:

4. Assess and track overall sector performance; and
5. Target assistance to utilities to improve performance.

Furthermore, it suggests that:

6. Water Boards and Regional Water Bureaus could use PI&BM data in tariff review and approval processes (Ministry of Water and Energy, 2012).

5.6.1 Indicators

IBNET established a standard (minimum) set of core utility performance indicators to enable comparison across multiple utilities at a given point in time or within a single utility over time. It included 79 indicators, of which 29 are related to wastewater management by utilities (van den Berg and Danilenko, 2010). Although utilities in principle have the mandate to provide wastewater services in Ethiopia, most utilities do not do so in reality. The PI&BM initiative in Ethiopia therefore focused on 51 indicators. A set of 17 KPIs (4 technical indicators, 3 personnel indicators, 3 operational indicators, 5 financial indicators, and 2 customer management indicators) were established (Tadesse, 2020). The full list of indicators and the KPIs can be found in Annex 6.

As the indicators cover different topics, including service quality, economic and financial issues, and managerial issues, the indicators are aligned with the intended PI&BM data uses presented above.

5.6.2 Monitoring tools and procedures

To facilitate data collection, the standard IBNET questionnaire was contextualised and translated into Amharic. The MS Excel-based data collection forms included 60 variables (Ministry of Water and Energy, 2012), all aligned with the 51 water indicators.

Utility staff were to fill in the questionnaires, based on available data, and submit them to a focal person from the Ministry, responsible for compiling the data, supported by a national

consultant and an expert from WSP/World Bank. This team was also responsible for data cleaning and quality control. The team spent considerable time and effort to ensure production of good quality data, through training of utility staff, and through rigorous validation and data cleaning. A report was to be prepared with support from the World Bank Headquarters in Washington DC and presented to all stakeholders in a workshop setting. This process of submission of benchmarking data, data cleaning and processing and report writing and sharing was to be repeated on an annual basis (Ministry of Water and Energy, 2012).

In reality, however, two data collection rounds have taken place: in 2013 (covering 2011 and 2012 data) and in 2019 (covering 2013 to 2018 data). Data were cleaned, processed and made available on the online ICT platform, but information products never materialised.

5.6.3 ICT platform

Produced data are available through the IBNET website (<https://www.ib-net.org/>), which provides data users with the opportunity to visualise the data in tables and graphs. In the long term, the PI&BM data and indicators would be (at least partially) integrated into the WASH M&E MIS (pers. comm. Azeb, 2018; pers. comm. Tesfaye, 2022). However, at the time of writing, no steps towards operationalising this had been taken, and there was no plan for doing so.

5.6.4 Financial framework

Development of the PI&BM system in Ethiopia has been partially funded by the World Bank (Ministry of Water and Energy, 2012). Financial frameworks for ensuring ongoing data collection were not specified.

5.6.5 Summing-up

The data produced by the PI&BM system were mainly intended to inform planning at the national level, and operational and strategic decision-making at the local level, and to facilitate downward accountability towards water users. The PI&BM indicators, monitoring tools, and the intended annual process of data compilation, and the ICT system which provides open access to the KPI data, are all aligned with the intended data uses. However, a solid financial framework for ensuring ongoing functioning of the monitoring system was not in place.

5.7 The joint monitoring programme (JMP)

UNICEF and the World Health Organization (WHO) started collaborating under its Joint Monitoring Programme (JMP) in 1990 to monitor global progress in water supply and sanitation. This positioned JMP to take on the mandate of monitoring progress towards globally established drinking-water and sanitation targets, set by the United Nations as part of the Millennium Development Goals (MDGs) in 2000, and the Sustainable Development Goals (SDGs) in 2015. JMP acts as the custodian for SDG 6.1, focused on achieving universal and equitable access to safe and affordable drinking water for all by 2030¹³.

13. In addition, JMP is the custodian for SDG 6.2, focused on access to adequate and equitable sanitation and hygiene for all, and end open defecation, with special attention to the needs of women and girls and those in vulnerable situations, by 2030.

5.7.1 Explicitly stated data use cases

JMP intends *'to compile, analyse and disseminate high quality, up-to-date, consistent and statistically sound global, regional and country estimates of progress towards internationally established drinking-water and sanitation targets in support of informed policy and decision-making by national governments, development partners and civil society'* (WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation, 2021, p. 20; WHO/UNICEF Joint Water Supply and Sanitation Monitoring Programme, 2009). JMP data are thus intended to inform:

1. Reporting of progress towards internationally established targets; and
2. National policy and planning processes.

5.7.2 Indicators

In the MDG era, the JMP water coverage indicator related to the proportion of people with access to drinking water from an 'improved' source. This indicator was used to track progress towards MDG7c, which was to halve the proportion of the population without sustainable access to safe drinking water and basic sanitation between 1990 and 2015. Access to drinking water was defined as the availability of at least 20 litres per person per day from an improved source within 1 kilometre of the user's dwelling (World Health Organization and United Nations Children's Fund, 2006).

With increasing global coverage levels towards the end of the MDG era, there was a push from global academics and practitioners (for example, Bartram et al., 2014; Kayser et al., 2013) for JMP to differentiate between coverage of different water service levels. Development of new, post-MDG water supply indicators involved a consultative process, including a series of meetings (in Berlin in May 2011 and in The Hague in December 2012), a working group consisting of experts from the global North and South, and an open online consultation process (WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation, 2011; WHO/UNICEF Joint Water Supply and Sanitation Monitoring Programme, 2012). The majority of participants in these consultations were representatives from academia, development partners and civil society. At the first consultation meeting in Berlin, only three of the 65 participants represented governments (WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation, 2011).

This resulted in the new indicator SDG 6.1.1 defined as the 'Proportion of population using safely managed drinking water services', with safely managed water services defined as water from an improved water source, on premises, free from contamination, and available when needed. Basic water services were defined as water services from an improved water source, within a 30-minute round trip. Water services from an improved source which is not within a 30-minute round trip, were categorised as 'limited'.

5.7.3 Monitoring tools and procedures

From 1990 to 1996, JMP collected coverage data directly from participating countries, based on their own definitions of 'access to safe water'. As this presented a challenge with data quality, comparison, and aggregation, JMP decided in 2000 to define access to safe water supply based on the technology of the main source of drinking water supply, differentiating between 'improved' and 'unimproved' facilities.

In 2000, it stopped using coverage data submitted by countries and started doing linear regression (using the least-square method) of multiple sets of data, including population census data, administrative or 'provider-based' data (predominantly from high-income countries), and nationally-representative household surveys (World Health Organization et al., 2000).

Household surveys are commonly undertaken by the country's national statistics agency, in collaboration with (and often designed and funded by) development partners. These include the five-yearly Living Standard Surveys, supported by the World Bank or regional development banks (Chandy and Zhang, 2015), Demographic Health surveys, supported by USAID, and the Multiple Indicator Cluster Survey (MICS), supported by UNICEF. See Annex 8 for an overview of the JMP source data for Ethiopia for the past 25 years. Most of these surveys intend to collect data on a wide variety of topics and sectors, including water supply.

The amount of water used is commonly not included as a variable in household surveys. Therefore, data could not be compiled on the proportion of people with access to at least 20 litres per capita per day (lpcd) within 1km, defined as improved access. Instead, during the MDG era data were collected on three variables: the proportion of households that use 1) piped drinking water on premises; 2) any drinking water facility classified as improved; and 3) water collected from a surface water source (Bartram et al., 2014). To harmonise variables across the different household surveys, JMP published guidance on 'Core questions on drinking water and sanitation for household surveys' in 2006 (World Health Organization and United Nations Children's Fund (UNICEF), 2006).

In the SDG era, JMP has been compiling data from different sources on seven water supply variables, related to the proportion of households that use water from 1) improved water sources; 2) piped water sources; 3) water source on premises; 4) water source within 30 minute round trip; 5) a water source with water available when needed; 6) a water source that is free from contamination (microbial, fluoride, arsenic, other); and 7) surface water. In line with the new variables, a set of updated core survey questions was published in 2018 by JMP, in collaboration with UNICEF's Multiple Indicator Cluster Surveys (MICS). However, with the exception of the MICS and DHS, most surveys do not use these standardised questions, making data compilation challenging.

JMP consists of a small global team of some five full-time UNICEF and WHO staff, overseen by the WHO Coordinator of the Water, Sanitation, Hygiene and Health unit, the UNICEF Chief of the Data and Analysis Section, and the UNICEF Chief of Water, Sanitation and Hygiene Section. The JMP team sources technical advice and recommendations on specific issues by convening ad hoc expert groups of academics, policy makers and practitioners. A Technical Advisory Group, provided strategic guidance and technical input on methodological issues (WHO/UNICEF Joint Water Supply and Sanitation Monitoring Programme, 2009), until it was replaced in 2009 by a Strategic Advisory Group, which meets annually (as and when needed) to review progress and provide strategic advice on the continued development of JMP¹⁴. It consists of some 12 leading

14. This advisory committee also advises WHO's Global Analysis and Assessment of Sanitation and Drinking-Water (GLAAS).

experts in the field. Advisory group members cannot represent donor organisations (WHO/ UNICEF Joint Water Supply and Sanitation Monitoring Programme, 2018).

Since 2020, JMP has been promoting country consultations on JMP coverage estimates, facilitated by WHO and UNICEF country offices, engaging national statistical offices and other relevant national stakeholders to review the draft estimates and provide technical feedback to the JMP team. This is focused on checking completeness of the data sources, ensuring used data sources are reliable and suitable for use as official statistics, and ensuring that the JMP interpretation and classification of data from data sources is accurate and appropriate (WHO/ UNICEF Joint Water Supply and Sanitation Monitoring Programme, 2020).

5.7.4 ICT platforms

JMP coverage data and information products, including (more or less) bi-annual progress reports, are made available online (www.washdata.org). In 2017, JMP launched a re-vamped website to support global monitoring of WASH during the SDG period. The site includes interactive tools enabling users to explore the JMP databases and to create, download and share charts and data tables, per country or per region (WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation, 2021).

5.7.5 Financial framework

The running costs of JMP are covered by UNICEF and WHO, complemented by funding from a group of development partners, including bilateral funders (including ADA, AfD, BMZ, DFAT, DGIS, SDC, FCDO, USAID), EC and the Bill & Melinda Gates Foundation. Average expenditure on JMP amounts to about 2.6 million USD per year (based on expenditures reported in 2020, 2018, 2017, 2016, 2015, 2013 and 2012 JMP annual reports). Divided across the 234 countries and territories for which JMP compiles data, this amounts to about 11,200 USD per country per year. This does not include the costs of the production of the source data, through different surveys. Cost estimates related to the production of the source data vary. Jerven (2014) estimate census costs to amount to 1 USD to 3 USD per person, approximately every 10 years. According to Bartram et al. (2014) the costs of a MICS amounted to about 750,000 USD per country, while a DHS survey typically costs around 2-2.5 million USD (0.8 million USD to 1.2 million USD, according to estimates by Jerven (2014).

5.7.6 Summing-up

JMP data are intended to be used for 1) reporting on progress made against global targets and 2) informing national-level decisions by governments, development partners and civil society. The indicators, tool and procedures and ICT platforms are aligned with these uses.

Development of the JMP monitoring system has mainly been driven by the UN's desire to monitor progress on its (Millennium and Sustainable) Development Goals for informing macro-level planning decisions and for holding governments accountable for progress on these goals. Although national government is perceived as one of the key users of the JMP data, their involvement in the development of the JMP system has been limited.

5.8 Annual compilation of regional and national coverage data

In parallel with JMP, the Ministry compiles coverage data in terms of people served based on annual submissions from Regional Water Bureaus.

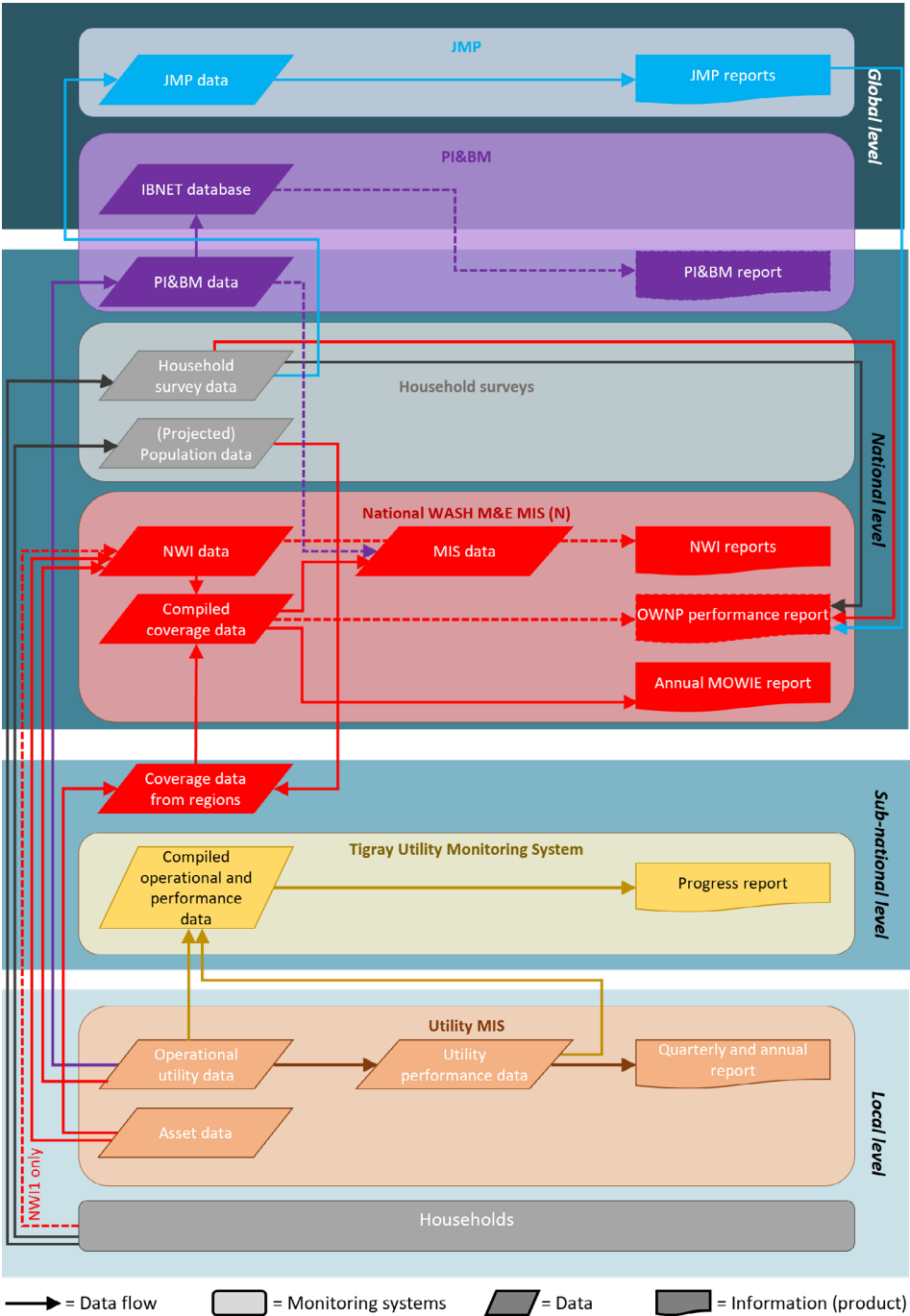
Coverage estimates have been based on the number of people estimated to be served by different facilities, combining asset data with population data provided by the Ethiopian Statistical Services (ESS). Asset data build on the findings of the latest NWI round, to which additional assets accumulated since then are added annually. The latest census forms the basis for the population data. However, the latest census data (at time of writing) are from 2007 and therefore likely out-of-date. ESS provides annual projected population data, with obviously increasing levels of inaccuracy. Compilation of regional coverage data is done by the Ministry staff and national consultants, rather than through ICT systems. It is part of the general activities of the Ministry and does not have a dedicated source of funding.

5.9 Summary and observations

5.9.1 Monitoring systems, the data they produce and intended data uses

This chapter has given an overview of Ethiopia's town water supply monitoring system. Figure 5-2 presents an overview of this system and the data and information that it produces. Regular data flows include 1) the production of quarterly and annual utility performance reports by utilities, based on the utility's operational and performance data; 2) compilation of utility operational and performance data as part of the TUMS; 3) regular data collection through different household surveys, processed by JMP into coverage estimates; and 4) assessment of regional coverage data based on asset and population data, with compilation at national level by the Ministry. The PI&BM and household survey data were supposed to feed into the WASH M&E MIS, but this was never operationalised.

Figure 5-2: Data and information flows



Source: Author

5.9.2 Explicitly stated data use cases

Table 5-2 presents an overview of the explicitly intended and potential uses of the data from the monitoring systems introduced in this chapter. It shows a total of 20 data use cases, involving different data sets.

Table 5-2: Intended (I) and potential (P) data use

Data use case		Type of data								
		Coverage data		Utility performance data					Operational data	Asset data
		JMP	National WASH M&E MIS		Phase 1	Phase 2	PI&BM	TMS	Utility MIS	
Policy-making	Policy-making	I/P	I/P	P	I	P				
Planning	Macro-level planning, asset development	I/P	I/P							
	Macro-level planning, utility performance strengthening			P	I	I/P				
	Regional strategic planning		I/P	P		P	I/P			
	Strategic (business) planning by utility					I/P	I/P	I/P	I/P	I
Operation and asset maintenance	Technical support from Regional Water Bureau to utility			P		P	I/P	I		
	Operational decisions and corrective measures by Water Board								I/P	I
	Operational decisions and corrective measures by utility								I/P	I
Tariff setting	Tariff setting by utility							I/P	I/P	I
Regulation	National level regulation			P		P				
	Economic regulation (tariff approval)			P		I/ P	P	P		
	Performance regulation of utility by Regional Water Bureau			P		P	I/P			
	Oversight and performance regulation of utility by Water Board							I/P	I/P	
Reporting for accountability	Reporting for upward accountability at national level, on coverage	I/P	I/P							
	Reporting for upward accountability at national level, on utility performance			P	I	I/P				
	Reporting for upward accountability at regional level						I/P			
	Reporting for upward accountability at local level							I/P	I/P	
	Reporting for downward accountability by Ministry	P	P	P		I/P				
	Reporting for downward accountability by Region						P			
	Reporting for downward accountability by utility							P		

Level: Local; Sub-national; National; **Intended or potential data use:** I=Intended use, as explicitly mentioned in frameworks and guidelines; P= Potential use, as implicitly expressed in the monitoring system components

In data use cases with both intended and potential use of a specific data set (indicated in the table with 'I/P'), there is alignment between the explicitly expressed intended data use and the system components of the monitoring system. As shown in the table, this alignment between intended and potential data use was mostly observed for the Utility MIS, the National coverage data, and JMP.

The table also shows that multiple monitoring systems have similar intended data use cases. For example, coverage data from JMP and the Ministry are intended to inform national-level decision-making and reporting for accountability on coverage. Likewise, the WASH M&E MIS and PI&BM both intend to inform national-level decision-making and reporting for accountability on utility performance. Several monitoring systems produce data intended to inform strategic planning by utilities.

Some data use cases relate to a single monitoring system. Several data use cases at local level, including reporting for upward accountability by the utility, informing operational decisions and tariff setting by the utility, and regulatory decision-making by the Water Board, are related to the Utility MIS data.

This chapter demonstrated that the design of monitoring system components does not always align with the explicit intended use of data. The table shows there are several cases where the explicit data use of a monitoring system is not supported by the monitoring system components. For example, although utilities are expected to maintain asset data to inform asset management, Utility MIS for supporting this are rarely in place. Also, due to misalignment of the data collection tools with the indicators, the phase 2 WASH M&E MIS utility performance data did not have the potential to inform policy-making, macro-level planning, and reporting for accountability. Utility performance data from the Utility MIS are intended to inform technical support from the Regional Water Bureau to the utility. However, as indicators and data tools were mostly developed by utilities themselves, without regional alignment, aggregation of these data, needed for informing technical support from Regional Water Bureaus, is a challenge in several regions.

On the other hand, monitoring system components have been found to enable potential data uses beyond the explicitly stated ones. For example, although economic regulation (tariff approval) was only explicitly mentioned as a potential data use case for PI&BM, utility performance data produced by the other monitoring systems could potentially be used for this as well. Likewise, use of utility performance data for informing performance regulation was only explicitly mentioned for TUMS, while PI&BM and National WASH M&E data could inform performance regulation as well (expressed as an intended use for IBNET data (van den Berg and Danilenko, 2010), but not for the IBNET-inspired PI&BM system in Ethiopia). Although various data sets were found to have the potential to inform reporting for downward accountability, this only was explicitly mentioned as an intended data use case for the PI&BM system.

5.9.3 Drivers for monitoring system development

This chapter has shown that development partners have played an important role in driving and shaping the development of monitoring systems involved in the Ethiopian town water supply sector.

Development of Utility MIS was supposed to be driven by national guidelines and reporting requirements of service authorities and regulators, and by the drive of utilities themselves to improve their service provision and performance. However, in reality, these driving forces have been relatively weak, which has resulted in a generally weak Utility MIS.

The development of systems focused on producing utility performance data (PI&BM and TUMS) was driven by a desire to inform peer learning and regulation. Different initiatives were driven by different actors, with the PI&BM system development driven by the World Bank in collaboration with the Ministry, the Federation benchmarking driven by the Federation of utilities, and the TUMS driven by the Regional Water Bureau, in its role as regulator of urban water services in the region.

The development of the national WASH M&E MIS has been driven to a large degree by the desire of both development partners and the Ethiopian Government to harmonise reporting on national plans and programmes with the UAP and OWNPs. Different development partners have supported (and influenced) the national WASH M&E MIS in the different phases of its development, with the World Bank/WSP playing a strong role in phase 1a, UNICEF in phase 1b, and DFID in phase 2. Development of the PI&BM in Ethiopia was supported strongly by the World Bank/WSP. The development of TUMS and the development of Utility MIS were less driven and influenced by development partners.

Although the objective of JMP focuses largely on informing national-level processes, its development has been driven mainly by a desire from development partners to have globally comparable data.

5.10 Way forward

This chapter has introduced the Ethiopian town water supply monitoring system, its intended uses, and how these have been shaped by and expressed in the different monitoring system components, and the actors involved in their development. The next chapter focuses on how monitoring data are used in reality by different actors, at different institutional levels, for different purposes, and whether these data uses are in line with the intended and potential uses presented in this chapter.

6 ACTUAL USE OF MONITORING DATA

6.1 Introduction

Chapter 5 presented the Ethiopian town water supply monitoring landscape. It described the development of the different monitoring systems and their intended and potential data use. But are these monitoring data actually used in line with their intended and potential uses? This chapter addresses the second main research question of this thesis: *'How and to what degree are monitoring data actually used?'*. Based on document reviews and a series of interviews at different institutional levels, this chapter assesses the degree of actual use of monitoring data.

As established in Chapter 2, the use of monitoring data takes place at different institutional levels, at the interface of the monitoring building block and other building blocks, including the policy-making, planning, infrastructure development and management, and regulation and accountability building blocks. The chapter describes and rates the degree of observed data use, applying an adapted version of Knott and Wildavsky's (1980) scaling framework, introduced in Chapter 3:

1. No transmission or reception of the data, but without cognition;
2. Cognition, but no referencing to the data;
3. Process use or referencing to the data, but no actual use;
4. Low use, with decisions mainly informed by factors other than the data;
5. Moderate use, with decisions informed by factors other than the data to some degree;
6. High use, with decisions mainly informed by the data.

The following Sections each examine the data use cases identified in Chapter 5: Section 6.2 focuses on national-level normative functions; Section 6.3 planning; Section 6.4 on operational decision-making; Section 6.5 on tariff setting; Section 6.6 on regulation; and Section 6.7 on reporting for accountability. A summary overview of the main observed actual uses of data produced by different monitoring systems is presented in Section 6.8 and the way forward in Section 6.9.

6.2 Data use in national level normative functions

As assessed in Chapter 5, data from JMP, the WASH M&E MIS and PI&BM data have the potential to inform policy-making. However, as no major formal national policy reforms took place in the town water sector over the study period, this section focuses on normative functions related to the development of a national standard, specifically on the setting of new coverage standards and the introduction of utility performance standards under GTP2. This section assesses the type and degree of actual data use in these processes.

6.2.1 Changing town water service coverage norms and standards under GTP2

National water coverage standards have been set by the Ministry as part of UAP/GTP1 and GTP2. According to Feyissa (2011) and confirmed by interviewees, the role of development partners in the development of the GTPs and in setting standards accordingly, has been limited.

Under the UAP and GTP1, the Ministry set 20 lpcd within 500m as the standard for urban domestic water supply. The Ministry reported the 2014 urban water supply coverage based on the GTP1 standard to amount to 91%. Based on high reported national coverage figures, WSP suggested in 2011 that going forward, priority should not be on asset development, but on maintaining service levels and increasing cost recovery ratios (World Bank, 2011). However, the high coverage masked the reality of unreliable, unsafe and unsustainable water supply in towns (Adank et al., 2016).

With development of the GTP2 in 2015, the Ministry increased the water supply standards and differentiated these for different town categories, as shown in Table 6-1.

Table 6-1: Urban service level standards according to GTP 2

Indicator	UAP / GTP1 standard	GTP2 standard per town category				
	Urban	Category 5	Category 4	Category 3	Category 2	Category 1
Typical town population size	NA	2,000-20,000	20,000 - 50,000	50,001 - 100,000	100,001 – 1 million	> 1 million
Water quantity standard (lpcd)	20	40	50	60	80	100
Accessibility standard: Distance to water point	<500m	<250m				

Source: Compiled by author from Ministry of Water Resources, Irrigation and Electricity (MOWIE) (2015)

The application of the higher standard, which significantly reduces the coverage figures, would provide the Ethiopian government with a strong case for additional investments. This strategic consideration likely played a role in the Ministry's decision to introduce the higher GTP2 standards. The decision also stemmed from the government's ambition for Ethiopia to become a lower-middle-income country by 2025 and was informed by a review of standards from other middle-income countries with similar demographics and settlement patterns as Ethiopia (Ministry of Water Resources, Irrigation and Electricity (MOWIE), 2015). Coverage data use thus played a limited role in coverage standard revision (level 5, conceptual use), with the country's ambition to become a middle-income country mainly shaping the decision.

The move from GTP1 to GTP2 standards occurred in parallel with the JMP's move from MDG to SDG indicators. While JMP data were not referred to in the GTP2 documents, and have not (instrumentally) informed the Ministry's decision to revise the service level standards, the process of the introduction of JMP's higher standard for the safely managed water indicator likely influenced (level 3, process use) this decision.

6.2.2 Introduction of utility performance norms and standards under GTP2

GTP2 also introduced utility performance goals and standards, on recovery of operational and (for category 1-3 towns, with a population of 50,000 or more) investment costs, water supply continuity, and non-revenue water. An overview of these standards is presented in Table 6-2.

Table 6-2: GTP 2 Utility performance standards

Indicator	GTP2 standard per town category				
	Category 5	Category 4	Category 3	Category 2	Category 1
Typical town population size	2,000-20,000	20,000 - 50,000	50,001 - 100,000	100,001 – 1 million	> 1 million
Water quality	In line with water quality standards of WHO, supplied by schemes labelled as ‘improved’ by Joint Monitoring Program (JMP) of UNICEF and WHO				
Continuity	NA		Uninterrupted for at least 16 hours per day		
Non-Revenue Water (NRW)	NA		<20%		
O&M cost recovery	100%				
Recovery of investment costs	30%	60%	80%		

Source: Compiled by author from Ministry of Water Resources, Irrigation and Electricity (MOWIE) (2015)

Utility performance data had been collected under NWI1 and the PI&BM initiative and were available for informing utility performance standards setting under GTP2. However, these data are not referred to in the GTP2 document introducing the new standards. The document does refer to a NRW rate of 39%, in line with the national NRW rate referred to in the OWNPN phase I review (National WASH Coordination Office, 2018, p. 1) and OWNPN phase II document (Federal Democratic Republic of Ethiopia, 2018a). However, these documents do not indicate the data source for this figure. Several sector experts believe it refers to the NRW rate of Addis Ababa (pers. comm. Haimanot Belete, 2022, pers. comm. Gedefa Wami, 2022, pers. comm. Asmamaw Molla, 2018), rather than to a national average. NWI data indeed shows a NRW rate for Addis Ababa of 39%. Also its average NRW for the period 2012 to 2015 as indicated in the IBNET database amounted to 39%.

Baseline values on the other utility performance standards are not mentioned in the GTP2 document. While NWI1 did not include data on service continuity, PI&BM data were available (in the IBNET database), which showed utilities had an average service continuity of 14.4 hours per day (15.0 hours for category 1 to 3 towns). A bit more than half (51% of all and 55% of category 1-3 towns) of utilities with 2011 and 2012 PI&BM data reported service continuity of at least 16 hours per day.

The operational cost recovery standard was set based on the rationale that all utilities should be able to cover operational costs through their revenues to ensure sustainable water service provision.

Although direct instrumental utility performance data use was not observed in setting the GTP2 standards, involvement of the Ministry in the PI&BM and NWI1 initiatives likely contributed to the inclusion of standards on service continuity, NRW and cost recovery into the GTP2 (process use).

Setting of the utility performance standards under GTP2 has thus not been directly influenced by NWI1 and PI&BM data, but by the process (level 3, process use).

6.2.3 Summing up the use of data in policy-making

The decision to revise water supply standards was mainly driven by political and developmental ambitions to move the country towards becoming a lower-middle-income country. However, although not explicitly stated, the high urban coverage figures likely influenced this decision as well (level 4, conceptual use).

Utility performance data from NWI1 and PI&BM, although available, were not used to inform the setting of the GTP2 utility performance standards.

The JMP and PI&BM processes, rather than the available data from these systems, likely influenced the revision of the higher access standards and inclusion of the performance standards in the GTP2 (level 3, process use).

6.3 Data use in planning

As presented in Chapter 5, JMP and national WASH M&E MIS coverage data are intended to inform macro-level planning related to asset development. National WASH M&E MIS and PI&BM utility performance data are intended to inform macro-level planning related to utility performance strengthening. Several data sets (with the exception of the nationally representative household survey and JMP data) were intended to inform sub-national and local planning processes as well. This section assesses the type and degree of actual data use in planning processes at the different institutional levels.

6.3.1 Macro-level planning and budgeting for asset development

Macro-level planning and budgeting for asset development have occurred as part of the Growth and Transformation Plans, the OOWNP plans and the Ministry's ten-year strategic plan. Unlike the GTPs, which were first and foremost developed by government, the OOWNP plan development involved different stakeholders, including development partners and consultants. The OOWNP phase II was for example developed by a team of international and national consultants, with funding from UNICEF and with input and feedback from a wide group of stakeholders. Macro-level planning includes setting of targets (Section 6.3.1.1), and planning and budgeting for asset development as part of the OOWNP and the Ministry's ten-year strategic plan (Section 6.3.1.2).

6.3.1.1 Setting coverage targets

The Ministry set coverage targets in line with GTP1 norms in GTP1, the Urban UAP, and the OOWNP phase I plan. GTP2, OOWNP phase II plan and the Ministry's ten-year strategy targets aligned with GTP2 norms. Figure 6-1 presents an overview of coverage targets set under these different macro-level plans and their baselines (in grey). It shows the national coverage data (in red) according to the GTP1 norm (square markers) and GTP2 norm (circle markers), pre- and post-NWI1 and NWI2. It also displays JMP reported urban coverage data (in blue), in terms of the proportion of the urban population with improved water services, piped water services on premises, and with safely managed water services. This reveals that rather ambitious targets were set, not fully in line with data on earlier trends in coverage progress.

The original GTP1 and urban UAP baselines were set before NWI data were available and had been informed by data compiled by the Ministry, based on number of schemes multiplied by number of people served as per design capacity. Based on these data, a 2012 target of 100% was set. Under the 2011 revised Urban UAP, the target year was adjusted to 2015, in line with the GTP1 target (Ministry of Water and Energy, 2011). NWI1 resulted in a downward adjustment of the 2010 urban GTP1, but this did not lead to an adjustment in the UAP/GTP1 target set by government, which remained at 100% by 2015.

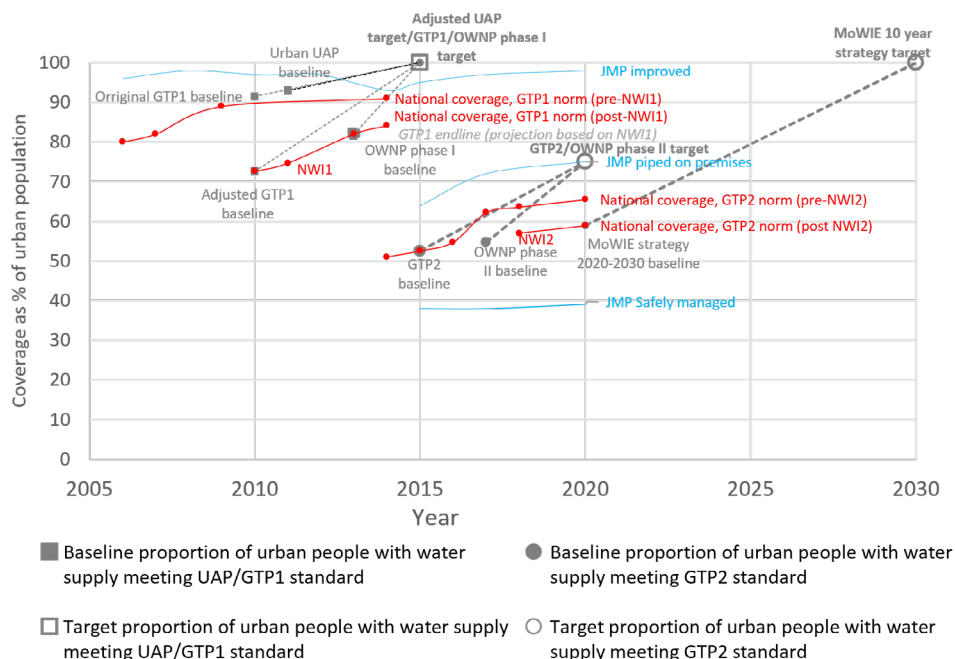
The GTP2 referred to and used NWI1 data in setting its baseline and targets. Introduction of the higher GTP2 standards led to a considerable decrease in the urban coverage baseline figure. Taking this into account, the 2020 GTP2 urban water coverage target was set at 75%, instead of 100%. The national coverage data thus directly (instrumentally) informed the setting of the GTP2 coverage target.

The 2017 baseline of the OOWNP phase II was set just before data collection on NWI2 was about to start. Therefore, it was estimated based on the data from NWI1, combined with data on number of schemes constructed and rehabilitated and people served. Although this baseline was considerably below the required coverage level at that point, given the trajectory from GTP2 baseline to target (shown by the dotted line), the OOWNP phase II target was set to be aligned to the GTP2 target.

NWI2 revealed an actual urban coverage far below the 2015 GTP2 and OOWNP phase II targets (and below the 2018 Ministry's urban coverage estimate). Based on the NWI2 data, the 2020 urban coverage was projected to amount to 58.9% (in line with the projected increase in estimated urban coverage by the Ministry from 63.6% in 2018 to 65.5% in 2020). This was set as the baseline for the ten-year MoWIE strategy, with the target of ensuring water services at the GTP2 standard for 100% of the urban population by 2030.

JMP coverage was not referred to in macro-level plans and was not used to inform these.

Figure 6-1: Macro-level plan baseline, targets and endlines



Source: compiled by author, based on JMP and the Ministry data, GTP1, GTP2, OOWNP phase I review, OOWNP phase II, MoWIE ten-year strategy, NWI1, NWI2

Rather than JMP coverage data, the Ministry instrumentally used its own coverage data to inform baselines and targets. New coverage data did not lead to an adjustment of the targets, indicating moderate rather than a high use of coverage data in target setting. The (political) desire to retain the originally set target was likely stronger than the rational argument for lowering the targets in line with the lower baseline figures (level 5, instrumental use).

6.3.1.2 Macro-level planning for asset development

The Ministry and its partners have developed various investment plans to meet the above-mentioned targets. GTP1, the Urban UAP, OOWNP phase I and II, and the Ministry's ten-year strategy each included a macro-level plan and budget (except for the ten-year strategy, which included a plan, but not a budget). These plans have mainly been developed by (international and/or national) consultants, under the auspices of the Ministry.

Table 6-3: Urban macro-level plans and budgets

Plan	Period (number of years)	Required increase in coverage in percentage points (pp per year)	Population to be served	Number of schemes to be constructed or rehabilitated	Budget in million USD total (USD/year)	Average budgeted cost per scheme in USD/ additional person served
GTP1	2010/11-2014/15 (5)	8.5% (1.7%)	3.2 million	387	387 (77)	121
Urban UAP	2011-2015 (5)	7% (1.4%)		970	547.5 (109)	
OOWNP, phase I	2013/14-2014/15 (2)	18% (9.0%)	4.4 million	777	786 (393)	179
GTP2	2015/16-2019/20 (5)	15.9% (3.2%)			1,965 (45)	
OOWNP, phase II	2018-2020 (3)	20% (6.7%)	5.65 million	1,256	1,745 (582)	309
MoWIE 10 year strategy	2021-2030 (10)	41% (4.1%)		1,513		

Based on the gap between the baseline and target coverage, and projected population growth, GTP1 determined 387 urban schemes needed to be constructed by 2015 to serve an additional 3.2 million people (Ministry of Water Resources, Irrigation and Electricity (MOWIE), 2015).

OOWNP phase I used updated coverage data from NWI1, updated planning models and data received from the regions and other sources, to establish a baseline. The gap between the GTP1 target and the OOWNP phase I baseline informed an ambitious implementation plan and budget: to construct and rehabilitate a total of 777 urban water schemes in 2014 and 2015 (Federal Democratic Republic of Ethiopia, 2013). The plan specified the number of schemes to be constructed or improved per region, based on the proportion and projected number of people served and to be served. The OOWNP also intended to use NWI1 data for identification and targeting of areas with low access to safe water, to reduce regional and social disparities (Federal Democratic Republic of Ethiopia, 2013).

The baseline of OOWNP phase II was set just before the start of the NWI2 data collection. Based on the data from NWI1, combined with data on the number of schemes constructed and rehabilitated and people served, the OOWNP phase II baseline was estimated to amount to 54.7%. Although this was considerably below the projected required urban water coverage of GTP2 standards at the time, given the GTP2 baseline and target, the OOWNP phase II target was aligned to the GTP2 target of 75% by 2020. To achieve this, the OOWNP phase II plan (2018-2019) included the construction of an additional 280 water schemes and rehabilitation and expansion of 973 schemes (Federal Democratic Republic of Ethiopia, 2018a).

Development of macro-level plans and budgets for asset development was informed by national coverage data. As other factors also influenced these plans and budgets, there is a moderate degree of coverage data use (level 5 instrumental use). Use of coverage data from national household surveys and JMP to inform macro-level plans has not been observed, although decision makers were familiar with these data (level 2).

6.3.2 Macro-level planning and budgeting for improving utility performance

Utility KPIs were included in the OOWNP phase I, OOWNP phase II, GTP2, and the Ministry's ten-year strategic plan. Table 6-4 provides an overview of the goals and targets set under these macro-level plans on non-revenue water, service continuity and cost recovery.

Table 6-4: Macro-level plans, service provider performance goals and targets

KPI	OOWNP phase I	GTP2 2015-2020	OOWNP phase II	MOWIE ten-year strategy
Non-revenue water (NRW)	Percentage of NRW <i>[no target set]</i>	Decrease urban NRW from 39% to 20% for urban water supply utilities of category 1 to 3 by 2020.		Reduce water loss from 39% in 2020 to 20% by 2030
Service continuity	Percentage of TWU supplying water for more than 6 hours a day for all costumers	Improve continuity to 16 hours per day excluding water supply delivery through public taps for utilities of category 1 to 3 by 2020.	At least 50% of category 1 to 3 towns have UWS continuity to 16 hrs per day excluding WS delivery through public taps by 2020.	
Cost recovery	Proportion of water utilities covering O&M and replacement costs by region and national	100% of towns recover 100% of O&M cost by 2020 Enable investment cost recovery of 80% for category 1, 2, and 3 towns, 60% for category 4 towns, and 30% for category 3 towns by 2020.		

Source: Compiled by author from Federal Democratic Republic of Ethiopia (2013), Ministry of Water Resources, Irrigation and Electricity (MOWIE) (2015), Federal Democratic Republic of Ethiopia (2018), MoWIE (2021)

Although performance indicators were mentioned in the OOWNP phase I programme document, no clear targets were set. The phase I review did not reflect on these indicators either. The GTP2 and OOWNP phase II plan did include targets on all three indicators, but only provided a baseline for the non-revenue water indicator.

The OOWNP phase II plan included a preliminary strategic action plan for achieving the utility performance goals set out in GTP2, related to NRW, service continuity and cost recovery, with annual targets of the percentage of utilities which were to have achieved the GTP2 standard on these indicators. However, annual targets seem to have been set arbitrarily and not based on available data from NWI1 or PI&BM. The Ministry's ten-year strategy only included a target (and baseline) on the NRW indicator.

The GTP2, OOWNP phase II, and the Ministry's ten-year strategy all include the same baseline for NRW: 39% which, as discussed above, is likely to represent the NRW from Addis Ababa, rather than the average NRW for all category 1 to 3 towns. However, although raw data on NRW were available from NWI1 and PI&BM, these data were never processed or used to inform target setting on this indicator. The target of 20% NRW was set mainly in line with international standards.

NWI1 did not differentiate between operational and investment cost recovery, and therefore could not have informed this target setting. PI&BM provided data on operational cost recovery, showing that 67% of utilities achieved this. In line with this, the setting of the OOWNP phase II target of having operational cost recovery for all utilities by 2020 seems ambitious. It was set in line with the policy, which states that utilities need to cover their operation and maintenance costs through tariffs.

Data on continuity were only available from PI&BM, which showed that 56% of category 1 to 3 utilities were providing continuous services for at least 16 hours in 2015. This exceeded the OOWNP phase II target of having at least 50% of towns with continuous services for at least 16 hours per day by 2020. This clearly shows that existing data had not been used to inform the continuity target.

Although the macro-level plans included targets on utility performance KPIs, they did not include costed plans for improving utility performance towards achieving the targets.

This demonstrates that although data on utility performance were available from NWI1 and PI&BM at the time of GTP2 target setting, decision makers had not engaged with these data (level 1).

6.3.3 Strategic planning by Regional Water Bureau

Regional Water Bureaus develop strategic plans for new water supply assets and for ensuring sustainable water service provision, setting targets in line with national standards and targets. The water service part of the first Tigray Growth & Transformation Plan (2010/11 - 2014/15) included the construction of 7,152 new schemes, maintaining already existing schemes, and improving utility performance, to increase urban water supply coverage from 72% to 100% (Tigray Bureau of Plan and Finance, 2010). It did not clarify how utility performance was to be advanced. It did not clarify the basis of the 7,152 schemes to be constructed, but this was probably mainly informed by coverage and projected population. The Regional Water Bureau in Tigray thus instrumentally used the regional coverage data for informing strategic planning on the number of schemes to be implemented (level 6 instrumental use).

In 2018, utility performance data were available from the TUMS and was used to inform the mid-term revision of the regional GTP2 (pers. comm. Zeruu Haile, 2018). Utility performance

targets were not set fully in line with the national GTP2 standards and targets. The standard for NRW for example was set at 10% to 13% (for the smaller and bigger towns respectively), instead of at the NRW GTP2 standard of 20%. Many utilities (46 of 61 utilities or 75%) reported NRW rates lower than 20% already in 2018. This (probably) informed the setting of more ambitious targets.

The Regional Water Bureau in Tigray thus instrumentally used data from the TUMS to inform the development of utility targets and the regional strategic plan (GTP2). However, as these decisions were also, at least partially, informed by other factors (including national goals and targets), data use was moderate (level 5 instrumental use). Although NWI and PI&BM data were in principle available, regional decision makers did not engage with these data (level 1).

6.3.4 Strategic (business and annual) planning

The Jinka annual plan 2010 EC (2017-2018) presented goals related to water production, coverage, water quality, non-revenue water, number of connections, cost recovery and user satisfaction. However, the monthly, quarterly and annual monitoring reports of the utility did not provide information on four (coverage, water quality, non-revenue water, and user satisfactions) of these seven indicators, nor can these be assessed based on the data presented in these reports. For example, the reports did not present data on amount of water sold, and levels of non-revenue water. It is therefore unlikely or even impossible the targets had been set based on monitoring data. Rather, these were set based on higher level directives, including regionally set targets. The annual plan also presented a variety of detailed objectives, which were mainly activity-focused, like number of maintenance rounds, disinfection, leakage detection and repair activities in the year. However, the plan was also not very clear on how the detailed objectives contributed to achieving the main goals for the year to come. The monthly, quarterly and annual reports did include parameters for tracking progress on these detailed objectives, which have (at least partially) informed the setting of goals and targets related to the annual plan. So, the Jinka utility had not or hardly used its performance data for informing strategic planning (level 2 to 4, symbolic or instrumental use). Decision makers did not engage with utility performance data from other sources (NWI, PI&BM) (Level 1).

In Wukro, the town water utilities had a strategic multi-year plan in place: the Wukro five-year plan from 2007 EC (2014-2018). This plan, developed by a committee consisting of representatives from the different departments, informed annual, quarterly and monthly plans. Budgets were prepared accordingly by the finance team. These were reviewed and, where needed, revised by the management team and sent to the Water Board for approval (pers. comm. Hailu Baralo, 2018). In line with its five-year strategic plan, the 2010 EC (2017-2018) annual plan of the Wukro utility included a total of 16 weighted key performance indicators, as presented in Chapter 4. The annual plan included annual and quarterly targets on the key performance indicators, set based on the status on the indicators from the previous year. It indicated a NRW target of 10%, in line with the regional GTP2 target, rather than with the national GTP2 standard of 20%. It also indicated that last year's non-revenue water amounted to 16%. Quarterly targets have been set accordingly: 14% for quarter 1, 12 % for quarter 2 and

10% for quarter 3 and 4. The Wukro utility had used its performance data to instrumentally inform planning processes to a moderate degree (level 4 instrumental use). However, it is questionable how realistic this is, especially as measuring and recordkeeping of the amount of water produced seems challenging. The relatively low reported NRW rate of Wukro (and many other utilities in Ethiopia), could be the result of gaming behaviour of the utility, reporting (desirable) estimated, rather than measured rates of NRW. This would imply perverse use of monitoring data in planning decisions. Also in Wukro, decision makers did not engage with NWI and PI&BM utility performance data (Level 1).

Although this is not the case in Jinka and Wukro, it is not uncommon that development partners technically and financially support business planning processes. For example, UNICEF, under its Utility Systems Strengthening Programme, engaged two consortia (IRC/VEI consortium, and NWSA/ 2ML/BMC consortium) to support utility business development in a total of seven towns in 2022 and 2023. Consultants worked with utility management and staff to develop costed business plans for the timeframe up to 2030, the end of the SDG era and the end of Ministry's ten-year strategic plan. They processed available asset and operational data into utility performance data to inform vision target setting on utility performance indicators, including NRW, operational cost recovery, bill collection ratio, and staffing efficiency. Operational and asset data were used as a basis for development of the costed strategic plan for achieving the set targets. Strategic directions were co-developed with utility staff and management. However, because of challenges with lack of availability and inconsistency of available data (discussed in more detail in Chapter 7), the business planning process was not fully informed by utility operational and asset data, but also by assumptions made by the co-producers. Consultants and utilities made moderate instrumental use of utility asset, operational and performance data in business plan development (level 5 instrumental use).

In Tigray, the Regional Water Bureau observed that an increased number of utilities had introduced auditing procedures, double entry finance systems, and user satisfaction assessments following inclusion of variables related to these aspects in the TUMS (pers. comm. Zeru Haile, 2018). This is considered a case of process, rather than instrumental or conceptual use of TUMS data in informing planning by the utility.

6.3.5 Summing up data use in planning

National actors have not used JMP data in macro-level planning. Performance data from the national WASH M&E MIS and PI&BM have not been used either in planning at any level. Ministry coverage data have been used to a moderate and high degree in informing planning at national and regional level respectively (level 5 and 6 instrumental use).

TUMS data have informed regional level planning to a moderate degree (level 5 instrumental use). Furthermore, the process of ranking utilities under the TUMS has informed planning by utilities at local level (level 3 process use).

Utility MIS data have informed strategic planning by utilities to different degrees. In the case of some utilities, operational and asset data use have instrumentally informed the development of strategic plans, though also other factors, like estimations and assumptions played a role (level 5 instrumental use). This was especially the case for utilities that were

supported to develop business plans, for example under UNICEF's Utility Systems Strengthening programme. In other cases, the amount of data used to inform the plan has been limited (level 4 instrumental use).

6.4 Data use in operational decision-making

As presented in Chapter 5, the TUMS was intended to inform regional decisions about provision of technical support to utilities. Operational and utility performance data from utility MIS, and in Tigray, from the TUMS, were intended to inform operational decisions of the Water Boards and utilities. This section assesses the type and degree of actual data use in operational decision-making by the Regional Water Bureaus, Water Boards and utilities.

6.4.1 Informing technical support to utilities by regional Water Bureau

At the time of data collection, decisions about provision of technical support to utilities in Tigray were made through the Monitoring, Support and Maintenance Sub-Process (MSMSP). The MSMSP was not aware of M&E MIS and PI&BM utility performance data, but as producers of the TUMS data, they did have easy access to the data, which provided good insight into the support needs of utilities. However, the MSMSP only consisted of seven staff members, responsible for monitoring and supporting all 69 town water utilities and the 34 rural woredas, covering a total area of more than 50,000 km³. They require an estimated 500,000 ETB (almost 15,000 USD) per year to cover transport and per diems, though they only received about a third of that (pers. comm. Zeruu Haile, 2018). Although the TUMS data provided good insight into the support needs of utilities, decisions on provision of technical support to utilities were thus constrained by resource limitations.

The Regional Water Bureau did not engage with the national M&E MIS and PI&BM data at the operational decision-making (level 2) and only used TUMS data to a limited degree (level 4 instrumental use).

6.4.2 Operational decisions by the Water Board

Both the Jinka and Wukro Water Boards meet on a quarterly basis, mainly to discuss progress and approve budgets and procurements. Emergency meetings can occur, for example, in the case of breakdowns, the need for speedy reallocation of budgets or procurements. As the Water Board is responsible for approval of budgets and procurement, Board members are especially interested in the operational (financial) data from the quarterly utility reports submitted to the Water Boards. They use these data to inform their decisions (pers. comm. Haylu, 2018; pers. comm. Anonymous Wukro Water Board member). However, operational decision-making by the Water Board is mainly informed by other factors, including availability of financial resources and political factors.

The Water Boards have thus only instrumentally used part of the reported operational utility data to inform approval of budget and procurement to a limited degree (level 4 instrumental use). Water Boards engaged with and understood utility performance data, but did not use these in their operational decision-making (level 2).

6.4.3 Operational decisions and corrective actions by utilities

In both Jinka (pers. comm. Teko Zebo, 2018) and Wukro (pers. comm. Behalu, 2018), utility management sit together on a weekly basis to discuss operational challenges and actions. During these meetings, department heads (verbally) present data produced by the utility, especially on activity and output parameters. This directly informs the operational decisions by utility management. As explained by the Jinka Utility manager *'Reports are very important to me, as it shows me the gaps. We take action accordingly.'* (pers. comm. Teko Zebo, 2018). Although monitoring data played an important role in informing operational decisions, utilities also relied on judgment-based heuristics, observations and information from the public, complementing or competing with the operational data. Furthermore, pressure from specific customers seeking to advance their interests by influencing utility management and staff played a role in influencing operational decision-making. So, utility management and staff instrumentally use the monitoring data that they produce to inform decisions related to operations and corrective action to a moderate degree (level 5 instrumental use). Utilities have not used asset data for informing operational decision-making, mainly because such data were not or hardly available (level 1).

6.4.4 Summing up data use in operational decision-making

Data use in operational decision-making has mainly taken place at local level, where utilities used operational utility data to inform operational decisions (level 5 instrumental use). Furthermore, the Tigray Water Bureau has used TUMS data in informing operational decisions to a limited degree (level 4 instrumental use).

6.5 Data use in tariff setting

As presented in Chapter 5, tariff setting by utilities is supposed to be informed by asset, operation and performance data. Utilities can also rely on additional information, e.g. from financial feasibility or willingness to pay studies.

In Wukro, the nearby Mekelle University had undertaken a willingness to pay study in 2017, which indicated that the tariff could be increased from 3 ETB/m³ to 12 ETB/m³. The utility was eager to use this information to suggest a tariff increase accordingly (pers. comm. Behalu, 2018). However, the suggested new tariff was not approved by the Regional Water Bureau (see Section 6.6.1). Therefore, the utility was reluctant to propose a new tariff increase for over five years, waiting for the ongoing scheme expansion (under UNICEF's ONEWASH Plus Project) to be completed in 2020 (pers. comm. Redda, 2018). This was expected to help break through the vicious cycle of low tariffs leading to poor services, which in turn lead to a reluctance to approve a tariff increase.

In Jinka, a new tariff was not proposed for years either. The utility was struggling to cover its operational expenditures through its tariff revenues and saw the need to increase the tariff. It undertook a tariff study, using data from its MIS, complemented by additionally collected data. The data showed high operational expenditure, especially because of the use of generators, and low revenues from water sales, due to low tariffs, but also due to commercial losses because of inaccurate or delayed billing, and due to low supply because of inadequate

water sources and distribution schemes and frequent leakages (pers. comm. Tsegereda, 2018). Although the data showed cost recovery challenges, the Jinka utility was reluctant to propose an upward tariff revision because of the prevailing water shortages due to a discrepancy between water demand and supply from available water sources and dissatisfaction of customers with the services provided (pers. comm. Tsegereda, 2018).

Like many utilities in Ethiopia, the utilities of Wukro and Jinka struggle with the vicious cycle of low tariffs leading to poor revenues, leading to poor services, leading to poor revenues. Breaking through this vicious cycle is a big challenge.

Interestingly, little to no reference is made to utility performance data in discussions about approval of tariff changes. Arguments about low service levels justifying tariff increases were generally informed by observations and customer feedback, rather than by data. Also utility performance issues such as non-revenue water (an important driver for low revenues) are generally not brought up in tariff decision-making processes. Utilities mainly use data that supports their argument for the need to increase tariffs. It could therefore be argued that utilities tend to make, at least to some degree, symbolic rather than instrumental use of data in developing tariff proposals.

These examples show use of asset, operation and performance data by utilities in informing tariff setting. They, however, also show that tariff proposals are mostly influenced by other factors, including other or additional information (as was the case in Wukro) and perceptions about whether the water services provided can justify tariff increases. So although there was instrumental use of asset, operational and performance data in informing tariff setting, the degree to which these data were used was limited (level 4 instrumental use).

6.6 Data use in regulation

As described in Chapter 5, national utility performance data (national M&E MIS and PI&BM) had the potential to inform national regulatory decision-making, but there is no central regulatory body which could do so. Regional Water Bureaus and Water Boards fulfil key regulatory roles, including economic (tariff) and performance regulation. Utility MIS and TUMS performance data are intended to inform regulatory decision-making. This section assesses the type and degree of actual data use in regulatory processes at the different institutional levels.

6.6.1 Economic regulation (tariff approval)

According to the 2013 national guidelines on tariff setting, town water utilities should submit a tariff proposal to their Water Boards if an adjustment of tariff is needed. The Regional Water Bureau, in collaboration with the Water Board, should then check the proposed tariff based on an analysis of the proposed tariff, as well as the performance of the utility. When approved, the proposed tariff is submitted to the Woreda or town council for approval. The council should approve the tariff, if it believes the tariff is affordable for the town community. Financial and utility performance monitoring data should thus play a strong role in informing tariff approval by the Water Board, Regional Water Bureau and woreda/ town council. However, in reality, Regional Water Bureaus and town councils have been reluctant to approve tariff increases, even when these were based on solid evidence.

As described above, the Tigray Regional Water Bureau did not allow a tariff increase in Wukro, much to the frustration of the Wukro utility manager, who explained *'the regional government has allotted it is only 3 birr per m3 that can be charged. We try to collect knowledge and information, but we face difficulties when trying to apply it, because some things are already set at regional level'* (pers. comm. Behalu, 2018). Data which could inform tariff approval decisions was received by regional decision makers, who were aware of it and understood it, but they did not use it in the tariff approval decision-making process, rejecting the data and deciding against a tariff increase.

Although performance data from the national M&E MIS and PI&BM systems could be used to inform regulation of town water utilities, Regional Water Bureaus have not engaged with these data. The Regional Water Bureau has not used data to inform tariff regulation.

6.6.2 Performance regulation at national level

Although it does not have an official 'regulatory mandate', the Ethiopia Water Federation has played a(n informal) role in regulating utilities at national level. At its annual utility forums, it rewards best performing utilities and utility managers. Rewards can include cars for the utility, and smart phones and / or laptops for the utility manager (pers. comm. Ahmed, 2018). Although ranking of utilities was reported to be based on PI&BM data between 2016 and 2018 (pers. comm. Ahmed, 2018), this seems unlikely, as the only PI&BM data which was available at the time was from 2011 and 2012. Also, Dessie utility was reported to have won best utility in 2015 (pers. comm. Ahmed, 2018), while the 2011 PI&BM data available at that time did not indicate Dessie as the best performing utility as per the APGAR indicator, nor on the utility performance indicators included in GTP2 (though it did rank amongst the highest scoring utilities on continuity and water quality). It was unclear which criteria and data the Federation used to rank and reward utilities. Although the Federation referred to PI&BM data for utility ranking, it does not seem to have actually used these data for this (level 3).

6.6.3 Performance regulation by the Tigray Water Bureau

The MSMS of the Tigray Regional Water Bureau had set up an annual process for ranking utilities based on their performance and rewarding the best performing ones. Ranking and rewarding of utilities was primarily informed by data from the TUMS. The type of award depended on the available budget of the Water Bureau. When sufficient budget was available, laptops, cameras etc. were rewarded, and when this was not the case, the award took the form of a certificate. (pers. comm. Zeruu Haile, 2018). This shows that the Tigray Regional Water Bureau instrumentally used the TUMS data to a relatively high degree (level 6) for regulating town water utilities, while it did not engage with or use I&BM and NWI data (level 1).

6.6.4 Performance regulation by Water Boards

To inform performance regulation, utilities submit quarterly reports to the Water Boards, which oversee the utilities and use these reports as input for their quarterly meetings. However, to the frustration of the utility managers in both Jinka and Wukro, actual feedback on quarterly reports from the Water Board is rare. The Jinka Utility manager reported to have asked the town

administration *'What is the point of taking the reports from us if you do not do anything?'* (pers. comm. Talo Zobi, 2018). According to a Wukro Water Board member, the Wukro Water Board does provide feedback to the utility, for example, on the fact that the level of non-revenue water was reported as higher than the target of 10% set by the Regional Water Bureau (pers. comm. anonymous (Wukro Board member), 2018). However, mechanisms for the Board to enforce corrective action, e.g. through punitive measures, are not in place. Water Boards were thus found to not have used utility monitoring reports to inform regulatory decisions.

6.6.5 Summing up data use for regulation

The Tigray Regional Bureau used utility TUMS data for informing performance regulation through ranking of utilities (level 6 instrumental use).

Although the Utility Federation reported to have used PI&BM data to inform utility ranking at the national level, this thesis did not manage to find evidence of this use. The factual basis for the Federation's ranking of utilities was not clear, but is likely based on anecdotal information rather than data (level 3).

Other regulatory data use was limited. Tariff regulation was not informed by data, but mainly by political considerations (level 1 to 2). NWI and PI&BM utility performance data were not used at institutional level (level 1). Also, Water Board members referred to utility operational and performance data, but did not actually use these data for informing regulatory decision-making (level 3).

6.7 Data use in reporting for accountability

As presented in Chapter 5, JMP and the national WASH M&E MIS data were intended to inform national-level reporting for upward and sideways accountability. TUMS data were intended to inform reporting to the Regional Water Bureau head. Utility MIS operational and performance data were intended to inform reporting for upward accountability to the Water Board and Regional Water Bureaus. This section assesses the type and degree of actual data use in reporting for accountability at the different institutional levels. In addition, as shown in Chapter 5, coverage and utility performance data had the potential of being used for informing downward accountability reporting.

6.7.1 National-level reporting for sideways and upward accountability

The use of JMP data in accountability reporting at national level has been limited in Ethiopia. As mentioned by the Director of the Water Supply SD & CM Directorate at the Federal Water Development Commission of the Ministry, *'We do not report JMP report, but we refer to it. We observe how the JMP data differs from our [Ministry coverage] data.'* (pers. comm. Gedefa Wami, 2022). The government of Ethiopia and JMP did use JMP data to report progress on MDG 7c, target 10, which aimed to halve the proportion of the population without access to improved water services from the 1990 baseline by 2015. The announcement to this effect was made on 23 March 2015, in the presence of the President of the Federal Democratic Republic of Ethiopia, the MOWIE minister, Government Officials, Ambassadors, UN representatives, WASH partners and members of the media (Mulatu, 2015). The use of JMP data for celebrating the achievement

of the water service MDG target in 2015 can be considered use of JMP data for reporting for upward (e.g. towards the UN and the president), sideways (towards sector partners) and downward (towards citizens, through the media). It is, however, not very clear whether this has led rights holders to hold the Ministry, as the duty bearer, accountable for its achievements based on JMP data. JMP data are thus occasionally referred to for reporting on upward and sideways accountability.

The Ministry mainly uses national coverage data for its annual reporting. Data from the two NWIs have been used as a check for the coverage data and have led in both rounds to a downward revision of the coverage figures. The Ministry, as duty bearer for ensuring water provision services, has used coverage data to report progress to rights holders (sector stakeholders) through annual Multi-Stakeholder Forums, other national and international fora, such as the Sanitation and Water for All (SWA) 2019 Sector Ministers' Meeting (Sanitation and Water for All, 2019), parliament and the President's office. The Ministry's coverage data have thus been used to inform progress reporting by the Ministry on its national coverage goals and targets for upward and sideways accountability. However, there was no clear evidence of these stakeholders holding the Ministry accountable based on these data.

Under the OWNPN, the National Coordination Office intended to produce annual OWNPN reports. However, in reality, these reports were only produced for 2008 EC (2014-2015) (National WASH Coordination Office and IRC, 2016) and 2009 EC (2015-2016) (National WASH Coordination Office and Coffey, 2018), with support from consultants, under a five-year DFID-funded programme focused on strengthening the national monitoring system. Both reports present the Ministry's data on the number of schemes and people served. The 2008 EC report also presents household survey data from the 2016 Ethiopia Demographic and Health Survey, and the 2009 EC report presents national JMP data. Neither of the reports includes data on performance indicators, such as non-revenue water, cost recovery rates, and continuity of services. The 2009 EC report indicated there was insufficient data to present information on these key indicators (although in principle these data should have been available from NWI1 and PI&BM).

The 2018 review of the first phase of the OWNPN (National WASH Coordination Office, 2018), produced by consultants with UNICEF funding, referred to Ministry, JMP and EHS coverage data, but did not include data on utility performance. Reporting on utility performance data was done by the Ministry to the World Bank on project-based data from 22 secondary towns, including on several utility performance indicators (notably operation cost recovery ratio and collection efficiency) which are part of the project results framework of the Second Urban Water Supply and Sanitation project (2017-2024). The project sourced data directly from utilities (World Bank, 2017). Utility performance data from PI&BM and National M&E MIS have not been used for reporting for accountability.

6.7.2 MSMSP reporting TUMS data for upward accountability

The head of the MSMSP stated they reported TUMS data from utilities as the duty bearer, to the Tigray Regional Water Bureau head on an annual basis (pers. Comm. Zeruu Haile, 2014). The management unit of the Water Bureau evaluates the data and approves it. However, there was no evidence of the use of these reports by the Regional Water Bureau for holding utilities accountable for provided services.

6.7.3 Utility reporting for accountability

Utilities were found to use their operational and performance data for reporting to their Water Board and Regional Water Bureau. However, as discussed above in Section 6.6.3, these data were not or hardly used by Water Boards to hold the utility accountable for its provided services. Water Board members see the appointment of the utility manager (which is mainly a political appointment) as one of their main roles. However, in spite of the potential of utility performance data for holding a utility manager accountable for the performance of the utility, utility monitoring data are generally not used for this purpose by the Water Board.

6.7.4 Reporting for downward accountability

Utilities are, as duty bearers, accountable for provided water services to utility customers as rights holders. Utility customers can hold utilities accountable through complaints addressed to the utility, Water Board, or Town Council. Consumer platforms were (in the process of) being established at town level, but an overarching consumer forum at national level was not in place at the time of writing. Utility operational or performance data are often not shared with consumer platforms (pers. comm. Behalu, 2018). Lack of awareness and understanding of these data prevents their use in consumer fora for holding utilities accountable. Discussions in these platforms are primarily informed by observations, experiences and perceptions of consumers. In both Jinka and Wukro, water users mainly hold utilities accountable based on their direct observations and experiences of the provided services, rather than based on data. Water users mainly do so through informal channels, by complaining about provided services in person to utility staff, management or people representing the town administration. This is the reason that the utility manager of Wukro uses most of his afternoons going into town and talking to customers. However, the possibilities for water users to hold the utility accountable remain limited. This frustration was expressed by a water user asking the Wukro utility manager *'If we pass the deadline to pay, you penalise us, but how would you be penalised if you don't supply water?'* (pers. comm. Behalu, 2018). The Jinka and Wukro utilities did not use operational or performance data for reporting for downward accountability to water users.

Although one of the objectives of the PI&BM data in Ethiopia was to inform reporting for downward accountability, Ministry staff did not use these data. In principle, PI&BM data were made available online through the IBNET platform, but customers and customer fora were not aware of these data and hence did not use them for holding utilities accountable (level 1). Although utility performance data from the national M&E MIS had the potential to be used for reporting for downward accountability by the Ministry, this has not taken place in reality (level 1).

6.7.5 Summing up data use for reporting for accountability

This section has shown that, although there was regular reporting of data by duty bearers, there was little evidence of use of these data by rights holders for holding duty bearers accountable (level 3).

NWI and PI&BM utility performance data were not reported (level 1).

Although other data sets could be used for reporting for downward accountability, this has not actually taken place (level 2).

6.8 Summary of actual level of data use

This chapter described and analysed how and to what degree different data sets produced in the town water supply sector in Ethiopia are actually used to inform processes at different institutional levels. Table 6-5 presents an overview of the main findings. It shows that actual use of these data was generally low.

Although national level decision makers were aware of and understood the coverage data produced by JMP, these data were only referred to for reporting on progress under the OWNPN. Although also intended to inform macro-level planning decisions, there was no actual use of JMP data. There is well-documented use of these data at global level (e.g. Bartram et al., 2014), but this was outside the scope of this thesis.

The Ministry, responsible for macro-level decision-making, primarily used its own coverage data to inform target setting and macro-level planning decisions. It also used the coverage data for reporting on progress of macro-level plans, like the GTPs and OWNPN phase I and II plans, for upward and sideways accountability.

WASH M&E MIS and PI&BM utility performance data were not used to inform decision-making or reporting for accountability. Decision makers were hardly aware of these data. The only exception as the reported use of PI&BM data by the Ethiopia Water Federation for informing performance regulation (in the form of rewarding of best performing utilities), though there was no clear actual use of these data.

TUMS utility performance data mainly informed performance regulation by the Regional Water Bureau, in terms of rewarding the best performing utilities. The data also informed regional strategic planning decisions to a moderate degree and operational decisions to a low degree. Data from the TUMS were not used for informing strategic planning by utilities.

Operational data produced by the utility were used to a moderate degree to inform local-level operational and strategic decisions. Utility performance reports were primarily used for progress reporting to the Water Board and Regional Water Bureau. However, there was little evidence that the Water Board and Regional Water Bureau held the utility accountable based on these reports.

Table 6-5: Overview of degree to which the decision has been informed by monitoring data

Data use case		Type of data						
		Coverage data		Utility performance data			Operational data	Asset data
		JMP	M&E MIS	PI&BM	TUMS	Utility-level monitoring and reporting system		
Policy-making	Setting of national standards	3 (P)	4 (C)	3 (P)	3 (P)			
Planning	Macro-level planning, asset development	2	5 (I)					
	Macro-level planning, utility performance improvement			1	1			
	Regional strategic planning		6 (I)	1	1	5 (I)		
	Strategic (business) planning by utility			1	1	3 (P)	4-5 (S/I)	4-5 (I)
Operation and asset maintenance	Technical support from Regional Water Bureau to utility			1	1	4 (I)	2	
	Operational oversight by Water Board						2	4 (I)
	Operational decisions and corrective measures by utility						5 (I)	0/1
Tariff setting	Tariff setting by utility						4 (I)	4 (I)
Regulation	National level regulation			1	3			
	Economic regulation (tariff approval)			1	1	2	2	
	Performance regulation of utility by Regional Water Bureau			1	1	6 (I)		
	Performance regulation of utility by Water Board						3	3
Reporting for accountability	Reporting for upward and sideways accountability at national level, on coverage	2.5	3					
	Reporting for upward and sideways accountability at national level, on utility performance			1	1			
	Reporting for upward accountability at regional level					3		
	Reporting for upward accountability at local level						3	3
	Reporting for downward accountability	2.5	2	1	1	2	2	2

Level: Local; Sub-national; National; Rating of actual use of data; 1 = Data are available to the decision maker(s) / duty bearer; 2 = Decision makers / duty bearers have engaged with and understand the data; 3 = Decision makers refer to, but does not use data / Duty bearers reports data, but rights holder does not hold duty bearer accountable/process use; 4 = Low use: Decision makers have made use of data for informing decisions, but these decisions are mainly informed by other factors than the data / Rights holders have hardly used data for holding the duty bearer accountable; 5 = Moderate use: Decision makers have made use of data for informing decisions, but these decisions have to some degree been informed by other factors than the data / Rights holders have used data for holding the duty bearer accountable to a moderate degree; 6 = High use: Decision makers have made use of data for informing decisions, mainly depending on the data for informing their decision / Rights holders have used data for holding the duty bearer accountable to a high degree; (I) = institutional use; (C) = conceptual use; (P) = process use; S = symbolic use.

Data were not used for reporting for downward accountability. Rather, consumers hold utilities responsible for services provided through customer complaint systems and, more commonly, through informal communication channels. This confirms the assessment by McGinnes and Elandy (2012) that the public are often not really interested in using performance data, preferring to obtain information informally through interpersonal relationships.

Many decisions were primarily driven by factors other than data, resulting in low data use. For example, the changing of service level standards was strongly driven by the political desire to become a lower-middle-income country. Decisions related to provision of technical support to utilities by the Regional Water Bureau were mostly shaped by availability of financial and logistical resources to provide this support. Although data to support decisions on tariff setting and approval were available, known to, and understood by decision makers in Jinka and Wukro, these data were not used in tariff approval processes. Rather, these decisions were informed by political and socio-economic considerations.

Some decision processes were informed by monitoring processes rather than by monitoring data. The JMP and PI&BM processes informed decisions related to coverage and service provider performance standards under GTP2. Furthermore, utilities in Tigray started implementing some processes and mechanisms (e.g. double entry accounting), pushed by the fact that they had to report on the presence or absence of these as part of the TUMS.

In summary, this chapter has shown that monitoring data from different monitoring systems involved in town water supply in Ethiopia have been used to inform both reporting for accountability and decision-making, but that actual data use is generally below its intended and potential use.

6.9 Way forward: Exploring the reasons behind limited use of monitoring information for informing decision-making

This chapter showed clear discrepancies between intended/potential, and actual data use. There are various reasons for this. The next chapters explore these possible reasons from four theoretical perspectives introduced in chapter 1 and 2: the linear perspective, focusing on characteristics and attributes of the data (Chapter 7); the relationship perspective, focusing on the relationship between data producers and users (Chapter 8); the behaviour systems perspective, focusing on capacity, motivation and opportunities for data use of intended data users (Chapter 9); and the comprehensive systems perspective, which considers all factors introduced under the other perspectives and how these factors influence data use directly as well as indirectly in a complex data-use system (Chapter 10).

7 LINEAR PERSPECTIVE

7.1 Introduction

Chapter 6 exposed the gap between intended/potential and actual use of monitoring data in town water supply in Ethiopia. This leads to the second research question of this thesis: *'What factors enable or hamper actual monitoring data use?'*

This chapter starts addressing this question, exploring the enabling and hampering factors for the use of monitoring data from a linear perspective. Linear models assume that if the right data are available in the right format, at the right time, these will be used to inform decisions and facilitate accountability. This chapter therefore focuses on the characteristics and attributes of monitoring data and how these enable or hamper data use.

The conceptual framework that guides this analysis was presented in Chapter 2. This framework, building on the CRELE and ATCA frameworks, includes the following data attributes and their linked data characteristics:

- Data relevance, related to data content, scale and frequency;
- Data credibility, related to data accuracy;
- Data timeliness, related to data processing time;
- Data comprehensiveness, related to number of variables and indicators, number of units of observation, and data availability on these;
- Physical accessibility of the data;
- Availability of data in accessible formats, based on the level of data processing and level of information product development.

These attributes of data pertaining to different data use cases are rated as low/moderate/high. This rating is guided by the assessment framework presented in the methodology Section 3.2.3 and informed by a review of monitoring data, a (grey) literature review and a series of semi-structured interviews. In order to understand how data attributes enable or hamper data use, the rating of the data attributes is compared with the degree of actual data use across the different data use cases (as assessed in Chapter 6).

The chapter addresses the following detailed questions, introduced in Chapter 3:

1. What are the characteristics of data produced under different monitoring systems? What are the attributes of these data, in terms of relevance, credibility, timeliness, comprehensiveness, accessibility, and availability of data in appropriate formats vis-à-vis potential use?
2. How have the data attributes been shaped?
3. What role have the data attributes played in enabling or hampering the actual use of these data and to what extent can they explain the actual use of these data or lack thereof?

Section 7.2 addresses the first detailed question, describing the characteristics and attributes of the different data sets. Section 7.3 addresses the second detailed question, describing how data characteristics and other factors shaped the data attributes. Section 7.4 addresses the third detailed question, assessing how the data attributes relate to the actual use of the data sets. Section 7.5 summarises the main findings and Section 7.6 outlines the way forward.

7.2 Data characteristics and attributes

As introduced in Chapter 5, several monitoring data sets are intended or have the potential to inform town water supply decision-making and accountability processes at national, sub-national and local levels. This section describes the characteristics of these data sets, and their related data attributes (relevance, credibility, timeliness, comprehensiveness, accessibility, and accessible formats) in data use cases identified in Chapter 6. Each section presents a table with an overview of the data attributes across the different data use cases. An overview of the data characteristics can be found in Annex 9.

7.2.1 Asset data

Asset data are intended to inform operational decision-making, tariff setting and strategic planning by the utility. This section describes the data characteristics and attributes vis-à-vis these data use cases. For an overview of the data attributes, see Table 7-1.

Table 7-1: Asset data attribute rating across data use cases

Data use case	Attributes					
	Re	Cr	Ti	Co	PA	AF
Strategic (business) planning by Utility	H	L	H	M	L	L
Tariff setting by Utility	H	L	H	M	L	L
Operational decisions and corrective measures by Utility	L	L	L	L	L	L

Attributes: Re= Relevance; Cr=Credibility; Ti=Timeliness; Co=Comprehensiveness; PA=Physical Accessibility; AF= Accessible formats; **Levels:** Local; **Rating of data attributes:** L = low; M= moderate; H = High

Relevance: Asset data on year of implementation, location, and technical specifications variables are generated at the time of asset implementation. These data should be recorded, maintained, regularly updated and managed on an ongoing basis by the utility. However, in reality, utilities do not have up-to-date asset data readily available. Instead, asset data were collected or updated when they are needed, e.g. to inform strategic planning processes or tariff setting. Because of irregular data collection, relevance of asset data for informing operational decision-making is rated as low. These data are often collected or updated to serve strategic planning and tariff setting processes, and therefore rated as highly relevant for informing these processes.

Credibility: Asset data registered at the time of construction tend to be accurate. However, these data are often not available to the utility, which instead often relies on partially available asset records and institutional memory. As a result, asset data available to utilities are not rated as highly credible by utilities. The Wukro utility manager, for example, mentioned he would score the credibility of the asset data five out of ten (pers. comm. Behalu, 2018). Credibility of asset data is therefore rated as low.

Timeliness: Asset data on some variables (e.g. location and type of asset) only need to be collected once, while data on other variables require regular updating (e.g. on status). Updating of asset data has proven a challenge. Wukro and Jinka utilities did not have processes in place for doing this on an ongoing basis, but rather do so at times when such data are needed, e.g. for informing strategic planning processes or tariff setting. Therefore, timeliness of asset data is rated as low for informing operational decision-making, and high for informing strategic planning and tariff setting.

Comprehensiveness: As mentioned in Chapter 5, data on at least seven variables should be available for all relevant assets. The number of assets (as units of observation) differs from scheme to scheme, depending on the scheme size and complexity. Many utilities in Ethiopia, including Wukro and Jinka, did not have comprehensive data on all assets in place at the time of this study¹⁵. Asset data are often collected or updated when these need to be used in occasional processes, such as tariff setting and strategic planning. Therefore, comprehensiveness is rated as moderate for informing planning and tariff setting, but low for informing operational decision-making by the utility.

Physical accessibility: Many Ethiopian utilities, including Wukro and Jinka, struggle with access to asset data. As asset development and renewal is often undertaken by contractors funded by external parties, such as the Regional Water Bureau or development partners, contractors feel primarily accountable towards the funder, rather than to the utility. Construction documentation and records, including asset data, are often provided to the funder, rather than to the utility. As a result, utilities are not always provided with produced asset data. Even when asset data are produced and handed over to the utility by a contractor, utilities generally do not have systems in place for managing these data and keeping them up to date. Therefore, accessibility of asset data is rated as low for all uses.

Accessible formats: Asset data mainly consist of raw data and do not have to be processed into information products that can be used. However, due to the lack of asset management systems, asset data, where available, were not accessible in formats that are conducive to actual use of these data by utility staff and management. Availability of asset data in accessible formats is therefore rated as low.

Summing up: Poor data attributes make asset data unsuitable for operational decision-making. Poor credibility and (physical and format) accessibility of asset data may hamper their use in tariff setting and utility-level strategic planning.

7.2.2 Operational data

Operational data produced by utilities are intended to inform decisions by utilities and their Water Boards on day-to-day operations, tariff setting, strategic planning, regulation, and accountability reporting. This section describes the data characteristics and attributes vis-à-vis these data use cases. For an overview of the data attributes, see table 7-2.

15. At the time of writing, a UNICEF supported initiative was in progress, which focused on establishing an online asset inventory (in mWater) for all town water utilities in Ethiopia. However, as this was very much a process in development, this was not taken into account in this thesis.

Relevance: Utilities produce operational data, including data on amount of water produced, sold, revenues, expenditure, connections/ customers, customer complaint data etc., on an ongoing basis and to process and compile these on a regular (monthly, quarterly, annual) basis. Data on amount of water produced are, for example, recorded on a daily basis and expenditures and revenues are recorded as they come in. Based on the scale, content and frequency of the data are rated as highly relevant for all data use cases.

Timeliness: As operational data are produced on an ongoing basis, and compiled into monthly and quarterly reports, their timeliness are rated as high for all uses.

Table 7-2: Utility operational data attribute rating across data use cases

Data use case	Attributes					
	Re	Cr	Ti	Co	PA	AF
Strategic (business) planning by Utility	H	M	H	H	M	M
Tariff setting by Utility	H	M	H	H	M	M
Operational decisions and corrective measures by Utility	H	M	H	H	M	M
Reporting for upward accountability by Utility	H	M	H	H	M	M
Reporting for downward accountability by Utility	H	M	H	H	L	L

Attributes: Re= Relevance; Cr=Credibility; Ti=Timeliness; Co=Comprehensiveness; PA=Physical Accessibility; AF= Accessible formats; **Levels:** Local; **Rating of data attributes:** L = low; M= moderate; H = High

Credibility: The level of accuracy differs over different operational data sets. Data on inputs (expenditure and staffing), activities and their direct outputs are for example generally accurate, while data on amount of water produced and sold are often less accurate.

Data on revenues and expenditure are generally well recorded and accurate. In Jinka, financial records were kept on the only computer available to the finance team, while in Wukro, the finance department used off-the-shelf (Peach Tree) software for accounting and financial management.

Measuring devices and human resources to operate them and produce accurate data, are often missing. In Jinka and Wukro, for example, and in many towns in Ethiopia, most water sources do not have functional bulk water meters. Water production is therefore mainly estimated based on manual records of operating times of the sources and source capacity. In Jinka, most of the consumer meters needed for recording the amount of water sold were old and needed replacing (pers. comm. Tsegerada, 2018)¹⁶. The situation was slightly better in Wukro where the scheme had more recently been renovated (2014-2020)¹⁷. Meter reading was a manual process in both utilities, with dedicated staff having to read all water meters on a monthly basis within a timespan of five-six days. With an average of 1,500 meters to be read per meter reader, this was an almost impossible task. According to the Jinka system manager:

16. The manager of the Jinka utility has expressed a desire to improve this situation by procuring GPS-water-meter software. However, as this kind of procurement is perceived to be beyond the capacity of an individual (smaller) utility like Jinka, procurement is to be done by the Regional Water Bureau, which has caused long delays of the procurement.

17. As part of the DFID-funded UNICEF project ONEWASH Plus

‘Sometimes they [water meter readers] estimate instead of reading the meter. For example when they cannot find their customer, they estimate. This leads to errors in the data on amount of water sold. There was also no continuous evaluation on the reliability of the data.’ As a result, there are data quality issues related to data on amount of water produced and sold.

Both in Jinka and in Wukro utility management staff were eager to obtain systems for automating water meter readings, as these were believed to provide more accurate data with less effort and time spent. The Jinka utility had requested the board to support them with this. As the utility itself did not have the financial means to procure the required system, the board forwarded the request to the Regional Water Bureau (pers. comm. Teko Zebo, 2018). The Wukro utility had expressed interest in having the same mobile water meter reading software that had been introduced by Action Aid (in collaboration with WaterAid) in Adegrad and Axum towns as part of the 20-town project. Reportedly, these utilities have managed to reduce their NRW drastically using the GIS software for water metering producing more accurate data. However, the Water Board did not approve this, as the utility had only recently procured a new financial management and billing system (pers. comm. Redda, 2018) and because they believed utility staff did not have the capacity to use the software (pers. comm. Hailu Baralo, 2018).

Despite the challenges with data accuracy, operational data were generally considered credible by utility management and staff. The Jinka utility manager, for example, gave operational data quality a score of 8 out of 10 (pers. comm. Teko Zebo, 2018), while the Wukro utility manager scored data quality at 7 out of 10 for operational data. Data credibility is therefore rated as moderate for use by the utility.

Comprehensiveness: As mentioned in Chapter 5, utilities generally design their own data recording and reporting formats. For example, the monthly technical report from Jinka utility, developed by the utility itself, consists of 35 operational variables, mostly related to operational activities or outputs, like line rehabilitation, meter relocation, and public tap maintenance. For each of the variables, the report presented the total achieved values in the previous year, total planned values for the current year (targets), the quarterly targets (which generally consists of the annual targets divided by four) and the achieved values. The monthly financial report of the Jinka utility consisted of an overview of expenditure and revenues on different cost categories.

Operational data were generally found to be reported on all operational variables. Data are therefore rated as highly comprehensive for all data uses.

Physical accessibility: As presented in Chapter 5, town utilities in Ethiopia generally have weak ICT systems in place, including for keeping and providing access to operational data. At the time of writing, the Jinka and Wukro utilities did not have internet connections and data were mainly available and stored in hard copy format. Where digital data systems are available, e.g. in Wukro’s finance department, soft copies were available on computer hard drives. Utility monitoring data were not readily accessible to stakeholders such as customers/water users, NGOs or researchers, but could be provided on request. As mentioned by the planning manager from Wukro: *‘Data from 2 or 3 years ago are not immediately available. You have to go through the file cabinets.’* (pers. comm. Redda, 2018). The accessibility of operational data for use by utility staff and management is therefore rated as moderate. Water Board members have access to the operational data through reports submitted regularly (quarterly) by the utility.

However, record keeping of these reports is generally poor, limiting the physical accessibility of the reports. Accessibility of operational data for use by Water Boards is therefore also rated as moderate. The general public, however, does not have access to these data. Date accessibility is therefore rated as low for reporting for downward accountability.

Accessible formats: Operational data have not been converted into information products (other than compilation into tables and reports) to facilitate accessibility and use by utility staff and management as data users. However, these formats were suitable for informing the different uses. Formats are therefore rated as moderately accessible for all uses, except for reporting for downward accountability, for which it is rated as low.

Summing up: Except for the low physical and format accessibility for reporting for downward accountability, the data attributes are rated as moderate and high for all uses. This could enable the use of these operational data in the local-level data use cases.

7.2.3 Utility MIS performance data

Utilities produce performance data intended to inform various processes at local and sub-national level as shown in Table 7-3. This section describes the data characteristics and attributes vis-à-vis the data use cases.

Table 7-3: Utility MIS performance attribute rating across data use cases

Data use case	Attributes					
	Re	Cr	Ti	Co	PA	AF
Strategic (business) planning by Utility	H	M	H	M	M	M
Tariff setting by Utility	H	M	H	M	M	M
Operational oversight by Water Board	H	M	H	M	M	M
Performance regulation of utility by Water Board	H	M	H	M	M	M
Reporting for upward accountability at local level by Utility	H	M	H	M	M	M
Reporting for downward accountability by Utility	H	M	H	M	L	L
Direction of RWB Technical support to utility by RWB	H	M	H	M	M	M
Economic regulation (tariff approval) by RWB	H	M	H	M	M	M

Attributes: Re= Relevance; Cr=Credibility; Ti=Timeliness; Co=Comprehensiveness; PA=Physical Accessibility; AF= Accessible formats; **Levels:** Local ; Sub-national; **Rating of data attributes:** L = low; M= moderate; H = High

Relevance: Each utility produces and compiles performance data on a periodic (commonly quarterly) basis. The content, scale, frequency of the data make them highly relevant for all data use cases.

Credibility: Accuracy of performance data depends on the accuracy of the source data, which include asset and operational data. As discussed above, the quality of these data tends to vary. Data on revenues (and expenditure) are generally well recorded and accurate, and therefore tend to provide good data on indicators related to these data. However, data on the amount of water produced and sold, and hence on non-revenue water, are less likely to be accurate.

Especially on indicators on which accurate data were not available, like NRW, utilities often report desired, rather than actual data. As mentioned by a national-level interviewed stakeholder: *'Utility managers want to be liked by politicians. They want to get praised. An important driver for utility management is that they want to stay in position or move up.'* (pers. comm. anonymous, 2018).

According to the Wukro system manager, the utility used to misreport water sales, whenever losses were found to have increased, because they felt ashamed. They wanted to adhere as much as possible to the standard of a maximum NRW rate of 15% as set by the Regional Water Bureau and manipulated data accordingly. However, the Wukro utility manager mentioned that under his leadership, information is reported as is and action will be taken accordingly. He mentioned: *'One region presented [a non-revenue water rate of] 0%. That is not possible. We reported 24%. Rather than presenting wrong data, let them fire us. We want to report the truth.'* (pers. comm. Behalu, 2018) Indeed, 65% of the 46 utilities which had reported to the Tigray Regional Water Bureau on NRW in 2009 EC (Ethiopian Calendar) reported NRW rates lower than 15%, which seems very implausible. Wukro presented NRW of 27% that year.

However, although there are clear challenges regarding the accuracy of the utility performance data (and its underlying source data), utilities, Water Boards and Regional Water Bureaus, as potential users of these data, generally perceive these as credible. These data are therefore rated as moderately credible, despite the accuracy challenges.

Stakeholders at national level tend to be more sceptical about the credibility of operational and performance data produced by utilities (pers. comm. Belete, 2022; pers. comm. Berhane, 2018). As mentioned by a national level interviewee: *'The problem with [local] government is that everything is believed from reports, without verification of reliability of data.'* (pers. comm. anonymous, 2018). He also mentioned *'At the end of the year, they play with the data they have. They don't do anything with the data. Utility reports are mostly fabricated.'* (pers. comm. anonymous, 2018).

Timeliness: Periodic town utility performance reports are generally produced and submitted in a timely fashion, making them suitable for informing periodic (e.g. quarterly) operational, strategic (planning) and regulatory decisions. Reports were generally submitted in time for informing the Water Board meetings (pers. comm. anonymous (Wukro Waterboard), 2018). The timeliness of the data is therefore rated as high for all uses.

Comprehensiveness: Utility performance reports from Jinka and Wukro were not found to consistently include data in line with all (respectively 13 and 16) indicators, mainly due to a mismatch between the indicators and available data. Nevertheless, data were available on sufficient indicators to enable the intended uses. The data are therefore rated as moderately comprehensive.

Physical accessibility: Utility performance data and reports are made available to the utility management, Water Boards, but are not publicly available. As mentioned above, utilities tend to struggle with data and information management. Physical accessibility of the data is therefore rated as moderate, with the exception of data use for reporting for downward accountability which is rated as low.

Accessible formats: The utility reports mainly include narrative descriptions, recommendations and points for attention for the way forward. They generally do not include intuitive tables and graphs displaying the performance data. Availability of the data in accessible formats is therefore rated as moderate for all uses, except for the general public.

Summing up: Data attributes for utility performance data were similar to those of the operational data, on which they are mainly based. Data attributes are rated as moderate and high for all uses, except for the low physical and format accessibility for reporting for downward accountability.

7.2.4 TUMS utility performance data

TUMS performance data were intended to inform several processes at local, and especially at sub-national level. This section describes the data characteristics and attributes vis-à-vis the data use cases. For an overview of the data attributes, see Table 7-4

Relevance: When the TUMS was operational, the Monitoring, Support and Maintenance Sub-Process (MSMSP) of the Tigray Regional Water Bureau compiled data submitted by all utilities on several indicators on a half-yearly basis. The scale, content and frequency of the TUMS utility performance data made it relevant for all uses.

Timeliness: Data compilation was done in time to inform annual (regulatory) utility ranking and awarding processes in June (pers. comm. Ato Gebreyesus). It was also available and sufficiently up to date to inform regional-level operation, planning and reporting processes. Timeliness of the data is therefore assessed as high for all uses.

Table 7-4: TUMS data attribute rating across data use cases

Data use case	Attributes					
	Re	Cr	Ti	Co	PA	AF
Strategic (business) planning by Utility	H	M	H	M	L	M
Regional strategic planning by RWB	H	M	H	M	M	M
Direction of RWB Technical support to utility by RWB	H	M	H	M	M	M
Economic regulation (tariff approval) by RWB	H	M	H	M	M	M
Performance regulation of utility by RWB	H	M	H	M	M	M
Reporting for upward accountability at regional level by RWB	H	M	H	M	M	M
Reporting for downward accountability at regional level by RWB	H	M	H	M	L	L

Attributes: Re= Relevance; Cr=Credibility; Ti=Timeliness; Co=Comprehensiveness; PA=Physical Accessibility; AF= Accessible formats; **Levels:** Local ; Sub-national; **Rating of data attributes:** L= low; M= moderate; H = High

Credibility: The quality of the source data submitted by different utilities varied between different data categories, as mentioned above, and between utilities. The Regional Water Bureau tried to ensure data accuracy through data review and follow-up. Also, the MSMSP checked and validated data through periodic onsite assessments of each utility (pers. comm. Zeruu Haile, 2018). Data accuracy was thus likely to be higher than the source data from the utility MIS, but, given the challenges with the source data, still relatively low. However, the main intended users of the data, the MSMSP, considered the data credible. Credibility of these data is therefore rated as moderate for all uses.

Comprehensiveness: As mentioned in Chapter 5, the TUMS consisted of some 32 variables and 8 KPIs and one composite, ranked indicator. The 2010 EC (2017/18) regional data set was supposed to contain data from 69 utilities, but data were not available from nine of these utilities. Furthermore, data on coverage was only available for 34 utilities and on user satisfaction from 28 town utilities. Data were especially lacking from the smaller utilities, with nine of the 11 category 6 towns (the smallest town category) not having submitted any data. This was due to a lack of data and information systems and low (human and logistical) capacity in these towns (pers. comm. Zeruu Haile, 2018). Regional Water Bureau staff visited these utilities to help in collecting and compiling the data. Overall, 68% of the performance indicator data were available

in 2010 EC (2017/2018). This would be sufficient to enable all uses. Comprehensiveness of these data is therefore assessed as moderate for all uses.

Physical accessibility: The TUMS data were only available on the computer of the head of the MSMSP. Data were therefore rated as moderately accessible for the Regional Water Bureau, with low accessibility for utilities (for strategic planning) and the general public (for downward accountability).

Accessible formats: The results were shared with the Regional Water Bureau and utilities in the form of a narrative report, indicating the best, average and worst performing utilities in terms of degree of progress related to the targets set on the indicators for each utility. Although these reports were not widely circulated and did not include intuitive figures and tables, they did provide accessibility to the data in a format accessible to the Regional Water Bureau and utilities. Data were not available in accessible formats for the general public, for downward accountability.

Summing up: Data attributes are rated as moderate and high for all uses at sub-national level, enabling regional decision-making and reporting. The low accessibility of the data to the potential data users at local level could hamper data use for downward accountability and strategic planning.

7.2.5 PI&BM data

The Performance Indicator and Benchmarking (PI&BM) data were intended to inform decision-making processes at different institutional levels. This section describes the data characteristics and attributes (relevance, credibility, timeliness, comprehensiveness and accessibility) vis-à-vis the data use cases. For an overview of the data attributes, see Table 7-5

Table 7 5: PI&BM data attribute rating across data use cases

Data use case	Attributes					
	Re	Cr	Ti	Co	PA	AF
Strategic (business) planning by Utility	M	L	L	L	H	L
Regional strategic planning by RWB	M	L	L	L	H	L
Direction of RWB Technical support to utility by RWB	M	L	L	L	H	L
Economic regulation (tariff approval) by RWB	M	L	L	L	H	L
Policy-making by Ministry	H	L	M	M	H	L
Macro-level planning by Ministry	M	L	L	L	H	L
National level regulation by Federation	M	L	L	L	H	L
Reporting for upward and sideways accountability at national level by Ministry	M	L	L	L	H	L
Reporting for downward accountability by Ministry	M	L	L	L	H	L

Attributes: Re= Relevance; Cr=Credibility; Ti=Timeliness; Co=Comprehensiveness; PA=Physical Accessibility; AF= Accessible formats; **Levels:** Local; Sub-national; National; **Rating of data attributes:** L= low; M= moderate; H= High

Relevance: Although PI&BM data were intended to be collected and compiled from all utilities on an annual basis, in reality these data had at the time of writing only been collected twice: round one in 2013, covering 2011 and 2012 data, and round two in 2019, covering 2013 to 2018 (and to some degree additional data collection from 2011 and 2012) data. Data timeseries are available for several utilities. Although data were to be included from all utilities on a census

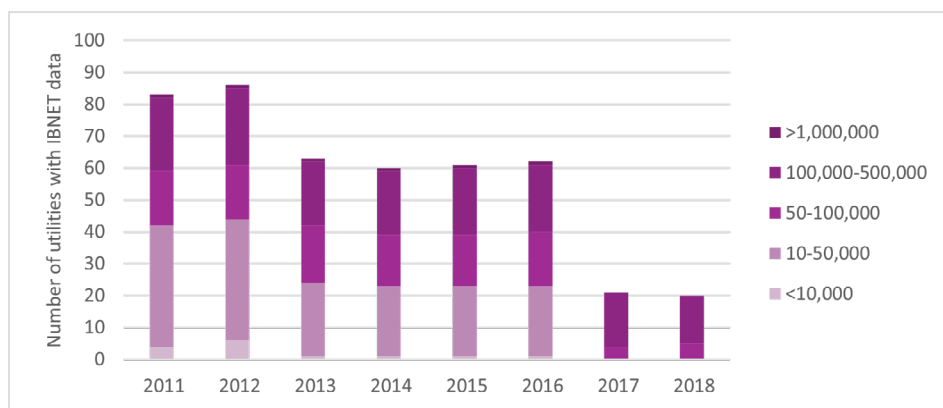
basis, data were only available from a sample. As data on a sample basis rather than on a census basis would be sufficient to inform policy, the PI&BM data are rated as highly relevant for informing policy, but moderately relevant for the other data use cases.

Credibility: The process of data compilation and processing itself brought data quality challenges to the front. WSP supported the data compilation and cleaning process. Before the first round, training-of-trainer sessions of Regional Water Bureau staff were organised, followed by regional-level training of utility staff in all regions. Data collection forms included a data quality questionnaire, where utilities could indicate whether the submitted data were ‘accurate’ to ‘estimates’. As mentioned by a national level interviewee, *‘[Utility staff] will not be able to cook the data, because the IBNET data will show when they cooked it.’* (pers. comm. anonymous, 2018) PI&BM data available in the IBNET database indeed seem to be consistent and do not present (many) obvious data quality red flags. Nevertheless, WSP considered the data to be of low credibility due to low accuracy of the utility source data (pers. comm. Tadessa, 2018). Credibility of the data is therefore rated as low for all uses.

Timeliness: Because of the lengthy data collection and cleaning process, the PI&BM data from the first round became available years after collection. Round one data covering 2011 and 2012 were presented for the first time at national level during the 2015 MSF, three years after they had been collected. At the time of writing, data from round two (covering 2013-2018) had been made available in the IBNET database, but had not been presented yet to the sector in any other way. This would not necessarily be an issue for use of data for informing policy-making, but would be an issue for all other uses. Timeliness of these data is therefore rated as moderate for policy-making, but low for all other potential uses.

Comprehensiveness: As presented in Chapter 5, the PI&BM system had 51 indicators, including 17 key performance indicators. Data were intended to be collected from all utilities in the country, but were in reality collected on (voluntary) sample basis. The 2012 data compilation initially involved 139 utilities, of which 93 utilities submitted data. After quality control by the Ministry and WSP, and rectification of the data by the utilities, 75 utilities re-submitted data. Data were finally accepted from 69 utilities. In the second round, data were accepted from some 90 utilities from the period 2011 - 2016. For Addis Ababa and the 22 secondary towns under the World Bank’s Second Ethiopia Urban Water Supply and Sanitation Project, benchmarking through annual submission of IBNET data is mandatory. As a result, data are available from these utilities in the IBNET database for the period 2017-2018, as indicated in Figure 7-1, which shows the number of utilities with data in the IBNET database per year.

Figure 7-1: Number of utilities with IBNET data per year, per town population category



Source: IBNET (2022)¹⁸

Overall, at the moment of writing, the IBNET database contained at least one data point over a timespan from 2011 to 2018 from a total of 101 utilities. This represents only about 30% of the 332 utilities included in NWI1. Based on data in the IBNET portal and JMP data on number of people served with piped water supply, Andres and Bahuguna (2020) estimate that some 37% of the urban population are served by piped schemes, and are covered by utilities for which performance data are available in IBNET.

Data were not available on all indicators from all utilities. Overall, about 80% of water supply data were available (with an average data availability of 83% in 2011-2012, 77% in 2013-2016, and 80% in 2017-2018). Data were mostly lacking on indicators related to staffing, water quality (in terms of residual chlorine), residential fixed component of tariff, connection charges, and gross fixed assets, and customer complaints.

Due to the relatively low comprehensiveness of PI&BM data in terms of utilities covered, this thesis rates data comprehensiveness as moderate for policy-making, but as low for other uses.

Physical accessibility: PI&BM data are available online on the global IBNET website (<https://www.ib-net.org/>). In principle, these data are thus accessible for all potential data users and therefore rated as highly accessible.

Accessible formats: Tentative findings from the first round were presented at the 2015 Multi-actor Forum, but data have not been processed into information products. Low trust in the accuracy of the source data had limited the interest and willingness of WSP to process the data into information products (pers. comm. Tadessa, 2018; pers. comm. anonymous, 2018). Furthermore, because of personnel changes in both the World Bank head office and the Ministry, people who had initially spearheaded the PI&BM initiative left. As a result, information products have not been produced (pers. comm. Tesfaye, 2022). This contributed to the low stakeholder awareness of and interest in the data. Utilities who had participated mainly saw the

18. It is assumed that data from Addis Ababa indicated as 2008 and 2009 data are in fact 2015 and 2016 data (assuming 2008 and 2009 referred to the year in Ethiopian calendar).

process as a ‘form filling’ exercise imposed on them by the Ministry and the World Bank (pers. comm. anonymous, 2018). In 2018, some five years after the first data collection round, a utility manager mentioned that they had filled in the data collection forms after having been trained, but had not heard anything since. He mentioned *‘They said they needed the information, but I am not sure for what’* (pers. comm. Talo Zobi, 2018). So, although the data are physically accessible, they were not available in accessible formats for the data use cases.

Summing up: Low timeliness, comprehensiveness, credibility and lack of accessible format of these data are likely to hamper their use.

7.2.6 NWI utility performance data

Utility performance data produced by the WASH M&E MIS through the National WASH Inventories (NWIs) have the potential to inform reporting for accountability at national level and policy, operational, planning and regulatory decision-making at the different institutional levels. This section describes the data characteristics and attributes vis-à-vis the data use cases. For an overview of the data attributes see Table 7-6.

Table 7-6: NWI data attribute rating across data use cases

Data use case	Attributes					
	Re	Cr	Ti	Co	PA	AF
Strategic (business) planning by Utility	M	L	L	NWI1: M NWI2: L	L	L
Regional strategic planning by RWB	M	L	L	NWI1: M	L	L
Direction of RWB Technical support to utility by RWB	M	L	L	NWI2: L	L	L
Economic regulation (tariff approval) by RWB	M	L	L	NWI1: M	L	L
Policy-making by Ministry	H	L	M	NWI2: L	M	L
Macro-level planning by Ministry	M	L	L	NWI1: M	M	L
National level regulation by Federation	M	L	L	NWI2: L	M	L
Reporting for upward and sideways accountability at national level by Ministry	M	L	L	NWI1: M	M	L
Reporting for downward accountability by Ministry	M	L	L	NWI2: L	M	L

Attributes: Re= Relevance; Cr=Credibility; Ti=Timeliness; Co=Comprehensiveness; PA=Physical Accessibility; AF= Accessible formats; **Levels:** Local ; Sub-national; National; **Rating of data attributes:** L = low; M= moderate; H = High

Relevance: The intention of the National WASH M&E MIS was to produce utility performance data on all utilities on an annual basis. However, the original process of annual reporting of utility performance data was replaced by national data collection processes: NWI1 (2010/11) and NWI2 (2018). These processes were time-consuming and expensive, which made annual data collection using these processes unrealistic. The content and scale made the NWI data relevant for all uses, but the occasional, rather than annual frequency of data availability made the data only relevant for informing processes which do not occur on an annual basis, such as policy-making. Therefore the NWI data are rated as highly relevant for policy-making, but as moderately relevant for other potential uses.

Credibility: NWI1 data accuracy was low. Data in the PUT MIS in 2018 did not seem to have been processed and cleaned, with data from 47 utilities including obvious data errors on one or

more variables¹⁹. Processed KPI data were also inaccurate. Table 7-7, comparing average KPIs values as presented in the PUT database with recalculated KPI values based on variable data, shows considerable discrepancy. This is likely to have been due to incorrect application of the developed algorithms²⁰.

Table 7-7: PUT MIS KPI values and recalculated KPI values

KPI (phase 1)	Average KPI value*	Recalculated KPI value**
KPI 112061 - Non-Revenue Water	17%	22%
KPI 112071 – Proportion of utilities with Full Cost Recovery	30%	80%
KPI 112081 - Proportion of utilities which fulfill Key Utility Staffs	23%	27%

Source: *:PUT MIS; **: recalculated KPI values based on PUT MIS data

Assessing the accuracy of the NWI2 data related to utility performance was found to be difficult as the NWI2 data collection tool design did not allow for accurate data collection on variables needed for KPI calculations, as also described in Chapter 5. For example, the survey included questions directly on certain KPIs (e.g. NRW), rather than on the variables needed to assess the indicators. Lack of data on such variables meant that data on the KPI data could not be verified. Also, the survey asked for average amounts of expenditure and revenues over a three-year period, which was likely to result in inaccurate data. Credibility of the NWI data is assessed as low for all uses.

Timeliness: Data processing and analysis of the NWI1 data took a long time. NWI data were officially released by the Ministry to WASH stakeholders in April 2013 (Federal Democratic Republic of Ethiopia, 2013), almost two years after data had been finalised in 2011. The use of mobile devices for NWI2 data collection was expected to increase the speed with which data and information products would become easier and quicker accessible²¹. NWI2 data were indeed made available in the Synergy MIS around 2019, relatively quickly after data collection was finalised in 2018. However, challenges with combining population data and NWI2 data in the MIS due to discrepancies in woreda and town names necessitated a more elaborate two-month post-data cleaning process by the consultant and a dedicated WDC task force (Water Development Commission, 2021). The draft of the only information product which resulted from the NWI2, the 'Report on National WaSH Inventory-II & MIS', became (officially) available by January 2021, but was only launched and officially published in 2022, some three years after data collection. Timeliness is therefore rated as moderate for data use in informing policy-making, but as low for all other uses.

19. Nine towns had for example double entries, 13 towns had unreliable (exactly the same) data on staffing, tariff data and data on number of connections, 22 towns had obvious wrong data on the revenue and expenditure variables.

20. The algorithm used for calculating cost recovery was based on the "income" variable rather than the "revenue" variable. Only 41% of utilities had data on this variable, while 78% did have data on the "revenue" variable, which could also be used to calculate the indicator. Also, instead of assigning "NA" to variables without data, a value of 0 was assigned and used in several KPI calculations.

21. Not having the household survey and institutional WASH surveys included in NWI2 was also expected to result in faster data and information processing.

Comprehensiveness: As presented in Chapter 5, NWI1 utility performance data were supposed to be collected on 83 variables and intended to result in utility performance data on eight KPIs. Data were not available from all utilities on all variables. Following the NWI1, the PUT MIS contained data from 332 utilities²². The majority (93%) of the utilities in the MIS were reported to serve towns with a population of between 2,000 and 50,000 people. Overall, some 84% of the data were found to be available.

NWI2 utility performance data were supposed to be collected on at least 52 variables and were intended to result in utility performance data on five KPIs, six supplementary indicators (SI) and four regional SIs. However, the design of the NWI2 data collection tools did not enable collection of data for producing data on four of the five KPIs and four of the nine SIs (see annex 7 for details). As a result, a large part of the collected utility performance data was not usable for tracking progress on utility performance and informing decision-making accordingly, including on the GTP2 goals. The NWI2 reportedly covered 91% of the urban settlement (Water Development Commission, 2021). However, comparing the number of Tigray utilities with NWI2 data (45) and with the number of utilities with TUMS data from the same year (69) raises questions about the actual comprehensiveness of the NWI2 data in terms of units of observation covered. Also, data were not available on all variables for all utilities.

So overall, comprehensiveness of the NWI data is rated as moderate for all uses for NWI1 data and as low for NWI2 data.

Physical accessibility: In 2010, when NWI1 was ongoing, the National WASH Inventory Project Office (NWIPO) programme emphasised the need to make NWI data accessible at all institutional levels. The plan was to make data accessible through an MIS, which was under development at the time. The Ministry and the NWIPO perceived the lack of computers and trained woreda-level staff as the main bottleneck in making data available at all institutional levels (Hailu Debela, 2013; Welle, 2013). To address the challenge, there was large-scale roll out of training and hardware supplies following NWI1 data collection (Coffey and IRC, 2015).

An interim MS Access-based database was designed by SNV and Hawassa University with support of UNICEF to enable data entry at regional level. However, as this was a non-networked solution, data were not easily accessible. After completion of the SQL-based PUT MIS, data were migrated. Subsequently, for several years, NWI1 data were available in the PUT MIS, accessible online as a password protected SQL database. However, the number of actors at national level with access to the database was relatively small. There was commitment from government at the time to make data electronically available for government institutions at sub-national level through the 'woreda net'. However, by April 2013, almost two years after data collection had been completed, the NWI data had been made available to only 58 out of more than 731 woredas. Despite the hardware procurement and trainings, actors at sub-national level generally did not have access to the online database, because of internet challenges and/ or because they did not have access to the required password.

22. It should be noted that the NWI data in the PUT MIS did not include data on Somali utilities, as the NWI1 did not include Somali region because of security issues. Data from Somali region was collected in 2014, but not added to the PUT MIS, but stored in the Akvo FLOW environment.

To ensure accessibility to NWI2 data, a new MIS was developed by Synergy International Systems Inc, a USA-based IT and consulting company, with operational acceptance of the system in December 2019. As the Ministry of Water and Energy preferred to have the data on its own servers instead of in the 'cloud', the Ministry started a process of service procurement. However, at the time of writing, the Ministry had still not succeeded in procuring the required servers. As Synergy could not permit access to the MIS following an 18-month warranty and six-month extension period, NWI2 data were not accessible from November 2021 onwards. Data have therefore not been easily accessible to potential data users, especially the ones at local and sub-national level. Accessibility of the NWI data is therefore rated as low for data users at local and sub-national level, and as moderate for users at national level.

Accessible formats: In addition to the data having been processed into KPI data and made available in the PUT MIS, NWI1 utility performance data had not been processed, analysed, visualised and made available in the form of information products at all, unlike coverage data, which were processed and presented in national and international fora. The emphasis on coverage was in line with the monitoring objectives of phase 1 and focused on tracking progress towards coverage targets. Also, lack of time, resources and capacity for processing, analysis and visualisation of the utility performance data may have played a role.

Although GTP2 and the revised OWNPN monitoring framework put more emphasis on utility performance indicators, data processing, presentation and analysis of the urban NWI2 data still focused on coverage findings. Utility performance data collected as part of NWI2 have hardly been processed as per the KPIs. The only urban KPI that was included in the Synergy MIS and the NWI2 report was the Urban KPI nine on the proportion of water supply schemes with a water safety plan. Furthermore, the report presented data on '% of urban water collection points with disability inclusion' (Asmamaw, 2021; Water Development Commission, 2021), although this was not a KPI or SI. Asmamaw (2021) considered these KPIs impossible to configure as data were not available. Availability of utility performance data from the NWIs in accessible formats is therefore rated as low.

Summing up: The low data credibility, timeliness, physical, and format accessibility for most use cases is likely to hamper these uses.

7.2.7 Ministry's coverage data

The coverage data produced by the Ministry has the potential to inform policy-making (related to setting national standards), regional- and macro-level planning, and reporting for upward and downward accountability. This section describes the data characteristics and attributes vis-à-vis the data use cases. For an overview of the data attributes, see Table 7-8.

Table 7-8: Coverage data attribute rating across data use cases

Data use case	Attributes					
	Re	Cr	Ti	Co	PA	AF
Regional strategic planning by RWB	H	M	H	H	M	M
Setting national standards by Ministry	H	M	H	H	M	M
Macro-level planning by Ministry	H	M	H	H	M	M
Reporting for upward and sideways accountability at national level by Ministry	H	M	H	H	M	M
Reporting for downward accountability by Ministry	H	M	H	H	L	L

Attributes: Re= Relevance; Cr=Credibility; Ti=Timeliness; Co=Comprehensiveness; PA=Physical Accessibility; AF= Accessible formats; **Levels:** Sub-national; National; **Rating of data attributes:** L= low; M= moderate; H= High

Relevance: The coverage data that the Ministry produces on an annual basis are representative at national and regional level and as such are highly relevant for all data use cases.

Credibility: Accuracy of the coverage data is questionable. This is, for example, illustrated by the fact that the 2010 water coverage figures amounting to 91.5% based on number of assets multiplied by number of people served per asset, divided by (projected) population of the area, needed to be adjusted downward by almost 20 percentage points from to 72.6%, based on insights from the NWI1. The 2018 urban coverage data based on NWI2 data were estimated to amount to 57%, which was some seven percentage points lower than the pre-2018-NWI urban coverage estimate of 64%.

There are several ways in which coverage accuracy is compromised. These include:

- The inaccurate practice of estimating coverage based on assets.
- The application of correction coefficients, determined by a national consultant for adjusting coverage data in line with the higher GTP2 service standards.
- Inaccurate population data, with official population data projected on an annual basis by the Central Statistics Agency (CSA), based on the census data, which is only collected occasionally. At the time of writing for example, the latest census data was over 15 years old. This, combined with the high level of urbanisation and town development, makes the projected population data highly inaccurate.
- Service areas of utilities not always correspond 100% with town (population) boundaries.
- Backdating of coverage data through extrapolation to ensure the data are relevant for informing macro-level planning processes.

Despite these accuracy challenges, the Ministry's coverage data are generally considered highly credible by national-level stakeholders and accepted by both the Ministry and development partners as the government's official coverage data. Data are therefore rated as moderately credible for all uses.

Timeliness: National coverage data are produced on an annual basis. The NWI1 data became available in time to inform the development of the macro-level plan within the framework of the first phase of the One WASH National Programme in 2013. The preliminary NWI2 became available around the time of the development of the ten-year strategy of the Ministry in 2020. Timeliness of coverage data is therefore rated as high.

Comprehensiveness: Coverage data involve a single indicator on which data are produced on an annual basis. The coverage data produced by the Ministry are rated as highly comprehensive for all uses.

Physical accessibility: Coverage data were intended to be accessible to sector stakeholders and the general public through the national WASH M&E MIS ICT platforms (PUT MIS and synergy MIS), but as described above, these platforms were not operational. However, as the Ministry and Regional Water Bureau are both producer and user of the data, physical accessibility is rated as moderate for all uses, except for reporting for downward accountability, for which is rated as low.

Accessible formats: NWI1 coverage data were originally planned to be included in information products, including Woreda report cards (Butterworth et al., 2010). However, due to delays with data cleaning, processing and analysis, such data products never materialised. The NWI1 coverage data were also planned to be presented in maps, which could help inform targeting and prioritisation of areas most urgently in need of interventions. However, the actual production of such maps has been limited. The OWNP programme document (Federal Democratic Republic of Ethiopia, 2013) included two maps showing woredas according to the level of access their rural populations had to water and sanitation services, as produced by OCHA (United Nations Office for the Coordination of Humanitarian Affairs) in collaboration with UNICEF. Two years after data collection had been completed, in April 2013, preliminary findings were presented at a seminar, bringing together some 100 sector actors. Data cleaning at regional level was still ongoing at the time. Besides the small number of presentations and maps, no national-level information products were produced based on the 2010/11 NWI data. NWI2 coverage data were published in the NWI2 report, available online. National coverage data from non-NWI years have mainly been presented in sector presentations and annual reports, available to national and regional stakeholders. Accessibility of national coverage data in accessible formats is therefore rated as moderate for all uses, except for reporting for downward accountability.

Summing up: Except for the low physical and format accessibility for reporting for downward accountability, the data attributes are rated as moderate and high for all uses. This could enable the use of the Ministry's coverage data in the national-level data use cases.

7.2.8 JMP coverage data

Like the coverage data produced by the Ministry, the JMP coverage data have the potential to inform policy-making (related to setting national standards), macro-level planning, and reporting for upward and downward accountability. As the data are only representative at national level, they are not relevant for informing sub-national and local processes. This section describes the data characteristics and attributes vis-à-vis the data use cases. For an overview of the data attributes, see Table 7-9

Table 7-9: JMP data attribute rating across data use cases

Data use case	Attributes					
	Re	Cr	Ti	Co	PA	AF
Setting national standards by Ministry	M	M	M	H	H	M
Macro-level planning by Ministry	M	M	M	H	H	M
Reporting for upward and sideways accountability at national level by Ministry	M	M	M	H	H	M
Reporting for downward accountability by Ministry	M	M	M	H	H	L

Attributes: Re= Relevance; Cr=Credibility; Ti=Timeliness; Co=Comprehensiveness; PA=Physical Accessibility; AF= Accessible formats; **Level:** National; **Rating of data attributes:** L = low; M= moderate; H = High

Relevance: JMP has been producing global and national water coverage data since 1990, making these data highly relevant for informing national level planning, reporting for accountability, and policy-making. However, during both the MDG and the SDG era, there was a mismatch between service level standards defined by JMP, based on globally accepted service level definitions, and Ethiopia's service level standards, set by the Ministry. Therefore, this thesis considers the JMP data as moderate, rather than highly relevant for the tracking goals set based on national standards and for informing macro-level planning in line with these targets. Also, OWN Phase II considered the JMP 'safely managed' service level as onerous to a water stressed country (Federal Democratic Republic of Ethiopia, 2018a). JMP data are therefore rated as moderately relevant for all uses.

Credibility: Household survey data, which form the basis of JMP Ethiopia coverage data, are based on samples, with intrinsic precision challenges. The household surveys used by JMP for urban water service estimations generally consider a 95% confidence interval. Household survey data are generally collected by trained data collectors, who are not necessarily WASH experts. However, because of large sample size and procedures for data cleaning, processing and verification, the JMP source data are likely to be of sufficient quality and accuracy.

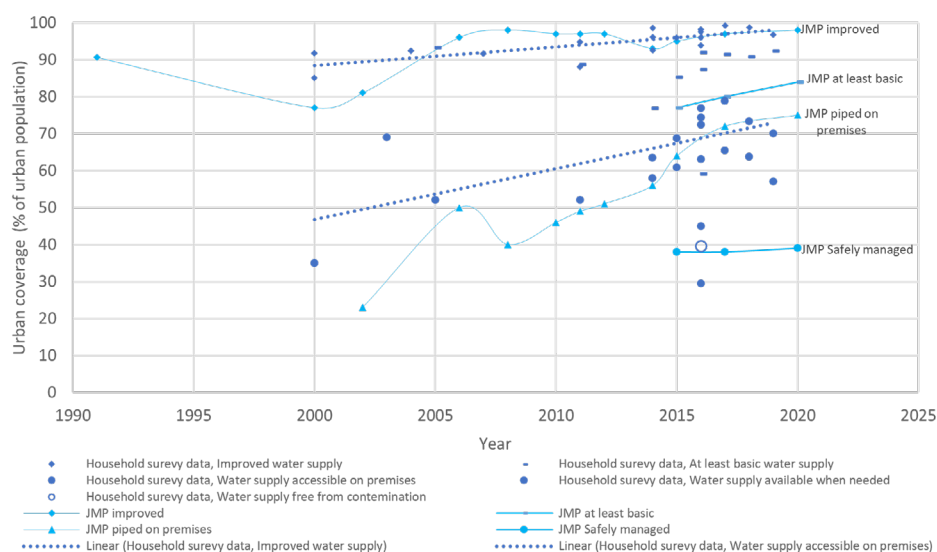
JMP data are produced through a linear regression of the source data. This poses both challenges and opportunities for data accuracy. As JMP data are based on multiple data sources, this circumvents accuracy challenges of a single survey. An important reason for JMP's move from focusing on using 'provider-based' data like the national coverage data, to linear regression from multiple data sources (in the case of Ethiopia mainly household surveys) in 2000, was largely driven by the belief that this would improve the accuracy and credibility of the JMP data (Bartram et al., 2014). However, it does make the data sensitive to outlier data from a single source. The accuracy of linear modelling has been questioned, with S-shaped trends in water supply coverage proposed as potential better fitting models, especially for countries with very low or very high coverage rates (Bartram et al., 2014). New source data can impact the slope of the regression curve, and hence can result in changes in past data, including the baseline data. Furthermore, the nature of linear regression means that rapid change cannot be adequately captured (World Health Organization and United Nations Children's Fund, 2012).

Figure 7-2 shows the reported urban JMP data, the data points from the source data, and the 2020 linear regression (in dotted lines). It shows fluctuation in the presented coverage figures over the years, which could indicate data accuracy challenges.

Based on this, the JMP data accuracy is rated moderate. However, as national stakeholders observed considerable discrepancies in JMP coverage data and national coverage data,

especially before the first NWI, the JMP data were regarded with some level of suspicion. At the time of the assessment, interviewed Ministry staff were aware that the differences in JMP and national coverage data are due to differences in assessment methodology and the definitions and standards used. Credibility of JMP data is therefore rated as moderate for all uses.

Figure 7-2: JMP coverage figures



Timeliness: JMP produced its first global monitoring report in 1992, presenting 1990 baseline data (World Health Organization and United Nations Children's Fund, 1992). However, for Ethiopia, this report did not disaggregate between urban and rural areas and only presented an overall coverage of improved water supply of 26.9%. The report that followed in 1993, presenting the status as of 31 December 1991, estimated overall coverage to amount to 25%. It did present disaggregated data, with an estimated 91% of the urban population with improved water supply (World Health Organization and United Nations Children's Fund, 1993). The 1996 JMP report did not include data from Ethiopia, but subsequent reports did. JMP data are generally published every two years, around the middle of the year. Because of the time it takes to process and analyse the data, data for a specific year are commonly made available one to two years later. Timeliness of the JMP data is therefore assessed as moderate for all uses.

Comprehensiveness: JMP data are estimated based on both comprehensive census data and some sample-based household data, which are representative at (at least) national level. The JMP data are therefore rated as highly comprehensive for all uses.

Physical accessibility: JMP reports and data are freely accessible online at www.washtdata.org. Therefore, physical accessibility of JMP data is rated as high.

Accessible formats: The online JMP platform enables presentation of the data in interactive tables and graphs. JMP also presents the data in the form of (global) reports with summary tables and graphs and detailed analysis of the data and observed trends. Also some country-specific JMP

reports are produced, but Ethiopia-specific JMP reports have not been produced. These formats are suitable for informing macro-level planning, reporting for accountability and informing policy-making, but arguably less suitable for informing reporting for downward accountability, if not presented in formats targeting the general public in Ethiopia. Format accessibility is therefore rated as low for reporting for downward accountability and moderate for the other uses.

Summing up: Except for the low format accessibility for reporting for downward accountability, the data attributes are rated as moderate and high for all uses. This could enable the use of the JMP coverage data in national-level data use cases.

7.2.9 Summing up data characteristics and attributes

This section has shown that the majority of data sets were rated as relevant in terms of scale, frequency and content to inform decision-making and accountability processes in line with their data use cases. The only exception has been the asset data relevance for informing operational decision-making, as its infrequent collection and updating made the data irrelevant to inform operational decision-making.

Credibility of the national utility performance data sets (NWI and PI&BM data) was rated as low, while other data sets were rated as moderately credible, despite considerable data accuracy challenges.

Timeliness was rated as high for data produced and used by the same stakeholder, e.g. a utility, MSMS or the Ministry using data they produced themselves. Timeliness was rated low where this was not the case. It was also rated as low for the national utility performance data sets (PI&BM and NWI data), due to the time-consuming nature of the data collection, cleaning and processing processes.

PI&BM data were rated as not comprehensive for most uses, as they covered less than half of the utilities in the country. As data on a sample of facilities was sufficient to inform policy-making, these data were rated as moderately comprehensive for informing these processes. JMP and national coverage were rated as highly comprehensive for all uses, as were utility operational data. Other data sets were rated as moderately comprehensive.

Physical accessibility was rated as high for the data sets freely available online (PI&BM and JMP data) and moderate or low for other data sets.

Availability of data in accessible formats was rated as only low or moderate. Although raw asset data could be used to inform operational and strategic decision-making by utilities, the asset management systems required for this were generally not in place. Although raw utility performance data were processed on indicators, further processing into accessible and user-friendly formats, rarely took place. Utility performance data (NWI and PI&BM) were not processed into accessible formats for their data use cases and national coverage data were not presented in formats that were accessible and understandable to the general public for downward accountability.

7.3 Factors shaping data attributes

Data characteristics were shaped by the design of the monitoring system components presented in Chapter 5. The indicator framework and data collection tools shaped the content and hence the relevance of the data. Data collection (and cleaning and processing) tools and processes can

shape data accuracy, data quantity, processing time, and level of data processing. ICT platforms shaped the accessibility (both physical and format-wise) of data. As described in Chapter 5, the design of these components was driven and shaped by various stakeholders, their capacities, interests and motivations, relationships etc.

The data characteristics shaped data attributes. However, data attributes were shaped by many other factors as well. Credibility was, for example, not only determined by accuracy of data, but also by the relationship between data producers and users.

Data attributes also shape each other:

- **Negative influence of timeliness on accessible formats and vice versa:** Data processing and making them available in accessible formats influences timeliness, as these processes take time. The production of the PI&BM and the NWI data took a long time, with raw and processed data becoming available years after data collection. Because of the low timeliness of the data, processing of the data into information products and other accessible formats was considered less useful.
- **Strong negative influence of credibility on timeliness:** The PI&BM data production process involved an elaborate and time-consuming process of data cleaning and processing, due to challenges with the credibility of the source data. This contributed to the PI&BM data being made available years after data collection, which meant the data were no longer suitable for informing (regulatory) decision-making. It demonstrates the need to clearly consider the trade-off between data credibility and the required level of data quality on the one hand and required timeliness of data on the other. This trade-off requires an accurate assessment of circumstances under which timeliness is important (Rein and White, 1975).
- **Strong influence of credibility on availability of data in accessible formats:** The data use cases for which credibility has been assessed as low (data use of asset data, PI&BM data and NWI data), were also found to have low format accessibility. Low credibility of the PI&BM data stopped data producers from processing the data into accessible information products. The same is likely to have been the case for NWI data.
- **Influence of comprehensiveness on relevance:** Comprehensiveness of data can be argued to have either a positive or negative influence on data relevance. The more comprehensive data are collected, the more likely that at least part of these data will be relevant. However, the more data are collected, the more likely that a large part of data may not be relevant. In the case of the NWIs, for example, comprehensive data were collected, but only a small part was relevant for assessment of performance indicators, making it considerably less relevant.
- **Strong negative influence of comprehensiveness on timeliness:** There can be a trade-off between having comprehensive and timely data. Collecting and processing comprehensive data sets was found to be time consuming, with data only becoming available years after data collection, making them less timely for use in decision-making and for reporting for accountability. This was especially the case for utility performance data.

- **Negative influence of comprehensiveness on credibility:** There can also be a trade-off between data comprehensiveness and data accuracy. Collection of comprehensive data sets means comprehensive data quality assurance, cleaning and processing procedures need to be in place to ensure data accuracy. Where this is not the case, data inaccuracy may result in lack of data credibility. Cleaning of the comprehensive NWI1 and 2 utility performance data sets proved to be challenging, for example, resulting in low data accuracy and moderate credibility.

7.4 Data attributes and actual use of data

To analyse the role data attributes play in influencing actual data use, this section compares the rated attributes of data involved with the degree of actual data use in different data use cases, as described and rated in Chapter 6. Table 7-10 presents an overview of this per data set. For the purpose of aggregation and comparison, the ratings have been converted into numbers, as indicated in the legend of the table.

7.4.1 Asset data attributes and use

The lack of asset data use for informing operational decision-making is in line with the low rating of all data attributes. The low use of these data for planning and tariff setting aligns with the low rated credibility and accessibility, and could therefore, at least partially, explain these low levels of actual use of asset data.

7.4.2 Operational data attributes and use

Operational utility data have been used to a moderate degree by utilities for informing operation and planning decisions. This is in line with the data attributes, which were all rated as high or moderate. The lack of use of the data for reporting for downward accountability, aligns with the low accessibility of these data to the general public. However, low use of these data in tariff setting and reporting for accountability by only looking at the data attributes does not align with the moderate and high rated data attributes.

7.4.3 Utility performance data attributes and use

This section elaborates on whether differences in the degree of actual data use can be explained by the data attributes.

Data attributes aligns with high use of TUMS utility performance data use for regulation by the Regional Water Bureau, but not with the low use by the Water Board. The degree of use of TUMS data for informing regulatory decisions by the MSMSB, was rated as high. This was in line with the moderate and high rated data attributes. The degree of use of the TUMS data in informing operational decisions by the Regional Water Bureau was rated as low, due to other restricting factors, including lack of human, financial and logistical resources to act on operational decisions, as presented in Chapter 5.

Table 7-10: Overview of data attribute and data use rating

Data set	Data use case	Attribute ratings							Data use rating
		Re	Cr	Ti	Co	PA	AF	Average	
Utility asset data	Strategic (business) planning by Utility	2	0	2	1	0	0	0,83	4,5
	Tariff setting by Utility	2	0	2	1	0	0	0,83	4
	Operational decisions and corrective measures by Utility	0	0	0	0	0	0	0,00	0,5
Utility operational data	Strategic (business) planning by Utility	2	1	2	2	1	1	1,50	4,5
	Tariff setting by Utility	2	1	2	2	1	1	1,50	4
	Operational decisions and corrective measures by Utility	2	1	2	2	1	1	1,50	5
	Reporting for upward accountability by Utility	2	1	2	2	1	1	1,50	3
	Reporting for downward accountability by Utility	2	1	2	2	0	0	1,17	2
Utility performance data	Strategic (business) planning by Utility	2	1	2	1	1	1	1,33	4,5
	Tariff setting by Utility	2	1	2	1	1	1	1,33	4
	Operational oversight by Water Board	2	1	2	1	1	1	1,33	4
	Performance regulation of utility by Water Board	2	1	2	1	1	1	1,33	3
	Reporting for upward accountability at local level by Utility	2	1	2	1	1	1	1,33	3
	Reporting for downward accountability by Utility	2	1	2	1	0	0	1,00	2
	Direction of RWB Technical support to utility by RWB	2	1	2	1	1	1	1,33	2
	Economic regulation (tariff approval) by RWB	2	1	2	1	1	1	1,33	2
TUMS data	Strategic (business) planning by Utility	2	1	2	1	0	1	1,17	3
	Regional strategic planning by RWB	2	1	2	1	1	1	1,33	5
	Direction of RWB Technical support to utility by RWB	2	1	2	1	1	1	1,33	4
	Economic regulation (tariff approval) by RWB	2	1	2	1	1	1	1,33	2
	Performance regulation of utility by RWB	2	1	2	1	1	1	1,33	6
	Reporting for upward accountability at regional level by RWB	2	1	2	1	1	1	1,33	3
	Reporting for downward accountability at regional level by RWB	2	1	2	1	0	0	1,00	2
PI&BM data	Strategic (business) planning by Utility	1	0	0	0	2	0	0,50	1
	Regional strategic planning by RWB	1	0	0	0	2	0	0,50	1
	Direction of RWB Technical support to utility by RWB	1	0	0	0	2	0	0,50	1
	Economic regulation (tariff approval) by RWB	1	0	0	0	2	0	0,50	1
	Policy-making by Ministry	2	0	1	1	2	0	1,00	3 (P)
	Macro-level planning by Ministry	1	0	0	0	2	0	0,50	1
	National level regulation by Federation	1	0	0	0	2	0	0,50	3
	Reporting for upward and sideways accountability at national level by Ministry	1	0	0	0	2	0	0,50	1
NWI	Reporting for downward accountability by Ministry	1	0	0	0	2	0	0,50	1
	Strategic (business) planning by Utility	1	0	0	1	0	0	0,33	1
	Regional strategic planning by RWB	1	0	0	1	0	0	0,33	1
	Direction of RWB Technical support to utility by RWB	1	0	0	1	0	0	0,33	1
	Economic regulation (tariff approval) by RWB	1	0	0	1	0	0	0,33	1
	Policy-making by Ministry	2	0	1	1	1	0	0,83	3 (P)
	Macro-level planning by Ministry	1	0	0	1	1	0	0,50	1
	National level regulation by Federation	1	0	0	1	1	0	0,50	1
	Reporting for upward and sideways accountability at national level by Ministry	1	0	0	1	1	0	0,50	1
national coverage data	Reporting for downward accountability by Ministry	1	0	0	1	1	0	0,50	1
	Regional strategic planning by RWB	2	1	2	2	1	1	1,50	6
	Setting national standards by Ministry	2	1	2	2	1	1	1,50	4
	Macro-level planning by Ministry	2	1	2	2	1	1	1,50	5
	Reporting for upward and sideways accountability at national level by Ministry	2	1	2	2	1	1	1,50	4
	Reporting for downward accountability by Ministry	2	1	2	2	0	0	1,17	2
JMP data	Setting national standards by Ministry	1	1	1	2	2	1	1,33	3 (P)
	Macro-level planning by Ministry	1	1	1	2	2	1	1,33	2
	Reporting for upward and sideways accountability at national level by Ministry	1	1	1	2	2	1	1,33	2,5
	Reporting for downward accountability by Ministry	1	1	1	2	2	0	1,17	2,5

Level: Local; Sub-national; National; Rating of data attributes: 0=low; 1=moderate; 2=high

Rating of data use: 0= Data are not available to potential users; 1= Data are available to the decision maker(s) / duty bearer; 2 = Decision makers / duty bearers have engaged with and understand the data; 3 = Decision makers refer to, but does not use data /Duty bearers reports data, but rights holder does not hold duty bearer accountable/process use; 4 = Low use: Decision makers have made use of data for informing decisions, but these decisions are mainly informed by other factors than the data /Rights holders have hardly used data for holding the duty bearer accountable; 5 = Moderate use: Decision makers have made use of data for informing decisions, but these decisions have to some degree been informed by other factors than the data /Rights holders have used data for holding the duty bearer accountable to a moderate degree; 6 = High use: Decision makers have made use of data for informing decisions, mainly depending on the data for informing their decision / Rights holders have used data for holding the duty bearer accountable to a high degree; (P) = Process use

In both Jinka and Wukro, the degree of actual use of data informing regulatory decisions by the Water Boards was very low, as presented in Chapter 5. However, as presented in this chapter, reported data were relevant, credible, comprehensive, timely and accessible enough to be used.

The lack of actual regulatory use of the Utility MIS data by the Water Board can therefore not be explained by the data characteristics. Factors other than the data characteristics played a role in hampering the use of data for regulation at Water Board level. Water Boards were found to have high staff turnover and low capacity to interpret and act on the data. Furthermore, they see their role mainly as approving budgets and procurement and therefore have little interest in performance data. These factors are explored in more detail in Chapter 9.

Lack of use of utility performance data use for policy-making and macro-level planning aligns with the low credibility and accessibility of these data in suitable formats. The NWI and PI&BM data were relevant for informing setting of GTP2 standards and targets related to macro-level plans. Timing of data becoming available aligned more or less to these decision-making processes. The fact that the data by that time was a couple of years old would not have prevented the data from being used for informing policy-making, as policy-making does not require very up-to-date data. Poor data accuracy would also not necessarily have prevented the use of these data for informing policy decisions, like the development of new norms and standards as part of the second GTP in 2015, which could be informed by more indicative, rather than highly accurate data. However, these data were not perceived as credible by national-level decision makers. Furthermore, although raw data were available, these had not or hardly been processed into usable information (products). The low credibility and availability of NWI and PI&BM data in accessible formats were therefore likely to have contributed to the lack of use of these data for informing policy-making and macro-level planning. However, if these data were considered essential for informing these processes, one would expect that data would be sufficiently cleaned and processed into usable information in order to be used. This is explored in more detail in subsequent chapters.

Lack of use of NWI and PI&BM utility performance data at sub-national and local levels aligns with low credibility, timeliness and accessibility of these data at these levels. Low accessibility of the NWI and PI&BM data were likely to have hampered the use of utility performance data at sub-national and local level. However, even where these data were (physically) available, there was no use of these data. Despite a large-scale roll out of training and hardware supplies at sub-national level, making NWI1 data more accessible at that level, a survey of 24 regional, zonal and woreda offices in 2015 found that all had knowledge of the WASH M&E MIS database, and had received training, but none reported using the MIS (Coffey/ IRC, 2015). This shows that although lack of accessibility to M&E MIS data at sub-national level may have been a factor hampering its use at that level, improved accessibility to the data at sub-national level did not ensure use of data at this level. So low physical accessibility did not hinder utility performance data use at this level. Timeliness and credibility of the data may have hampered actual data use as well. Beyond the attributes of the NWI and PI&BM data, the availability of more timely and credible sources of information on comparative utility performance available in Tigray from TUMS, and in most utilities on their own performance, may have played a role in the low use of the NWI and PI&BM data.

The low use of utility performance data, or lack thereof, for reporting for accountability aligns with the low credibility, timeliness and availability in accessible formats of the NWI and PI&BM data, but not with the relatively strong attributes of the performance data produced by utilities. Although utility performance data were used by utilities to report to their Water Boards and Regional Water Bureaus, actual use of these data by the rights holders (Water Board and Regional Water Bureau) for holding utilities accountable for provided services was low, despite the relatively high relevance, credibility, comprehensiveness, timeliness and accessibility. Factors beyond the data attributes are likely to have hampered actual data use in these cases.

Utility-level performance data were not physically accessible nor available in accessible formats to water users. This prevented them from keeping utilities (downward) accountable for provided services and performance. The low accessibility and lack of data in accessible formats is likely to have played a role in disabling this use of data.

7.4.4 Coverage data attributes and use

The lack of use of JMP data and the low to moderate use of the Ministry's coverage data in policy-making and macro-level planning does not align with the high relevance, credibility, accessibility, comprehensiveness and timeliness of the data. Rather than JMP data, the Ministry's coverage data have mainly been used to inform national-level decision-making processes. Although the Ministry's coverage data were relevant for informing policy decision-making, actual use of these data for informing policy decision, like the development of new norms and standards as part of the second GTP in 2015, was assessed as low in Chapter 6. As policy-making required indicative, rather than highly accurate data, the data accuracy challenges would not have hampered this use. The relatively low use of the Ministry's coverage data in policy-making, could thus not be fully explained by the data attributes.

7.5 Summing-up the linear perspective

This chapter has described the characteristics and attributes of different data sets produced in the town water supply sector in Ethiopia, and rated the attributes of these data in relation to the different data use cases. It found credibility and availability of data in accessible formats as lowest rating attributes.

The chapter has also explored the factors that shape data attributes. It found that data attributes are shaped by data characteristics, which were in turn shaped by the components of the monitoring system, in turn shaped by different stakeholders and their interests, motivations, capacities etc. Data attributes were also found to be shaped by various other factors, including relationships between data producers and users, and by each other.

Finally, this chapter has compared data attribute ratings as assessed in this chapter, with the degree of actual data use, as assessed in Chapter 6. It found that cases with actual data use involved data with all attributes rated at least moderate. However, data attributes could not explain the moderate and low degree of data use in these cases. Data attributes could also not explain lack of actual data use, in data use cases with (at least moderately) strong data attributes. In these cases, lack of data use could only be explained by availability of alternative

information or by limiting factors other than data attributes. These included:

- Moderate actual use of:
 - National coverage data by Ministry for planning
 - Utility operational data by Utility for operational decision-making
 - TUMS data by RWB for Planning
- Low actual use of:
 - National coverage data by Ministry for policy-making and reporting for upward accountability
 - TUMS data by RWB for operational decision-making
 - Operational data by Water Board for operational decision-making
 - Data from different data sets for tariff setting
- Reference use only of data for reporting for upward accountability
- No use of:
 - Utility performance data by Water Board for operational and regulatory decision-making
 - JMP data by Ministry for planning
 - TUMS data by RWB for tariff approval
 - Utility performance data by RWB

To understand the reasons for moderate, low or lack of data use in these cases, there is a need to look beyond the data attributes.

The chapter also found data use cases in which lack of data use could be explained by the data attributes. In the case of data use for reporting for downward accountability, availability of data in accessible formats was found to be a possible disabling factor. Also, the weak data attributes of the NWI and PI&BM are likely to have played a role in lack of use of these data. As shown in this chapter, these data attributes were shaped and influenced by each other and a host of other factors.

This chapter has demonstrated that (at least) moderately relevant, credible, comprehensive, timely and accessible data are an essential condition for data use, but that having such data in place is not a guarantee for their actual use.

7.6 Way forward

This chapter has demonstrated that data attributes can play a role in explaining actual data use or lack thereof, but it cannot fully explain actual data use in all data use cases. The chapters that follow continue the exploration into the factors that enable and hamper actual data use. Chapter 8 takes a relationship perspective, focused on the role of relationships between data producers and users in explaining actual data use. Chapter 9 takes a behaviour systems model perspective, focusing on the role of capacities, motivations, and organisational, institutional, and contextual opportunities for use of data.

This chapter also showed that data attributes are influenced by each other and by various other factors. These factors do not exist in isolation, but form a complex network of factors influencing actual data use, either directly or by influencing each other. This is explored in more detail in Chapter 10, the comprehensive systems perspective.

8 RELATIONSHIP PERSPECTIVE

8.1 Introduction

Chapter 7 started the exploration into the factors that enable or hamper data use in decision-making and accountability in town water supply in Ethiopia. It focused on how data attributes influenced the degree of actual data use. It found that having reliable, credible, timely, comprehensive and accessible data is indeed a pre-condition for data use, but that actual data use, or lack thereof, could not be fully explained by data attributes alone. This chapter continues exploring the third research question of this thesis: *'What factors enable or hamper actual use of monitoring data?'*

While Chapter 7 looked at this from a linear perspective, this chapter takes a relationship perspective, focused on how the quality of relationships between data producers and users enables or hampers actual data use. It does so by addressing the following sub-questions, introduced in Chapter 3:

- What is the quality of relationships between data producers and users in different data use cases, based on their structural, relational, and cognitive social capital?
- Does the quality of relationships between data producers and users influence actual use of monitoring data?

In Chapter 5, a total of 20 overall data use cases in Ethiopian town water supply were identified, including seven accountability and thirteen decision data use cases, involving policy-making, planning, tariff setting, operations and regulation. Chapter 6 described and analysed the level of actual use of different data sets in these data use cases.

To explore whether relationships between data producers and users influence the degree of actual data use, this chapter focuses on six decision cases, informed by different data sets. These six decision cases were selected as they each include a network of actors involved in data production and use, with varying levels of actor network complexity. Together, they cover the three institutional levels. An overview of these cases, the data sets involved and their degree of actual data use, is presented in Table 8-1.

Data attributes from the linear perspective managed to explain the degree of actual data use in some, but not all of these data use cases, as shown in Table 8-1. This chapter looks at these cases through a relationship lens, providing additional insights and deeper understanding into the factors that enable and hamper actual data use.

Section 8.2 introduces the above-mentioned decision cases in more detail, describing the social networks involved. Section 8.3 presents an assessment of the quality of the relationships between data producers and users, and other relevant actors in the networks, based on their structural, relational and cognitive social capital vis-à-vis each other. Section 8.4 brings this assessment of the quality of the relationships together with the actual use of data, providing insight into whether the quality of these relationships can explain the degree of data use. The chapter concludes with a summing up of insights from the relationship perspective in Section 8.5 and the way forward in Section 8.6.

Table 8-1: Overview of decision cases

Data use case		Degree of data use	Explained by linear perspective
Decision case	Data set used		
1. Operational decisions and corrective measures by Utility	Asset data	0	Yes
	Operational utility data	5	Yes
2. Performance regulation of utility by Water Board	Utility performance data	3	No
3. Strategic (business) planning by Utility	Asset data	4.5	Yes
	Utility operational data	4.5	No
	Utility performance data	4.5	No
	TUMS data	3 (P)	No
	PI&BM data	1	Yes
	NWI data	1	Yes
4. Economic regulation (tariff approval) by the Regional Water Bureau	Utility performance data	2	No
	TUMS data	2	No
	PI&BM data	1	Yes
	NWI data	1	Yes
5a. Macro-level planning for asset development by Ministry	National coverage data	5	Yes
	JMP Coverage data	2	No
5b: Macro-level planning for utility performance strengthening by Ministry	PI&BM data	1	Yes
	NWI utility performance data	1	Yes

Level: Local; Sub-national; National; **Rating of data use:** 0= Data are not available to potential users ; 1= Data are available to the decision maker(s) / duty bearer; 2 = Decision makers / duty bearers have engaged with and understand the data; 3 = Decision makers refer to, but does not use data /Duty bearers reports data, but rights holder does not hold duty bearer accountable/process use; 4 = Low use: Decision makers have made use of data for informing decisions, but these decisions are mainly informed by other factors than the data /Rights holders have hardly used data for holding the duty bearer accountable; 5 = Moderate use: Decision makers have made use of data for informing decisions, but these decisions have to some degree been informed by other factors than the data /Rights holders have used data for holding the duty bearer accountable to a moderate degree; P=Process use (decision informed by monitoring process rather than by monitoring data)

8.2 Social networks in decision cases

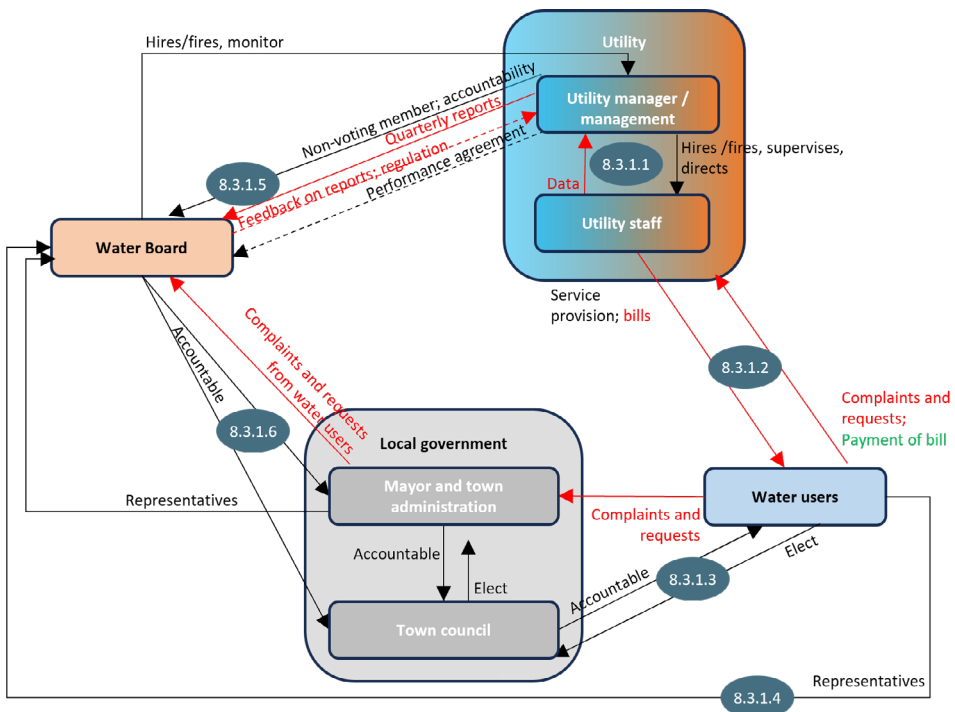
This section introduces the social networks involved in the decision cases discussed in this chapter. The social network involved in each decision case is visualised as a sociogram, with nodes representing actors, and edges representing relationships between the nodes. Data producers are indicated in blue, decision makers in dark brown, actors influencing the decision in light brown, and inactive actors in the network in grey. The sociograms show social connections between actors in black, data and information flows in red and financial flows in green. Actual connections and flows between stakeholders are indicated with solid lines, while theoretical connections and flows that were not actually observed, are indicated with dotted lines. The black ovals indicate the sections in this chapter in which the specific relationships between the actors are discussed.

8.2.1 Case 1: Operational decision-making by the utility

As described in Chapter 5, asset and operational utility data have the potential to inform operational decision-making by utility staff and management. Chapter 6 showed no actual use of asset data and rated the actual degree of use of operational data as moderate. Chapter 7 demonstrated that decisions were not only informed by the data attributes, but also by other factors.

Figure 8-1 presents the sociogram of the actor network involved in operational decision-making by the utility. Utility managers and staff rely on internally produced data for operational decisions. Managers compile operational data from department heads to inform operational (and strategic) decisions. Utility staff and managers serve as both data producers and users. However, Chapter 6 indicated that, in addition to operational utility data, citizens can influence decisions by providing complementary or competing information, e.g. in the form of complaints or requests. They can provide this information either directly, communicating with utility staff or management, or indirectly, communicating with members of the town administration, represented in the Water Board, which oversees operation by the utility.

Figure 8-1: Social network sociogram case 1



Source: Author

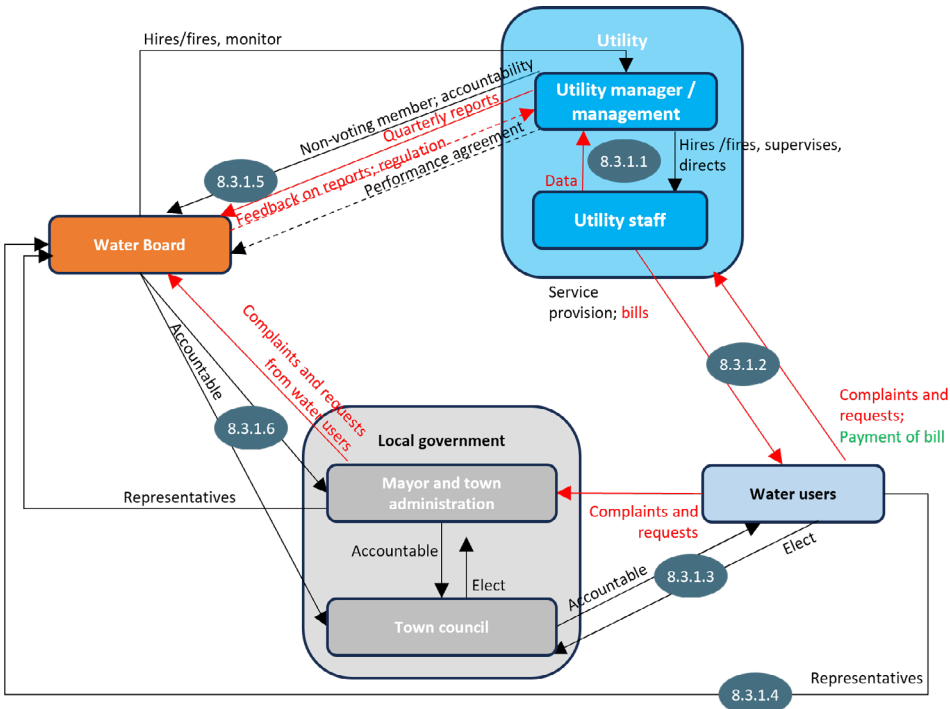
The main relationship between data producers and users of interest in this network is the relationship between utility staff as data producers and utility management as data users (Section 8.3.1.1). In addition, the relationship between water users as producers of complementary or competing information and the utility both directly (Section 8.3.1.2) and indirectly, through local government (Section 8.3.1.3) and Water Board (Section 8.3.1.4, Section 8.3.1.5, and Section 8.3.1.6), is also of interest.

8.2.2 Case 2: Regulatory decision-making by Water Board

As described in Chapter 5, utility performance data produced by the utility has the potential to inform operational and regulatory decision-making by Water Boards. However, as shown in Chapter 6, the actual level of use of these data was very low.

As shown in Figure 8-2, the sociogram for this decision-making process is similar to that of case 1, with the difference that the decision maker in this case is the Water Board and the data producer is the utility.

Figure 8-2: Social network sociogram case 2



Source: Author

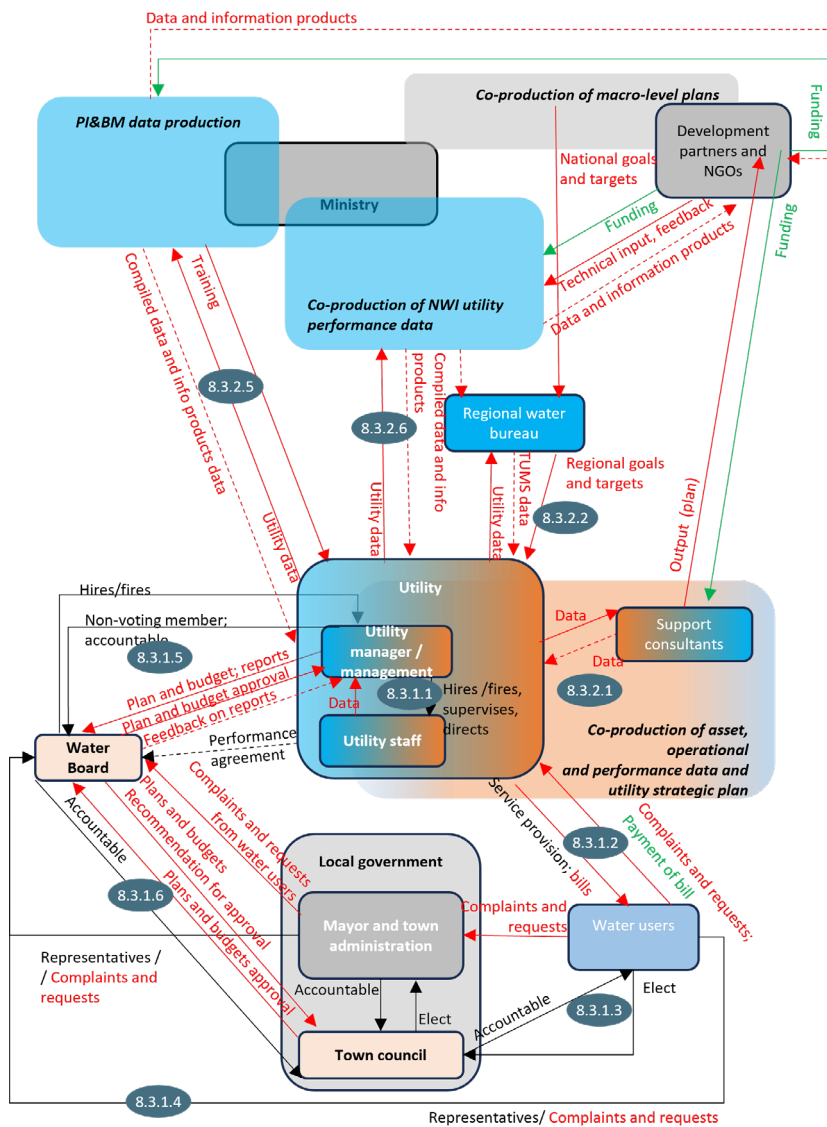
The main relationship of interest in this network is the one between the utility, as data producer, and the Water Board, as potential data user (Section 8.3.1.5). However, as in case 1, water users can be considered an alternative source of information, which they can share directly with the Water Board (Section 8.3.1.4) through water user representatives, or indirectly, through the town administration (Section 8.3.1.3 and Section 8.3.1.6). The relationship between the Water Board and local government (Section 8.3.1.6) can also influence data use by the Water Board.

8.2.3 Case 3: Local level strategic (business) planning

As described in Chapter 5, utility MIS, PI&BM, NWI and TUMS utility performance data and utility operational and asset data have the potential to inform strategic planning by utilities.

However, as shown in Chapter 6, the degree of actual use of operational utility data is rated as low to moderate, and that of performance data as low, with no use of PI&BM and NWI data, and process use of TUMS data, in informing strategic planning. Chapter 7 indicated the lack of use of PI&BM, NWI and TUMS data and the low use of asset data could be explained by the data attributes, but could not explain the relatively low degree of use of utility operational and performance data, despite the high rated data attributes.

Figure 8-3: Social network sociogram case 3



Source: Author

As illustrated in the sociogram in Figure 8-3, utility strategic (e.g. business) plans are in principle co-developed by utility management and staff, often with support from consultants, funded either by a development partner, or by the utility itself. Data informing strategic planning are mainly sourced from the utility itself. Utility performance data produced by the TUMS, PI&BM, and national M&E MIS also have the potential to inform these processes. However, although these systems depend on data from utilities, intended information flows back to utilities are generally lacking. In addition, the national goals and targets set by the Ministry, and the goals and targets set subsequently by the Regional Water Bureau inform the goals, targets and reporting requirements for utilities. Taking these goals and targets into account, the utility, where relevant in collaboration with a consultant, develops strategic plans and budgets, which it submits to its Water Board. The Water Board provides feedback and submits the final plans and budgets to the town council with recommendations for approval.

The main relationships of interest in this case are the relationship between utility management and staff (Section 8.3.1.1), and where relevant between utility and consultants (Section 8.3.2.1). In addition, the PI&BM and NWI co-producers and Regional Water Bureau can be considered potential data producers. Therefore, their relationship with the utility (Section 8.3.2.5; Section 8.3.2.6, and Section 8.3.2.2 respectively) is explored as well. Furthermore, the relationship between the Ministry and the Regional Water Bureau (Section 8.3.2.4), as producer of additional information and the utility as decision maker, is also likely to play a role.

8.2.4 Case 4: Economic regulation

As described in Chapter 5, different data sets have the potential to inform economic regulation in terms of tariff approval by the Regional Water Bureau and Water Board. Chapter 6 showed that the Regional Water Bureaus often reject these data and do not use them in this decision-making process.

According to the 1999 Ethiopian Government Water Management Policy, urban tariff structures should be site-specific, based on full cost recovery, with progressive tariff rates tied to consumption rates and flat rate tariffs for public stand posts. National guidelines state that based on an analysis of cost level and structure as well as performance and efficiency of the utility, proposed new tariffs would need to be checked by the Water Boards, in consultation with the Regional Water Bureau, and submitted to the town council for approval (Ministry of Water and Energy, 2013f). The SNNPR regulation 160/2018 states that utilities are to undertake tariff studies, which should be presented by the Water Board to the Town Council for approval. The Tigray proclamation 257/2014 states that both the town council and the Regional Water Bureau need to approve a new tariff. Water Board, town councils and Regional Water Bureaus are thus the decision makers in the tariff approval processes, as illustrated in the sociogram in Figure 8-4.

Tariff studies by utilities are supposed to be informed by asset and operational data. Sometimes additional sources of information can play a role, like in Wukro, where a willingness to pay study (pers. comm. Behalu, 2018) and a study into equitable urban water security (Grasham et al., 2022) both concluded that the tariffs could, and should be increased to ensure financial sustainability of the utility, without considerable anticipated affordability issues. However, the

The main relationship of interest in this case is that between the utility as data producer and the Regional Water Bureau (Section 8.3.2.2) and town council (Section 8.3.1.5 and Section 8.3.1.6) as data users. As researchers were identified as an additional source of information, their relationship with decision makers is also considered (Section 8.3.2.7). Furthermore, water users can play a role in providing complementary or contradicting information informing the tariff setting decisions through their demands for affordable tariffs and high-quality services. The relationship between water users and local government (Section 8.3.1.3), which in turn has a relationship with regional government (Section 8.3.2.3), which in turn has an accountability relationship with the main decision maker, the Regional Water Bureau, can also play a role in shaping data use in this decision case.

8.2.5 Case 5a: Macro-level planning for asset development

As described in Chapter 5, JMP and the Ministry's coverage data have the potential to inform macro-level planning by the Ministry. Chapter 6 rated degree of actual use of the Ministry's coverage data in informing macro-level planning as moderate, while there was no use of JMP data.

As illustrated in the sociogram in Figure 8-5, the Ministry is the main decision maker in this case. However, the Ministry can, and often does, delegate this task to consultants and involves a variety of stakeholders, including development partners and NGOs, through task forces and consultations, making these actors de facto co-producers of the plans.

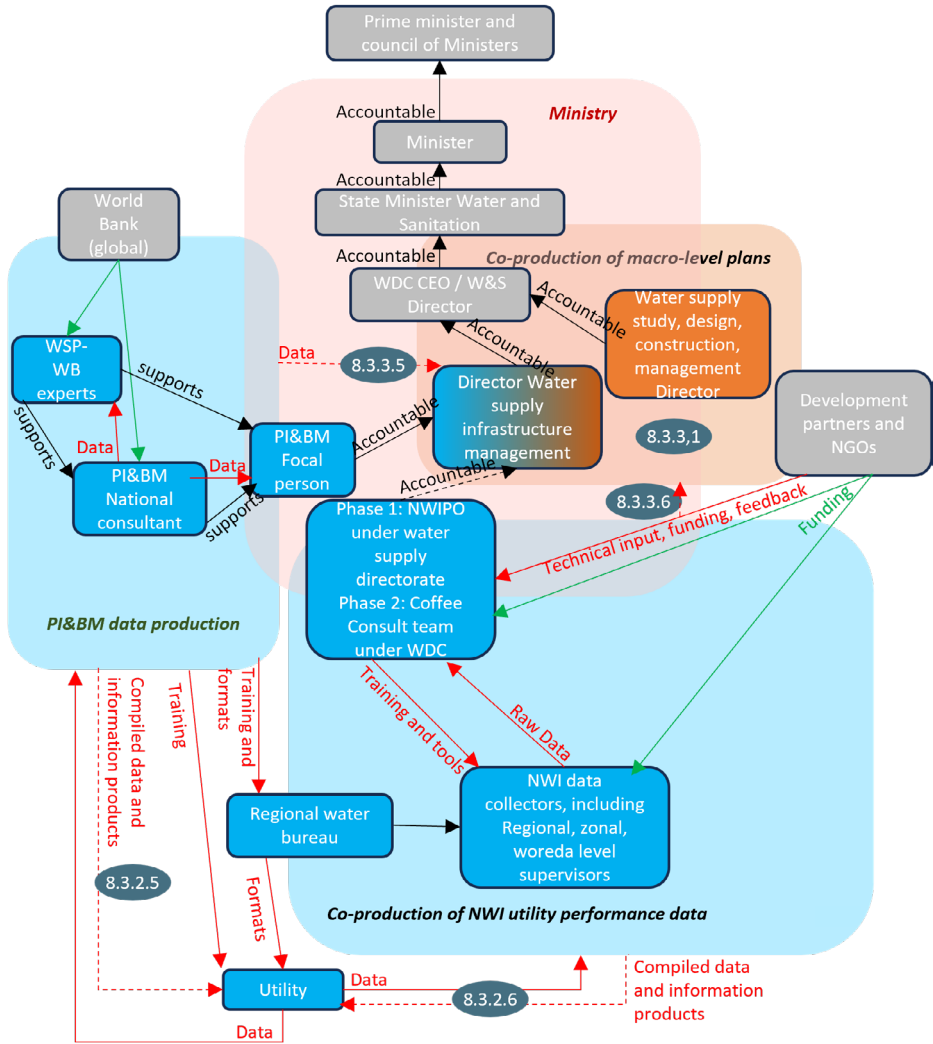
Involvement of a wide group of actors has especially been the case in the development of the OWNPN plans, but less so in the development of the GTPs and the Ministry's ten-year strategy. UAP baseline and targets have been informed by pre-NWI1 coverage data, and GTP1 and OWNPN phase I baseline and targets by NWI1-adjusted coverage data. GTP2 and OWNPN phase II baseline and targets have been informed by coverage data, adjusted to the higher GTP2 standards. The ten-year Ministry strategy includes a baseline and target set based on the NWI2-adjusted coverage data.

National coverage data have been mainly co-produced by the Ministry and its national consultants, based on coverage data produced by the Regional Water Bureaus and coverage data produced through the NWIs.

The main relationships of interest in this case are those between the co-producers of the macro-level plans as decision makers (Section 8.3.3.1), as well as those with producers of JMP (Section 8.3.3.4) and national coverage data co-producers (Section 8.3.3.2 and Section 8.3.3.3).

The sociogram in Figure 8-6 shows that the actors involved in the decision network are similar to the ones in case 5a, with the PI&BM system replacing the JMP system and with a focus on utility performance, rather than coverage data.

Figure 8-6: Social network sociogram case 5b



Source: Author

The main relationship of interest in this case is that between the co-producers of the macro-level plans as decision makers on the one hand and producers of PI&BM data (Section 8.3.3.5) and co-producers of NWI utility performance data (Section 8.3.3.6) on the other. Like case 5a, this includes the relationship between data co-producers (Section 8.3.3.1).

8.2.7 Summing up actor networks

The actor networks involved in the decision cases presented above, differ in size and shape. Table 8-2 presents an overview of the data producers and users involved in these networks. Local-level decision-making networks involved in operational decision-making and regulatory decisions by the Water Boards were high-density networks, with many actors often having (reciprocal) relationships. In the tariff approval and local planning case studies, the utility acted as a bridge between stakeholders at different levels.

Table 8-2: Summary of decision makers and data producers

Decision case	Data producer(s)	Data user(s)	Other actors
1. Operational decisions and corrective measures by Utility	Main: Utility staff and management Alternative: Water users	Main: Utility staff and management Additional: Water Board	Mayor and town administration; Town council
2. Performance regulation of utility by Water Board	Main: Utility staff and management Alternative: Water users	Main: Water Board	Mayor and town administration; Town council
3. Strategic (business) planning by Utility	Main: Utility staff and management Possible co-producer: Consultants Additional: NWI co-producers; PI&BM co-producers; Regional Water Bureau; water users	Main: Utility staff and management Possible co-producer: Consultants Additional: Water Board, Town Council	Mayor and town administration
4. Economic regulation (tariff approval) by the Regional Water Bureau	Main: Utility staff and management Additional: NWI co-producers; PI&BM co-producers; Regional Water Bureau; researchers	Main: Regional Water Bureau, Water Board, Town Council	Water users; Development partners
5a. Macro-level planning for asset development by Ministry	Main: Co-producers of Ministry coverage data Additional: JMP; Household survey data	Main: Co-producers, including Ministry, consultants, sector stakeholders	Development partners; Parliament; National WASH Coordination Office; Minister; State Minister; Prime Minister and Cabinet; OWNPs Steering committee
5b. Macro-level planning for utility performance strengthening by Ministry	Main: Co-producers of PI&BM data; co-producers of NWI data; Utilities producing source data	Main: Co-producers, including Director Water Infrastructure Management, Development partners, Ministry staff	Development partners; Minister; State Minister; Prime Minister and Cabinet

8.3 Quality of relationships

This section assesses the social capital of the different actors related to each other in the social networks of the decision cases. Quality of relationships are assessed in terms of the structural, relational and cognitive social capital of the actors in the bilateral relationship. As set out in Chapter 3, the thesis rates structural, relational and cognitive social capital between actors as low, moderate or high based on findings from grey literature, observations and interviews. The quality of the relationship between actors is rated as low if there is low structural, relational and cognitive social capital, high if there is high structural, relational and cognitive social capital, and moderate if the structural, relational and cognitive social capital have mixed ratings (not all high, not all low). Quality of relationships between local level actors are discussed in Section 8.3.1, between actors at different institutional levels in Section 8.3.2, and between actors at national level in Section 8.3.3. Section 8.3.4 presents an overview of the rating of quality of relationships between data users and producers.

8.3.1 Relationships between local actors

8.3.1.1 Utility staff and management

The quality of relationship between utility staff and management is expected to play a role in case 1, in which both utility staff and management act as producers and users of operational utility data for informing operational decisions. Furthermore, it is expected to play a role in local planning (case 3).

Structural social capital: There are clear formal social relations between the utility manager and staff, with the manager having the power to hire and fire staff and supervising and directing decisions made by staff. Flows between the two include the submission of data produced by staff to utility management on a frequent basis. Interactions between utility management and staff occur on a regular basis with daily interactions and weekly and monthly meetings. In terms of accountability relationships, utility staff can be considered as the duty bearer, accountable to utility management as the rights holder. In some cases, utility management tries to incentivise performance of staff through reward systems. In Wukro, for example, the utility manager decided to reward good performance of staff members. He mentioned *'The staff complained: "whether we do good or bad, we are never appreciated [...]. We don't see the system rewarding us."* Monetary rewards were given to the two best performing staff members (700 birr for the best and 600 birr for the second), while other high scoring staff received an appreciation certificate. Staff motivation and performance were reported to have improved as a result of this.

Relational social capital: In general, there seems to be a relatively high level of trust between utility staff and management (though this was difficult to verify objectively).

Cognitive social capital: Generally, utility staff and management share the same values, goals and language, with a general aim of providing good water services to people by undertaking specific assigned roles and responsibilities.

Quality of relationship: As utility managers have a relatively high level of structural, relational and cognitive social capital in relation to utility staff, and vice versa, the quality of their relationship is rated as high.

8.3.1.2 Water users and utility

The utility can be considered as duty bearers in their relationship with water users as rights holders. Utilities provide services, for which they bill water users, who pay accordingly. Water users can also act as providers of information in the form of complaints and requests (case 1, 2 3, and 4).

Structural social capital: Utility staff are responsible for providing water services to water users, with water users paying for these services, based on bills provided by the utility. Water users with a household connection have a formal relation with the utility, while water users using public standpipes do not. The water supply scheme in Wukro was characterised by a relatively high proportion (97% (Grasham et al., (2022)) of households with household connections. In Jinka, some 40% of households have household connections. The remaining 60% rely on relationships with neighbours, public tap attendants or vendors for their water supply. However, households with household connections generally do not rely on the utility as the only source of water supply, but complement water supply from the utility with rainwater and water from vendors (Grasham et al., 2022).

Interactions between water users and utility staff generally occur on a monthly basis, in connection with monthly water meter reading and revenue collection. Water users were also found to have frequent (informal) personal interactions with operational utility staff, as they are performing operational duties in different parts of the water scheme. In Wukro and Jinka, the utilities have (written and phone-based) complaint-procedures in place. Water users often also express grievances about water quality, quantity and reliability known through informal interactions with utility staff or management. The Wukro Utility Manager reported to be in frequent personal contact with water users, as he goes around town to talk to water users on most days after leaving this office (pers. comm. Behalu, 2018).

Relational social capital: A sample of 99 households as part of the 2020 ONEWASH Plus Programme endline survey in Wukro found that 28% of households were not satisfied with the financial management by the utility (Adank et al., 2019b), which this thesis assumes to be an indication of lack of trust by households in the utility. A sample of almost 9,000 households from SNNPR, including Jinka, found that the level of satisfaction of water users with the services of the town water utilities was low, especially on issues related to understanding customers (scoring 2.6 out of 5), responsiveness (scoring 2.8 out of 5), and communication of the town water utilities to the water users (scoring 2.9 out of 5) (Kassa et al., 2017).

Utility customers feel they do not have mechanisms for holding utilities accountable. As expressed by a customer to the Wukro utility manager: *'If we pass the deadline to pay, you penalise us. How would you be penalised if you don't supply water?'* (pers. comm. Behalu, 2018).

Citizens in Ethiopia have for long been relatively passive in demanding services and holding service providers and politicians accountable. However, since the social unrest pre-2018, this seems to be changing. It is questionable whether the culture of the utility has changed with this as well. As mentioned by the Wukro utility manager *'The season has empowered people. [] They know everything through Facebook, social media etc. [...] A government is a service provider. People with power are supposed to have servitude mentality. They are supposed to serve the people. It is the season of people starting to ask questions, following social media, education etc. People are*

so empowered, they are asking for their rights. [...] But the staff still have the old mentality. This is a problem for me.' (pers. comm. Behalu, 2018). The lack of trust and the absence of a reciprocal relation between the utility and its customers also contribute to low trust between them.

Cognitive social capital: The goal of the utility is to provide effective and efficient water service provision to all. This may contradict goals of individual water users, who mainly have the goal to optimise water service provision to their own household.

Quality of relationship: The amount of structural social capital that the utility has with clients (and vice versa) depends to largely on their contractual relationship. While utilities and their customers have relatively strong structural social capital vis-à-vis each other, their relational and cognitive social capital are considerably lower. The quality of the relationship between utilities and their customers is therefore rated as moderate.

8.3.1.3 Water users and local government

In general, local government can be considered as the 'long route' duty bearers in their relationship with water users as rights holders. As such, although citizens and local government do not play a direct role as data producers or decision makers in the discussed decision cases, their relationship is part of the social networks related to decision case 1, 2, and 4.

Structural social capital: In principle, citizens elect members of the town council, which can consist of 120-300 members. This council is supposed to elect a mayor from amongst its members in accordance with regional proclamations. The mayor is accountable to both the elected council and the regional state president (Fiseha, 2020). However, in reality, mayors (and sectoral local government office heads) tend to be political appointees, selected based on political and party seniority, rather than management experience, and the regional state has the power to dissolve local government (Fiseha, 2020). The vertical structural links between mayor and regional level are therefore stronger than the horizontal links between the mayor and the elected town council. Interactions between water users and town administration are often informal and typically consist of complaints by water users about the utility. According to the Wukro utility manager, water users increasingly approached the mayor of the town with complaints about water supply, as he is the chair of the Water Board. He believed political change in the country at the time (2018) and the influence of social media had recently empowered water users to approach the political leadership of the town with their grievances (pers. comm. Behalu, 2018).

Relational social capital: The level of trust of the general public in local government is not high. Afro-barometer data from 2400 interviewed people in Ethiopia showed that only about half (50.8%) of people trust their elected local government. Furthermore, about 87% of people considered at least some local government representatives, and 89% at least some civil servants to be corrupt (Afrobarometer, 2023). Fiseha (2020) noted that although detailed reports on the state of corruption at municipal level were not easy to find, he found that citizens interviewed in Tigray generally indicated corruption at local government level as a major problem. Tesfamariam Berhe (2020) found that 83% of purposefully sampled representatives from government offices in the Tigray town Adegrad reported rent seeking behaviour by the public sector and 80% reported rent seeking by the public seeking to influence the public sector.

Cognitive social capital: The goals and perceptions of local government and citizens are quite aligned, since local government's goal is to keep constituents satisfied.

Quality of relationship: Based on the moderate structural, low relational and moderate to high cognitive social capital between water users and local government the quality of their relationship is rated as moderate.

8.3.1.4 Water users and Water Boards

Water Boards are the main decision maker in decision case 2 and 4 and play a role in decision-making in case 1 and 3. Although water users do not play a direct role as data producer in these cases, they do have a relationship with Water Boards, which gives them a long-route accountability relationship with the utility, similar to the one described above through local government.

Structural and relational social capital: Besides being represented by two persons, water users do not have strong structural relations with the Water Board. Although (informal) interactions between water users and board members (especially the mayor, in the role of the Water Board chair) occur, there are no formal interactions or flows between the Water Board (as a unit) and water users.

Cognitive social capital: Goals and perceptions of Water Boards and water users are not necessarily fully aligned.

Quality of relationship: Based on the low level of structural and relational social capital between water users and Water Boards, the quality of their relationship is rated as low.

8.3.1.5 Utility manager and Water Board

Utility managers can be considered data producers in almost all decision cases discussed in this Chapter, with a direct role in the production of data involved in case 1,2,3 and 4, and as producer of the source data for the data related to case 5b. Water Boards are the primary decision maker in case 2 and 4 and a secondary decision maker in case 3.

Structural social capital: The Water Board is responsible for hiring and firing the utility manager, who is a no-voting member of the board. Although a utility is supposed to have performance contract agreements with its board, in reality these are generally not in place, as mentioned as well in Chapter 5.

Utility managers should share progress and performance reports with the Water Board on a frequent basis, as stipulated in the regional proclamation. The Tigray proclamation 257/2014 (article 11 and 14), for example, mentions that Water Boards are to meet and that utility managers are to report on a monthly basis to the Board and on a quarterly basis to the Regional Water Bureau. In reality, utility managers produced general progress reports on a monthly basis, and more elaborate reports, including utility performance data on a quarterly basis.

Due to low financial capacity of utilities, town administrations sometimes provide funding for covering utilities' operational expenditure. On the other hand, the town administration sometimes uses surplus financing resources from the utility to fund non-water supply related activities. As the town administration is strongly represented in the Water Board, which is responsible for hiring (and firing) the utility manager, it is almost impossible for the utility manager to go against this.

In Jinka, however, the town administration was reported to be unwilling to provide funding for supporting the operation of the utility. In addition to its own financial constraints, this was influenced by the national policy position that town water utilities should fully cover their

(operational) expenses from collected revenues (pers. comm. Teko Zebo, 2018). So although utilities are supposed to be autonomous units, there are often financial flows between the utility and the town administration.

Relational social capital: Utility managers mainly submit reports to meet reporting requirements, with little expectations that the Water Board would (re)act on these reports.

Cognitive social capital: The objective of the Water Board, as described in proclamations and guidelines, is primarily to support the utility to provide high quality water services on continuous basis to water users. This aligns with the main objective of utility managers. However, as the Water Board mainly consists of representatives from different local government Sector Offices, the Water Board members' level of understanding of water services performance concepts, as presented in performance reports, is not always in line with those of the utility.

Quality of relationship: The quality of the relationship between utilities and Water Boards is rated as moderate, based on the relatively high structural, moderate cognitive and low relational social capital of the Water Board and utility manager vis-à-vis each other.

8.3.1.6 Water Boards and local government

Water Boards and local government both play an intermediary role between water users as producers of alternative information and the utility as decision maker in case 1 and 2. Water Boards are the main decision maker in case 2, where local government mainly plays the role of intermediary between the Water Board as decision maker and water users as producers of (alternative) information. Water Boards and local government both play a decision-making role in case 3 and 4, as they have a role to play in approving strategic plans (case 3) and tariffs (case 4). The quality of their relationship can thus play a role in case 1,2,3, and 4.

Structural social capital: Water Boards are intended to be autonomous units, accountable to the authority that established them in accordance with regional proclamations. Like in most (but not all²³) regions, in Tigray (article 8 of proclamation 257/2014) and SNNPR, that is the town mayor, as the head of the town administration.

As mentioned above, local government also plays an informal role in conveying information from customers to the Water Board, which can complement or contradict the data from the utility. In cases 1,2 and 3, this mainly related to requests and complaints, while in case 4 (tariff approval) this mainly related to demands for affordable tariffs.

Relational social capital: Local government is represented in the Water Board, with the same actors playing dual roles (e.g. sector office head and Water Board member). Relational social capital of the two actors vis-à-vis each other is thus high.

23. In Oromia, for example, the proclamation adjustment by the Oromia National Regional State in 2005 (amended proclamation No. 78/2004) transferred accountability of the Water Board from the Mayor to the Regional Water Bureau for grade 1 and 2 towns and to the Zonal Water Office for grade 3 and 4 towns (Debela, 2017). In Amhara region, regulation No. 94/2012, article 7 states that Water Boards are to consist of members of the regional government, rather than local government institutions, in addition to two representatives from the water user community and one from the business community (and the utility manager as a non-voting member). Boards of grade 1 and 2 utilities are to be accountable to the Regional Water Bureau and boards for grade 3 to 6 utilities, are to be accountable to the town council (Ministry of Water and Energy, 2013d). The 2022 Water Board guidelines, however, suggest that this is against the decentralisation policy (Ethiopia Urban Water and Sanitation Federation and Ministry of Water and energy, 2022).

Cognitive social capital: Water Boards have an important role to play in ensuring the economic viability of the utility (Ethiopia Urban Water and Sanitation Federation and Ministry of Water and 2022; Ministry of Water and Energy, 2013d). Through its structural relationships with water users, interests of local government are likely to be shaped more and are in line with those of water users. Where the goals and objectives of the Water Board and water users do not align, this can result in low cognitive social capital of the Water Board and local government vis-à-vis each other.

This is mainly the case in case 4, with the Water Board advocating for higher tariffs to ensure economic viability of the utility and water users advocating for lower tariffs to ensure affordability. In other decision cases, the goals and objectives are relatively aligned between the Water Board and local government.

Quality of relationship: The quality of the relationship between Water Boards and local government differs among regions and among different utility categories. In the case of SNNPR and Tigray, the quality of the relationship is rated as moderate in case 4, as there is relatively high structural and relational social capital between the two, but limited cognitive social capital. In the other cases, the quality of the relationship is rated high.

8.3.2 Relationships between actors at different levels

8.3.2.1 Utility and support consultants

Utility staff and management and support consultants play a role in co-producing data and decisions related to strategic planning (case 3).

Structural social capital: A consultant supporting the development of a (strategic) plan (e.g. a multi-annual utility business plan) can either be funded by the utility itself, or, more commonly in Ethiopia, through a development partner. Structural social capital of the utility and consultants vis-à-vis each other is higher in cases in which the utility hires and funds the consultant. Furthermore, the way of working of the consultant can affect their structural social capital. Consultants can work more or less independently from the utility, with the utility mainly being the provider of raw data and the receiver of the final product (the strategic plan), or consultants can engage in a process of working closely with the utility, co-producing data and decisions for the development of the strategic plan. Time and budget constraints and pressure from development partners can negatively influence the potential for co-production of data and decisions, and hence structural social capital of the two parties vis-à-vis each other.

Relational social capital: When the consultant is hired and paid for by the utility itself, it will have a reciprocal relationship with the utility. Trust of the utility in a consultant working through a participatory process, co-producing data and information that can inform strategic decisions, will be higher than one working in isolation.

Cognitive social capital: Setting a clear commonly agreed vision with specific vision targets is often an important step in strategic planning processes. As such, the (strategic) planning process can play a role in ensuring alignment of visions and goals of the actors involved in the planning process. When the support consultant is funded by a development partner, there is a risk that the main goal of the consultant is to adhere to the expectations of the development partner, rather than those of the utility, potentially resulting in low cognitive social capital of the two vis-à-vis each other.

Quality of relationship: The quality of the relationship between the utility and support consultant can vary from low to moderate to high, depending on their structural, relational and cognitive social capital, which is influenced by the degree of co-production of data and decisions.

8.3.2.2 Utility and Regional Water Bureau

In case 3 (strategic planning), the utility is the main producer and user of data in the strategic planning process. The Regional Water Bureau, however, also plays a role in producing complementary or contradicting information, in the form of regional goals and targets and, in the case of Tigray, TUMS data. Furthermore, Regional Water Bureaus set variables and indicators on which utilities are to report, which can influence data use as well, as shown in Chapter 5. In case 4 (tariff approval), the Regional Water Bureau is the main decision maker. In this case, the utility is the main, though not only producer of data intended to inform the decision.

Structural social capital: In addition to being accountable to the Water Board as presented in Section 8.3.1.5, the utility manager is accountable to the Regional Water Bureau and is supposed to report as stipulated in the proclamation (which is the case for Wukro in Tigray region and is quarterly according to proclamation 257/2014, article 14). Roles and responsibilities of the Water Bureau are defined as part of the proclamations under which the Regional Water Bureau has been established (e.g. in Tigray, proclamation 215/2004). Regional Water Bureaus are responsible for ensuring that water services are provided in line with national and regional policies and laws, and for providing Water Boards and utilities with required technical and financial guidelines (Tigray: proclamation 215/2004). Structural social capital of the utility and Regional Water Bureau vis-à-vis each other is thus relatively high.

Relational social capital: Both interviewees from the Jinka and the Wukro Utility expressed reservations in the extent to which they perceived the Regional Water Bureau as a trustful support structure. In Jinka, requests for support towards the Regional Water Bureau had been reported to go unanswered for a considerable time (pers. comm. Teko Zebo, 2018), while in Wukro, the reluctance of the Regional Water Bureau to approve a higher tariff, suggested by the water utility, had led to a decline in the utility's trust in the Regional Water Bureau (pers. comm. Behalu, 2018). Also, although utilities report into TUMS, there was no process for feeding back TUMS data and findings to utilities. Relational social capital of utilities and Regional Water Bureaus vis-à-vis each other, in terms of trust and reciprocal relationships, is thus rated as low.

Cognitive social capital: The Regional Water Bureau determines the utility category based on a number of criteria, at least partially informed by utility performance data. As higher utility categories tend to imply higher staffing requirements and higher salaries for the utility manager, there is an incentive for the utility manager to inflate reported performance. As shown in Chapter 7, some of the scores on performance indicators reported to the Regional Water Bureau seemed suspiciously high. Similar inflation of utility performance data has been observed in other regions as well (e.g. Karat town in SNNPR). Arsano et al. (2010) similarly assessed that the incentive system from the upper tier of the government, include salary, funding and promotion opportunities, provided incentives for over-reporting progress against targets.

Utility and Regional Water Bureau staff tend to be water supply professionals, which means they generally share a 'common language'. Goals may, however, differ, with the utility focused on reporting in a way that is to the advantage of the utility, and the Regional Water

Bureau focused on stimulating utilities to perform better. Cognitive social capital of utilities and Regional Water Bureaus vis-à-vis each other is thus rated as moderate.

Quality of relationship: Taking into account the high structural social capital, but moderate cognitive social capital and relatively low relational social capital of utilities and Regional Water Bureaus vis-à-vis each other, the quality of their relationship is rated as moderate.

8.3.2.3 Local and regional government

Local and regional government do not play a direct role as producers or users of data in the studied decision cases. However, their accountability relationship which links water users as producers of alternative information and the Regional Water Bureau, could influence tariff approval decisions by the Regional Water Bureau (case 4).

Structural, relational and cognitive social capital: The town mayor is accountable to both the town council through relatively weak/thin horizontal accountability, and to the Regional State, through stronger vertical accountability. In terms of political (and party) positions, the heads of the Regional State are more senior than the mayor. They receive instructions (formal or informal through the party channel) from the Regional State. The Regional State has the power to impede and replace local decisions made by elected representatives of the people (Lemango, 2021) and even to veto decisions made at the local (town) level (Fiseha, 2020). As a result, mayors pursue the instructions of their political seniors, rather than the people's preferences (Lemango, 2021).

Quality of relationship: The quality of the relationship is rated as high.

8.3.2.4 Regional Water Bureau and the Ministry

Both the Ministry and the Regional Water Bureau act as providers of information for informing strategic planning decision-making by utilities (case 3), in terms of the standards and targets that they provide.

Structural social capital: Regional Water Bureaus do not have an accountability relationship with national government, but are rather accountable to the Regional State government and council. Proclamation 1097/2018 states that the Ministry can provide, where necessary, assistance and advice to Regional States and provide coordinated support to Regional States (Federal Democratic Republic of Ethiopia, 2018b). Interactions between the Ministry and Regional Water Bureaus happen on an ad-hoc, rather than on a structural basis. The Ministry occasionally disseminates guidelines to the Regional Water Bureaus, or provides capacity building support.

Relational social capital: There is no reciprocal relationship between the Ministry and the Regional Water Bureau in the local-level planning network. The Ministry sets national goals and targets (e.g. in the form of GTP1 and 2, and OWNPP phase I and 2) and disseminates these to the Regional Water Bureaus.

Cognitive social capital: As both Regional Water Bureau staff and the (relevant) Ministry staff tend to be water sector professionals, there are on the whole no problems related to differences in language and idioms. Goals and objectives may differ, as Regional Water Bureau staff try to optimise outcomes for their regions, while Ministry staff are more concerned with ensuring nationwide outcomes and equal distribution of resources needed to do so.

Quality of relationship: The quality of the relationship between the Ministry and Regional Water Bureaus is rated as low, based on their limited structural, relational and cognitive social capital vis-à-vis each other.

8.3.2.5 Coproducers of PI&BM data and utilities

PI&BM produced data that have the potential to inform strategic planning decisions by utilities (case 3). Utilities are the main source of data for PI&BM (case 2, 3, 4 and 5b).

Structural social capital: Several utilities have been trained in collecting and compiling source data for PI&BM, with several supplying data accordingly, as presented in Chapter 7. However, this was only done at the time of actual data collection (2013 and 2018) and thus not on a structural basis. In addition, as also discussed in Chapter 7, although compiled data have been made available online, accessible and usable compiled data and information products have not reached utilities.

Relational social capital: The lack of feedback from PI&BM to utilities has led to a lack of trust in PI&BM by utilities. Conversely, PI&BM had strong reservations about the accuracy and credibility of the data supplied by utilities, as mentioned in Chapter 7. As a result, the level of trust between PI&BM and utilities was low.

Cognitive social capital: As presented in Chapter 7, PI&BM put considerable effort into training utilities, to ensure alignment in understanding of utility performance variables and indicators. As a result, cognitive social capital of utilities and PI&BM vis-à-vis each other is rated as moderate.

Quality of relationship: The quality of the relationship between the PI&BM data producers and utilities is rated as low, based on their low structural, low relational and moderate cognitive social capital vis-à-vis each other.

8.3.2.6 Coproducers of NWI data and utilities

Like the PI&BM data, the NWI utility performance data have the potential to inform strategic planning decisions by utilities (case 3). The utility is also mainly a data source for NWI in case 2, 3, 4 and 5b). The relationship between NWI data producers and utilities is similar to the one between PI&BM and utilities.

Structural social capital: Utility asset, operational and performance data were collected by NWI data collectors from utilities on an irregular basis during the NWIs (2010-11 and 2018). However, accessible and usable compiled data and information products have not reached utilities.

Relational social capital: The lack of feedback from the NWIs to utilities has led to a lack of trust in NWIs by utilities. As a result, the level of trust between NWI and utilities was low.

Cognitive social capital: Data collection was undertaken by a large group of data collectors, many of whom have no knowledge and understanding of utility operations and performance. As a result, cognitive social capital of utilities and NWI vis-à-vis each other is rated as low.

Quality of relationship: The quality of the relationship between the NWI data producers and utilities is rated as low, based on their low structural, relational and cognitive social capital vis-à-vis each other.

8.3.2.7 Researchers and tariff approval decision makers

Researchers from Mekelle University had been found to play a role in case 4 (tariff approval) as a source of information that could complement or contradict the utility data in informing decision-making related to tariff setting.

Structural social capital: Research related to water supply in Ethiopia is often paid for by development partners. This was also the case in the two pieces of research that provided information regarding tariff setting in Wukro: A willingness-to-pay study executed by Mekelle University, funded by UNICEF's (DFID-funded) ONEWASH Plus Project, and the study into equitable urban water security in Wukro, executed by the UKAID-funded REACH consortium (Grasham et al., 2022). In both cases, the utility mainly acted as a source of data and information. Information products were disseminated by the researchers to the funder, utility and Regional Water Bureau.

Relational social capital: Although trust between researchers and the Regional Water Bureau is assumed not to have been an issue (as the researchers were well-respected locally), levels of reciprocity were limited, with mainly reciprocity between the utility and researchers.

Cognitive social capital: The goals of the data producers and the decision makers were not aligned. The utility's goal in the tariff setting process was to provide data and information to seek approval for a tariff increase, to ensure cost recovery and financial sustainability. This aligned with the research results, which showed willingness to pay for higher tariffs. However, the Regional Water Bureau, which was the main decision maker deciding against the tariff increase, considered a tariff increase not to be a suitable option, as it prioritised affordability.

Quality of relationship: Based on some degree of structural, relational and cognitive social capital of the researchers and utility vis-à-vis each other, the quality of their relationship is rated as moderate. However, based on the limited structural, relational, and cognitive social capital between researchers and the Regional Water Bureau, the quality of their relationship is rated as low.

8.3.3 Relationships between actors at national level

8.3.3.1 Co-producers of macro-level plans

Co-producers of macro-level plans play the role of decision maker in case 5a.

Structural social capital: As mentioned in Chapter 4, the Ministry has gone through several restructuring processes over the year. From 2018 to 2022, staff were accountable to the WDC CEO, and since to the W&S Director. The WDC CEO/W&S Director reports to the State Minister. The State Minister reports to the Minister, who in turn is accountable to the Prime Minister and the Council of Ministers. Together with the other Ministers involved in the OWNPN (Health, Finance and Education), the Minister and State Minister are represented in the OWNPN Steering Committee. The National WASH Coordinator is accountable to the Steering Committee. The Ministry's Director of Water Study, Design, Construction and Management, who also acts as the OWNPN Project Management Unit, is involved in macro-level planning.

Ministry staff involved in macro-level planning are supported by several national and international consultants. National consultants are mostly contracted by the Ministry itself. International consultants are mostly contracted by development partners for specific assignments, e.g. development of the OWNPN phase II strategic plan. They often work in close collaboration with local consultants.

Relational social capital: Although the Ministry has undergone frequent re-organisation, many actors remained involved in the Ministry, in different positions, or as national consultants. This is likely to contribute to relatively high levels of trust between actors within the Ministry. Many

national consultants have at some point been involved in government, either in the Ministry or a Water Bureau. This also contributes to strong trust relationships. As the Ministry issues licenses to national WASH consultants (Stolz et al., 2013), there tends to be a relatively strong relationship between the Ministry and national consultants. Trust and reciprocal relationships between the Ministry and international consultants, paid by development partners, tend to be less strong.

Cognitive social capital: Most actors involved in co-production of the macro-level plans are technocrats with water and sanitation or other relevant backgrounds. The co-production process has stimulated alignment of objectives and interests between the actors.

Quality of relationship: The quality of the relationship between the co-producers of macro-level plans varied over the different macro-level planning processes. Relationships between Ministry actors and national consultants contracted by the Ministry (who have, for example, been involved in the development of the GTPs and the Ministry ten-year strategic plan) were stronger than those between the Ministry and national and international consultants contracted by development partners (who have, for example, been involved in the development of the OWNPN). Overall, the quality of the relationships of actors involved in co-production of macro-level plans is rated as moderate.

8.3.3.2 Co-producers of national coverage data

Co-producers of national coverage data play a role in case 5a. The main producers of national coverage data are a small number of Ministry staff and national consultants, who produce national coverage figures based on coverage data compiled by the Regional Water Bureau and data from NWI1 and NWI2. As such, the NWI data producers and Regional Water Bureaus can be considered co-producers of these data as well.

Structural social capital in NWI1: As described in Chapter 5, the production of National WASH MIS utility performance data was driven by a demand pull from (future) OWNPN partners, especially in the second phase of the OWNPN (and national WASH M&E MIS system development process). The design of indicators and data collection formats of the National WASH M&E MIS had mainly taken place at national level, with limited opportunities for potential data users from service authority (Water Board, town administration and Regional Water Bureaus) and service provision (utility) level to provide feedback (Butterworth et al., 2013).

As presented in Chapter 5, data collection for NWI1 (October 2010 to October 2011) was done by almost 70,000 data collectors, including teacher and health extension workers, in addition to staff of the Woreda Water Offices. Supervision to data collectors at woreda, zonal and regional level was provided by supervisors from governmental offices and DPs and NGOs active in those areas and efforts were coordinated by governmental kebele managers, woreda team leaders, and zonal and regional coordinators (National WASH Inventory Project Office, 2010b).

These efforts were coordinated by the NWI Project Office, with technical support from UNICEF and a DFID-funded ODI fellow under the RiPPLE Project (Coffey and IRC, 2015). The NWIPO was thus set up as a dedicated project office within the Ministry with considerable support from development partners, rather than a department responsible for ongoing monitoring or a project unit under a formal institutional structure. Government, NGOs and development partners thus worked closely together in the data collection process, resulting in broad ownership for the NWI data collection process. (Coffey and IRC, 2015)

In May 2011, almost a year after data collection was started, the NWIPO wrote a briefing note recommending the establishment of a team for data management and analysis (National WASH Inventory Project Office, 2011a). This shows the lack of attention to data cleaning and analysis in the original design of the NWI. A team was never established, and the data processing and analysis was mainly done by the NWIPO.

The resulting coverage data were considerably lower than coverage data previously reported by the Ministry to the government and parliament, which prompted questions and discussions between the Ministry, as the data producer, and the government and parliament, as the data users. Finally, the new coverage data were accepted by parliament and reported coverage figures were adjusted accordingly. ESS approved the household survey results for use in JMP estimates.

The Ministry (staff and national consultants) used the NWI data to produce coverage data on an annual basis (thus being both a user of the NWI data, and a producer of the Ministry's coverage data). These data were used by Ministry staff (and its consultants) to inform baselines and targets for macro-level plans. Development partners and NGOs provided input and feedback to these processes through interactions (bi-lateral or in the form of task forces, steering committee, feedback sessions etc.). These were to a large extent the same development partners who had also been involved in the co-design of the NWI process.

Structural social capital NWI2: As introduced in Chapter 5, by 2015 there was strong pressure from the OWNPN partners to conduct a second NWI, particularly from development partners and the Ministry, who were potential users of the data for informing policy-making, planning and reporting on progress under the joint OWNPN (initiated in 2013) against the new GTP2 goals and targets set in 2015. One of the OWNPN development partners, DFID was willing to fund the initiative, for which they engaged a consortium of the UK-based Coffey Consult and the then Dutch-based IRC²⁴ (with IRC leaving the programme after one year due to insurmountable differences with Coffey regarding perceptions of how the programme should be implemented). Unlike the NWIPO which had during NWI1 been accountable to the Ministry, the NWI2 consultant team was not directly accountable to the Ministry. As mentioned by the formal NWIPO head *[the consultant team] is not accountable to me. I cannot tell him what to do. This is not even accountability to the ministry. They are accountable to Coffey in England. And Coffey is accountable to DFID*. (pers. comm. Hailu, 2018)

As part of the inception of the monitoring system strengthening initiative, indicators were reviewed and revised by the consultant team, with inputs and feedback provided by national level actors, including representatives from the Ministry (and other Ministries), development partners (including the OWNPN partners UNICEF, AfDB, World Bank and USAID) and NGOs (including WaterAid, Water Alliance, CARE etc.) (Abdi, 2018). There was thus a relatively high degree of co-production of the NWI2 indicators, involving producers, as well as potential (national level) users of the data. The indicators were approved at federal level by the OWNPN Steering Committee (pers. comm. Hailu, 2018). Data collection tools were developed by the consultant team.

Following the NWI1, in 2013, sector stakeholders started discussing how to make the NWI results publicly accessible to actors, how to keep the data up-to-date, and how to encourage its

24. In 2015, IRC opened an Ethiopia county office

use at different levels (Welle, 2013). Especially NGOs and civil society actors, including WaterAid, emphasised the importance of dissemination to and use of the monitoring data at local level for ensuring evidence-based decision-making and progress reporting at that level. In addition, national-level actors, including the Ministry and development partners started to realise use of data at these levels could be an incentive for ongoing data collection, ensuring availability of up-to-date monitoring data available at all levels. (Welle, 2013).

In spite of the relatively well discussed and documented challenges faced in the first NWI, the data collection process under NWI2 was organised in a similar fashion to NWI1 with the data collection and cleaning process again mainly organised by national level. The process was led by the National WaSH Coordination Office, with technical support from Coffey Consult. A total of 3,379 enumerators, supervised by 430 zonal (governmental and non-governmental) supervisors were trained and engaged (Water Development Commission, 2021).

Post data collection, data were cleaned by the Regional Water Bureaus. The CEO of the WDC, together with several national consultants, took two weeks in Adama, a town close to Addis Ababa favoured by Ethiopia government staff for doing meetings and workshops outside the daily routine in the office in Addis Ababa. This resulted in a draft report, focused on coverage, with little to no emphasis on results of utility performance. Through this process, the WDC CEO became thus both a potential user and a (co-)producer of the data.

As the Ministry issues licenses to national WASH consultants (Stolz et al., 2013), there tends to be a relatively strong social relationship between the Ministry and national consultants. Many national consultants have at some point been involved in the governmental water sector, either in the Ministry or a Water Bureau.

The produced report was approved and disseminated to sector stakeholders, including development partners, NGOs and government staff. A national consultant used the data to adjust national coverage figures, based on data compiled by Regional Water Bureaus. Sector stakeholders like NGOs and development partners provided input and feedback in this process.

Relational social capital: As presented in Chapter 5, alignment and harmonisation between development partner, government and NGO has been stimulated and facilitated through processes like the annual Multi-stakeholder Forums and the Joint Sector Reviews. In addition, the co-production process has resulted in trust between the different actors involved in the co-production process.

Cognitive social capital: The same processes that have resulted in trust between the actors involved in co-production of national coverage data, have also resulted in alignment of objectives and language between these actors.

Quality of relationship: Based on the high structural relationships and cognitive social capital of the actors in the national coverage data co-production network, the quality of the relationships between these actors is rated as high.

8.3.3.3 Co-producers of national coverage data and co-producers of macro-level plans

The relationship between the above discussed co-producers of macro-level plans and the co-producers of national coverage data may play a role in influencing data use under case 5a.

Structural social capital: As shown in Section 8.3.3.1 and Section 8.3.3.2, Ministry staff play a role in both producing and using coverage data for informing macro-level planning.

Relational and cognitive social capital: As a result of the institutional overlap in producers and uses of coverage data for macro-level planning, trust relationships between the actors are strong. Likewise, they share a language and understanding of coverage data, resulting in high social capital.

Quality of relationship: Based on the high structural, relational and cognitive social capital of the co-producers of national coverage data and co-producers of macro-level plans, the quality of the relationships between these actors is rated as high.

8.3.3.4 JMP and co-producers of macro-level plans

JMP produces coverage data which could inform co-production of macro-level plans (case 5a).

Structural social capital: The UN has played a strong role in the initiation of the JMP, by providing it with the mandate for monitoring progress on globally set targets (MDG 6 and SDG6). Different global sector professionals and academics have supported the design of JMP indicators and processes.

In Ethiopia, source data for JMP are mainly produced by the Ethiopian Statistical Services (ESS), with technical and financial support from various development partners. The global JMP team compiles and analyses the data and produces information products which are made available to all.

However, there are no direct social relations and flows between JMP and the intended national-level users of these data. Interactions between JMP and the Ministry and other national-level decision makers have been limited.

Since about 2010, JMP has been holding in-country workshops to explain the methodology behind JMP reports. This was considered important for ensuring quality data collection and building trust (WHO/UNICEF Joint Water Supply and Sanitation Monitoring Programme, 2009). During the 2016-2020 strategic period, JMP in collaboration with WHO and UNICEF regional and country offices provided technical support to some 10-15 countries per year to integrate SDG WASH indicators into national systems and intended to scale this up to 10-20 countries per year in the 2021-2025 strategic period (WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation, 2021). However, this has not happened (yet) in Ethiopia.

Relational social capital: Understanding of and trust in JMP data (producers) was low at the time of NWI1, mainly due to its considerable discrepancy with the Ministry's coverage data. The recent years have seen considerable increase in understanding and trust between JMP and potential JMP data users, with increased clarity in the sector on the different source data, methodologies and definitions used for each data set.

Beyond the sector, however, (e.g. politicians and the general public) this does still sometimes lead to confusion. Stronger social relations could improve trust relations. As mentioned by one of the Ministry's directors: *'JMP works with statistics agencies. [...] It would be better if they would be working directly with implementers, like the Ministry, starting from data collection. [...] In that way, we would not confuse people with some of the figures.'* (pers. comm. Gedefa Wami, 2022)

Cognitive social capital: As a member of the UN, the Ethiopia government has subscribed to the SDGs, including SDG6, with global progress on the goal monitored through JMP. However, coverage definitions applied by the Ministry (and the government of Ethiopia) are not fully in line with JMP definitions. Alignment in goals and language between the producers and users of JMP data in Ethiopia was thus rated as moderate to low.

Quality of relationship: Based on the low structural, relational and cognitive social capital of the JMP and co-producers of macro-level plans, the quality of the relationship between these (groups of) actors is rated as low.

8.3.3.5 PI&BM data producers and co-producers of macro-level plans

PI&BM data are produced by a small team consisting of Ministry staff and consultants. They act as producers of one of the data sets which is supposed to inform the co-production of macro-level plans in case 5b.

Structural social capital in initiation and design: The production of PI&BM data was initially driven by a demand pull from the Ministry, interested in having utility PI&BM data (pers. comm. Tadessa, 2018; Ministry of Water and Energy, 2012). During a workshop organised by the Ministry in August 2011 in Adama, draft performance indicators and benchmarks were developed and formalised in the so-called 'Adama declaration'.

However, this indicator set proved not operational. The Water and Sanitation Program (WSP) of the World Bank, requested by the Ministry to provide technical and financial support to the process, introduced its IBNET tools in a March 2012 workshop organised by the Ministry in Addis Ababa. A team consisting of experts from WSP, an assigned PI&BM focal point from the Ministry, the National Consultant and the Ethiopia Water Federation reviewed the IBNET indicators and tools and determined the KPIs (pers. comm. anonymous, 2018).

In May 2012, two staff from 150 selected utilities, two staff from each Regional Water Bureau and 2 staff from each regional utility association (a total of some 335 people) were trained by the national consultant in how to complete the IBNET tool (Ministry of Water and Energy, 2012). Data collection formats were transferred from the national consultant to the utilities, through the Regional Water Bureau utility facilitation departments. Utilities submitted data to the consultant.

The consultant, focal point and WSP experts interacted on cleaning and processing the data, which also involved interactions with several utilities to provide clarity on submitted data (pers. comm. anonymous, 2018). The national consultant and Ministry focal person, supported by WSP, interacted to compile and process the data. After data analysis was completed in 2013/14, the consultant and focal person interacted with other actors on the initial results and data quality issues through a workshop organised at national level. Data were not disseminated to actors, including potential data users, because of perceived data quality challenges (pers. comm. Tadessa, 2018). This shows relatively low structural social capital of the PI&BM data producers and macro-level plan co-producers vis-à-vis each other.

Relational social capital: Many utilities took considerable time to prepare and submit data, and, as mentioned in Chapter 7, the source data from the utilities was not considered accurate at national level. There was a lack of a reciprocal relation between the PI&BM data producers and the utilities as providers of the source data, with very little feedback on the results to the utilities. The Jinka utility manager for example mentioned *'We were asked for data, which we sent to them, but we have not heard back since then. This was about 2 years ago. They said they needed the data, but I am not sure for what.'* (pers. comm. Teko Zebo, 2018). The fact that there was limited dissemination of and communication about the PI&BM results with potential national level data users, is likely to have diminished trust between co-producers of macro-level plans and PI&BM data producers.

Cognitive social capital: Co-producers of macro-level plans had not all been involved in or exposed to the co-production of the PI&BM data. As a result, understanding of KPI definitions and ways of assessing them, varied widely.

Quality of relationship: Based on the low structural, relational and cognitive social capital of the PI&BM data producers and co-producers of macro-level plans vis-a-vis each other, the quality of the relationship between these (groups of) actors is rated as low.

8.3.3.6 NWI utility performance data producers and co-producers of macro-level plans

Like PI&BM data producers, NWI data producers were supposed to also play a role in producing data for informing macro-level planning under case 5b.

The relationship between NWI utility performance data producers and co-producers of macro-level plans was similar as the one presented in 8.3.3.3. However, there were no clearly defined roles and responsibilities for the actual data processing and use. Data processing in NWI1 was mainly done through the PUT system, based on algorithms developed by a commission consisting of Ministry staff and national consultants (pers. comm. Defere, 2018). Data processing in NWI2 was supposed to be done through the new MIS, though evidence of this actually happening was not available. So although raw data were available, actors responsible for processing these data, were not in place.

Quality of relationship: The quality of the relationship between NWI data producers and co-producers of macro-level plans actors is therefore assessed as low.

8.3.4 Summing up quality of relationships

Overall, relational social capital and cognitive social capital were rated lower than structural social capital, with relational social capital as the main limiting factor of moderate and high-quality relationships.

The quality of the following relationships was rated lowest:

- Water users and Water Boards;
- Regional Water Bureaus and the Ministry;
- Researchers (on willingness to pay studies) and tariff setting decision makers (other than the utility);
- JMP and macro-level plan co-producers;
- PI&BM data producers and co-producers of macro-level plans.

The quality of the following relationships was rated highest:

- Utility staff and management;
- Water Boards and local government;
- National coverage data producers and co-producers of macro-level plans.

This shows that quality of relationships were highest for relationships in which the data producer was the same or very close to the data use.

Table 8-3 presents an overview of the rated quality of relationships between different actors in the data use cases discussed in this chapter.

Table 8-3: Overview of assessed social capital and quality of relationships in data use networks

Section	Relationship	Decision case	Structural social capital	Relational social capital	Cognitive social capital	Quality of relationship
8.3.1.1	Utility staff and management	Case 1,2,3	High	High	High	High
8.3.1.2	Water users and utility	Case 1,2	High	Low	Moderate	Moderate
8.3.1.3	Water users and local government	Case 1,2,4	Moderate	Low	Moderate	Moderate
8.3.1.4	Water users and Water Boards	Case 1,1,4	Low	Low	Low	Low
8.3.1.5	Utility manager and Water Board	Case 1,2,4	High	Low	Moderate	Moderate
8.3.1.6	Water Boards and local government	Case 4	High	High	Moderate	Moderate
	Water Boards and local government	Case 1,2,3	High	High	High	High
8.3.2.1	Utility and support consultants	Case 3	Varying	Varying	Varying	Varying
8.3.2.2	Utility and Regional Water Bureau	Case 3,4	High	Low	Moderate	Moderate
8.3.2.3	Local and regional government	Case 4	High	High	High	High
8.3.2.4	Regional Water Bureau and the Ministry	Case 3	Low	Low	Low	Low
8.3.2.5	Coproducers of PI&BM data and utilities	Case 5b	Low	Low	Low	Low
8.3.2.6	Coproducers of NWI data and utilities	Case 5b	Low	Low	Low	Low
8.3.2.7	Researchers and utilities	Case 4	Moderate	Moderate	Moderate	Moderate
8.3.2.7	Researchers and tariff approval decision makers	Case 4	Low	Low	Low	Low
8.3.3.1	Co-producers of macro-level plans	Case 5a, 5b	Moderate	High	High	Moderate
8.3.3.2	Co-producers of national coverage data	Case 5a	High	High	High	High
8.3.3.3	Co-producers of national coverage data and co-producers of macro-level plans	Case 5a	High	High	High	High
8.3.3.4	JMP and co-producers of macro-level plans	Case 5a	Low	Low	Low	Low
8.3.1.5	PI&BM data producers and co-producers of macro-level plans	Case 5b	Low	Low	Low	Low
8.3.1.6	NWI data producers and co-producers of macro-level plans	Case 5b	Low	Low	Low	Low

Note: Quality of relationship: High if structural, relationship and cognitive social capital are high; Moderate if structural, relationship and cognitive social capital are not all high, but not all low either; Low if structural, relationship and cognitive social capital are low.

8.4 Quality of relationships and actual use of data

This section brings together the results of the assessment of the quality of the relationships between data producers and users (and other actors involved in the decision networks) with the observed degree of actual data use for each of the data use cases. It analyses whether the

quality of relationships aligned with observed levels of actual data use and reflects whether these can explain the degree of actual data use, as assessed in Chapter 6.

8.4.1 Case 1: Operational decisions and corrective measures by Utility

The high-quality relationship between the utility staff and management (as producers and users of data) in case 1 is likely to have enabled data use in operational decision-making, but does not fully explain the moderate (rather than high) degree of use. Water users can act as producers of alternative 'information', which they can either relay directly to the utility, or indirectly, through local government. Especially individual water users with high social capital and high quality direct or indirect relationships with the utility, could have considerable influence on the operational decision-making process. This explains the moderate (rather than high) degree of operational data use by utilities in operational decision-making.

Operational decisions by the Water Boards are informed by operational and performance data produced by the utility, but only to a low degree, with other factors playing a stronger role in influencing these decisions. The moderate quality relationship between the Water Board as data user and utility as data producer cannot explain this.

8.4.2 Case 2: Performance regulation of utility by Water Board

The social network involved in case 2 is the same as that in case 1. However, this case focuses on the relationship between the utility manager and the Water Board. The quality of the relationship between the Water Board as decision maker and the utility manager as data producer is rated as moderate. This cannot explain the limited use of utility data in informing operational and regulatory decision-making of the Water Board.

8.4.3 Case 3: Strategic (business) planning by Utility

Case 3 focuses on local level strategic (business) planning. Support consultant and the utility (management) can be co-producers of strategic plans and the data required for informing the planning process. The quality of the relationship between them depends on several factors. These include who hires and pays for the consultant's services (either the utility itself, or a development partner), the *modus operandi* of the consultant, and the degree of co-production of the (strategic) plan. High-quality relationships between support consultants and utilities can play a role in enabling moderate use of data in planning processes.

In addition to asset, operational and utility performance data, strategic planning decisions were informed by nationally and regionally set goals and targets. The moderate relationship between the Ministry, Regional Water Bureau and utilities enabled this.

Where support consultants were not in place, utilities themselves acted as both data producer and user in strategic decision-making. However, the good relationship between utility management and staff does not explain the low level of utility data in local level strategic planning.

The low-quality relationship between NWI and PI&BM data producers and utilities as data users, could have hampered use of these data in strategic planning processes, accounting for the low use.

8.4.4 Case 4: Economic regulation (tariff approval) by the Regional Water Bureau

There was no actual use of data from any of the data sets in this case, as presented in Chapter 6. The low quality of the relationship between PI&BM and NWI as data producers and the Regional Water Bureaus as potential data user could have played a role in this. However, the moderate quality of the relationship between the Regional Water Bureau as decision maker and utility as data producer, does not. The Tigray Regional Water Bureau was involved as both producer and potential user of TUMS data for informing economic regulation. This would be expected to have enabled data use. However, no actual data use was observed.

Perceptions of tariff affordability by the Regional Water Bureau and the regional government, with whom they have strong relationships, played a considerably stronger role in informing tariff approval than data-based tariff proposals and other information sources (e.g. from researchers).

8.4.5 Case 5a: Macro-level planning for asset development by Ministry

Section 8.2.5 showed that the network of actors involved in coverage data use to inform macro-level planning was rather dense, with overlap in some actors involved in both co-production of government coverage data and macro level plans. A national consultant was the key person responsible for production of the Ministry's coverage data. He acted as a bridge for the transfer of coverage data between producers of source data and users of coverage data. Together with Ministry staff, he co-produced the Ministry's coverage data. The high-quality relationship between co-producers and users of these data for informing macro-level planning may have contributed to the (moderate degree of) use of these data.

The relationship between JMP as data producers and the co-producers of macro-level plans was much weaker. This may have played a role in the lack of JMP data in macro-level planning.

8.4.6 Case 5b: Macro-level planning for utility performance strengthening by Ministry

Both the PI&BM and NWI data production processes involved co-production, especially in the design phase. However, joint analysis of PI&BM data was low, and joint analysis of NWI utility performance data has hardly taken place.

Where in case 5a a national consultant involved in the production of the Ministry's coverage data functioned as a de facto bridge between data producers and users, such a bridge function related to the production and use of utility performance data under the NWI, was not in place. This may have hampered or disabled the use of these data in informing macro-level planning.

PI&BM was more integrated into the Ministry structure than JMP (in case 5a), with stronger social relations between the PI&BM data producers and the Ministry and with the IBNET focal person functioning as a bridge between the Ministry and the PI&BM data producers. Nevertheless, the quality of the relationship between PI&BM data producers and co-producers of macro-level plans was assessed as low. As such it may have disabled or hampered the use of PI&BM data in macro-level planning.

8.4.7 Summing up quality of relationships and actual use of data

Table 8-4 presents an overview of the assessed quality of relationships between data producers and users in the cases discussed in this chapter.

As shown in the table, where quality of relationship between data producer and user is rated as low, the actual use is also rated as low. This suggests that the quality of the relationship between data producers and users can hamper actual data use. However, a moderate or high-quality relationship is not a guarantee for moderate or high actual use. As shown in the table, the degree of actual use of data could be explained for a number of instances, but not for all.

Table 8-4: Overview of assessed quality of relationships and level of data use

Decision case	Main data user	Data set used	Quality of the relationships	Degree of use	Explainable by linear perspective	Explainable by relationship perspective
1. Operational decisions	Utility	Asset data	Low	0	Yes	Yes
		Operational utility data	High	5	Partially	Partially
	Water Board	Operational utility data	Moderate	4	No	No
		Utility performance data	Moderate	2	No	No
2. Performance regulation	Water Board	Utility performance data	Moderate	2	No	No
3. Strategic (business) planning	Utility (possible co-production with consultants)	Asset data	High / varying	4.5	Yes	Yes
		Utility operational data	High / varying	4.5	Yes	Yes
		Utility performance data	High / varying	4.5	Yes	Yes
		TUMS data	Moderate	3 (P)	No	No
		PI&BM data	Low	1	Yes	Yes
		NWI data	Low	1	Yes	Yes
4. Economic regulation (tariff approval)	Regional Water Bureau	Utility performance data	Moderate	2	No	No
		TUMS data	High	2	No	No
		PI&BM data	Low	1	Yes	Yes
		NWI data	Low	1	Yes	Yes
5a. Macro-level planning for asset development	Macro-plan co-producers	Ministry's coverage data	High	5	Yes	Yes
		JMP Coverage data	Low	2	No	Yes**
5b: Macro-level planning for utility performance strengthening	Macro-plan co-producers	PI&BM data	Low	1	Yes	Yes
		NWI utility performance data	Low	1	Yes	Yes

Level: Local level; Sub-national level; National level data ; **Rating of actual data use:** 0= Data are not available to potential users ; 1= Data are available to the decision maker(s) / duty bearer; 2 = Decision makers / duty bearers have engaged with and understand the data; 3 = Decision makers refer to, but does not use data /Duty bearers reports data, but rights holder does not hold duty bearer accountable/process use; 4 = Low use: Decision makers have made use of data for informing decisions, but these decisions are mainly informed by other factors than the data /Rights holders have hardly used data for holding the duty bearer accountable; 5 = Moderate use: Decision makers have made use of data for informing decisions, but these decisions have to some degree been informed by other factors than the data /Rights holders have used data for holding the duty bearer accountable to a moderate degree. **= (partially) explained by the relationship perspective but not by the linear perspective

The quality of the relationship between data users and producers aligned with the degree of actual data use in the following cases:

- Moderate use of utility operational data by Utility for operational decision-making (case 1);
- No use of asset data produced by contractor for operational decision-making (case 1);
- Moderate data use in the co-production of strategic plan by utility and consultant hired by external funder (case 3);
- No use of NWI utility performance data in strategic planning by utility (case 3);
- No use of PI&BM data in strategic planning by utility (case 3);
- No use of PI&BM and NWI data in tariff approval (case 4);
- No use of PI&BM and NWI data in macro-level planning (case 4);
- No use of JMP data by Ministry for planning (case 5a);
- Moderate use of national coverage data by Ministry for macro-level planning (case 5a).

In the following cases, the quality relationship between data users and producers explains the fact that there is actual use of data, but not the actual degree (low, moderate, high) of use:

- Low use of data by Water Board for operational decision-making (case 1);
- Moderate use of utility data in strategic business planning by the utility (possibly with consultants, hired by the utility, or with a strong relationship with the utility) (case 3);
- No use of TUMS data by RWB for tariff approval (case 4).

In these cases, availability of alternative information or other factors explain the moderate or low degree of data use.

The following cases involved data producers and users with moderate relationships, which did not align with the lack of data use:

- No use of utility performance data by Water Board for Regulatory decision-making (case 2);
- No use of utility data by RWB for tariff approval (case 4).

In addition to exploring the relationships between the data producers and users, this chapter has looked at the social network involved in the selected decision cases, including relationships between (potential) data users and producers of alternative information. These provide additional insights into the factors that hamper and enable actual use of data. These include the water user interests influencing data use in operational decision-making in case 1, the national and regionally set targets influencing data use in strategic planning in case 3, and the perceptions on affordability influencing data use in economic regulation in case 4.

As shown in Table 8-4, the relationship perspective largely aligned with the linear perspective in its ability to explain the degree of data use based on the assessed factor strength. However, lack of use of JMP data, not explained through the linear perspective, was explained through the relationship perspective.

8.5 Summing up the relationship perspective

This chapter introduced the actor networks involved in six decision cases, including the producers of the different data sets and the potential direct and indirect data users involved. It assessed the quality of the relationships between the actors in these networks.

It showed that the quality of relationships between data producers and users varied. The quality of relationship was especially low between actors with weak accountability relationships. These included relationships between Water Boards and water users (case 1 and 2), researchers providing information for tariff setting and Regional Water Bureaus as tariff approval authorities (case 4), JMP and macro-level plan co-producers (case 5a), and; PI&BM data producers and co-producers of macro-level plans (case 5b).

High-quality relationships were observed in cases in which the data producer and user were the same or very close. This included the use of Ministry's coverage data for co-production of macro-level of macro-level plans, the use of utility data by utilities, and the use of TUMS data by the Tigray Water Bureau.

Comparing the quality of the relationships with the strengths of the data attributes as assessed in Chapter 7 revealed alignment. Data use cases with high-quality relationships involved data with strong (moderate to high) attributes. Data use cases with low quality relationships mainly involved data with low-rated attributes, especially in terms of data credibility, timeliness and availability in appropriate formats.

The chapter also explored whether the quality of relationships between data producers and users in the actor networks could provide insight into explaining the degree of actual data use in these cases, as assessed in Chapter 6. Some alignment between the degree of data use and quality of relationships was observed. While the lack of use of JMP data in macro-level planning was not explained by the linear perspective in Chapter 7, the relationship perspective did manage to explain this. However, like data attributes from the linear perspective, the good quality relationships were also found not to be a guarantee for actual data use.

The chapter further showed that it is not just the relationship between data producers and users that plays a role, but also relationships between (potential) data users and providers of alternative or even competing information, interests and ideologies. For example, national and regional targets have played a role in informing local level planning, ideologies about tariff affordability have informed decision-making in tariff approval, and interests and opinions of water users have informed operational decision-making. Influence of these alternative sources of information, interests and ideologies depend on the relationships between the related actors and the potential data users.

8.6 Way forward

This chapter has shown that the relationship perspective provides some (additional) insight and explanations for degree of actual data use. However, like the data perspective discussed in Chapter 7, it cannot fully explain data use or lack thereof. The chapter that follows continues the exploration into factors that can play a role in enabling and hampering data use. It does so by taking a behaviour systems perspective, focused on the capacities, motivations and opportunities for actual data use.

9 BEHAVIOUR SYSTEMS PERSPECTIVE

9.1 Introduction

This chapter continues the exploration into factors that enable or hamper data use, answering the third research question of this thesis: *'What factors enable or hamper actual monitoring data use?'.* Where Chapter 7 focused on the data supply side, and Chapter 8 on relationships between data producers and users, this chapter focuses on the demand side: (potential) individual data users and their context and how they influence data use. It takes a behaviour systems perspective, with data use as the behaviour of interest. It uses a COM-B model introduced in Chapter 2 as a model for understanding how individual Capacity, Motivation and organisational, sectoral and contextual Opportunities influence data use Behaviour. Organisational opportunities relate to organisational human and financial resources, and availability of decision-support systems. Sectoral opportunities relate to the presence and strength of data-use systems, with clear roles and responsibilities, mechanisms and incentives for data use. Contextual opportunities relate to political economy and national culture.

The sub-questions addressed in this chapter are:

- What is the level of capacity, motivation and opportunities for data use in decision-making by different intended data users?
- How have these capacities, motivations and opportunities to use data enabled and hampered actual use of data in decision-making?

This chapter focuses on data use for decision-making and does not assess the capacities, motivations and opportunities as factors for enabling and hampering data use for reporting for accountability.

A systematic rating approach is used to rate the behaviour system's factors as high/ moderate/ low for the different data use cases identified in Chapter 5. The ratings are based on evidence from grey literature, semi-structured interviews at the three institutional levels, and observations.

To understand how the behaviour system's factors enable and hamper data use, their ratings are compared to the degree of actual data use across the different data use cases (as assessed in Chapter 6).

Interrelationships between motivations, capacities and opportunities are an important part of the behaviour systems model, as stated in Chapter 2. Motivation, capacity and opportunities can both directly and indirectly influence data use, through their influence on each other. The influence of the factors on each other is explored and assessed based on insights from the data use cases. See Chapter 3 for details on the methodology.

Section 9.2 presents an assessment of the capacities, motivations and opportunities for data use of the main data users at the different institutional levels, addressing the first sub-question. Section 9.3 assesses for the different data use cases how the rates of the behaviour system factors align with the degree of actual data use. Section 9.4 presents an analysis of how the different factors of the behaviour system interact with and influence each other. The

chapter concludes with a summary of the main findings (Section 9.5) and the way forwards (Section 9.6).

9.2 Capacity, motivation and opportunities for data use

This section assesses the capacities, motivations and opportunities for data use by the main data users: Utility managers and staff (9.2.1), Water Boards (9.2.2), Regional Water Bureaus (9.2.3), and the Ministry (9.2.4). However, as presented in Chapter 8, these actors can be involved in co-production of decisions. Where relevant, the capacities, motivations and opportunities of these co-producers are explored. For each data user, the capacity, motivation, organisational opportunities, sectoral opportunities, and contextual opportunities for data use are described and rated.

9.2.1 Utility management and staff

As shown in Chapter 5, utilities were expected to use data produced at local level for operational decision-making and strategic planning. Furthermore, they were expected to use TUMS, PI&BM and NWI data for informing strategic plans. This section describes and assesses the capacities, motivations and opportunities for use of these data by utility management and staff. Table 9-1 presents an overview of capacities, motivations and opportunities for use of data by utilities across different data use cases.

Table 9-1: Level of capacity, motivation and opportunities for data use by utility staff and management

Factors			Utility data use case		
			Operational decision-making	Strategic Planning	Tariff setting
Individual capacity for data use			M	L/M	L/M
Motivation for data use			H	Utility MIS: H TUMS, NWI, PI&BM: L	M
Opportunities for data use	Organisational context	Human resources	M	L	L
		Financial resources	M	L/M	L/M
		Decision support tools	L	L	L
	Sectoral context	Data-use systems	L	L	L
		National culture for data use	M	L	M
		Political economy for data use	M	L	L

Rating of COM factors: L = low; M = moderate; H = High

9.2.1.1 Capacity for data use

For operational decision-making: Capacities for data use vary across Ethiopian utilities. In the case study utilities in Wukro and Jinka, the utility managers had extensive experience, having come up through the system over a period of 13 and 17 years respectively. Both utility managers rated the data use capability of their staff 7 or 8 out of 10. The Jinka utility consisted

of 32 staff at the time of the study, with 65% professional staff, and Wukro utility of 79 staff, with 72% professional staff.

However, findings from various other assessments found that, in general, the level of education of utility staff is not very high. NWI1 data showed that for only 84 of 307 utilities (27%) at least half of the staff were professionals. A 2020 assessment of 15 utilities even found that for more than a quarter of the assessed utilities the majority of staff had only completed basic education (Tesfaye et al., 2021).

Utilities generally struggle to undertake capacity building and skill development of staff. A diagnostic assessment of ten utilities found that none had formal skill development or training strategies, nor could they afford those (Jarco Consulting and Athena Infonomics LLC, 2022). A 2020 assessment of utility training budgets of 10 utilities, found that these had spent less than 2% of their operating costs on staff training, with nine reporting having spent even less than 1% (Tesfaye et al., 2021).

Turnover of utility managers and staff is high, with many utility managers vacating the job within three years to fill another (semi-) government position (Tesfaye et al., 2021). Especially for small utilities, Boards often appoint a utility manager with low capacity and experience. A national-level interviewee for example reported to have encountered a formal English teacher, without utility knowledge or experience, appointed as utility manager for a small utility (pers. comm. Berhane, 2018). Tesfaye et al. (2021) also found that utility managers are often appointees with no or little sector knowledge. All in all, based on general levels of education, skills, experience and training opportunities, utility management and staff capacity for data use in operational decision-making is rated as moderate.

For strategic planning: Utility capacity for data use in strategic planning is lower than for operational decision-making. Interviewees from national (pers. comm. Ahmed, 2018; pers. comm. Berhane, 2018) and local (pers. comm. Behalu, 2018) level identified lack of experience of utility staff and management as a major factor hampering data-based strategic planning by utilities. The head of the Wukro utility planning department mentioned *'We do not have sophisticated skills. In terms of analysis, when we break it down, we analyse it from a certain point of view. For example, from a reach [access] perspective – how many people we have reached, we do analysis on that; what problems we have, we do analysis on that. But we do not analyse it from a scientific point of view and from a detailed point of view. [...]. We need experience and knowledge and skills. We just don't have the right training.'*

To fill this capacity gap, national and international consultants often support the development of utility business plans, as described in Chapter 8. Capacities of these consultants in processing and using utility data in the development of a strategic business plan, were observed to be higher than that of utility staff. Therefore, the utility capacity for data use in strategic planning is rated low, but the capacity for co-production of plans by the utility and consultants, is rated as moderate.

9.2.1.2 Motivation for data use

For operational decision-making and planning: Both in Wukro and in Jinka, the utility managers expressed interest in using the data they produce for decision-making on operations and strategic planning. The Wukro utility manager mentioned *'I am the first person who is*

accountable. I need to know all the information from all [utility departments]’ (pers. comm. Behalu, 2018). He further stated that ‘Department leaders need their own information. Everyone will be given an assignment. For example, an assignment is given to the technical manager, so he does his diagnosis and finds out the evaluation and come up with a solution. So data are very important for us.’ (pers. comm. Behalu, 2018). The motivation that drives the interest in the use of data for informing operational decision-making is the perceived benefits of data use in terms of being able to do a better job. The level of interest of utility management and staff in data use for informing strategic planning was also found to be high. The head of the planning department in Wukro expressed his interest as follows: ‘If we have better data, we would apply that to provide better services for the community. [...] If our data are not specific enough, the planning is not specific enough. If we have more specific planning, then we have more specific action plan. So it is very important.’ The level of motivation of utility management and staff for use of locally produced data for operational decision-making and planning was therefore rated as high. There was no interest in the use of TUMS, NWI, and PI&BM data.

For tariff setting: Utilities are interested in using data to set tariffs, especially if the data show that tariff increases will improve the financial situation of the utility, while not affecting affordability. However, utility managers tend to have experience with tariff proposals being rejected, which lowers their motivation. Therefore, motivation of utility staff and management for using data for informing tariff proposals, is rated as moderate.

9.2.1.3 Organisational opportunities for data use

This section focuses on organisational capacity for data use, in terms of human and financial resources, and presence of decision-making tools.

Organisational human resource capacity: Staffing of utilities is often lower than required staffing level. In Jinka, only a bit more than two-thirds (68%) of the required (47) staff members were in place (2017), while in Wukro 89% (98 of 110) of the required staff members (2018) were in place. A diagnostic assessment of ten towns found that utilities struggled hiring and retaining qualified staff, to a large extent due to shortage of financial resources (Jarco Consulting and Athena Infonomics LLC, 2022). Especially small utilities do not have the required staff in place.

Utility staff and management in Jinka and Wukro are mainly pre-occupied with day-to-day operational issues. The Wukro Utility Manager mentioned: *‘Sometimes it seems this is not a water office, but a fire brigade’* (pers. comm. Behalu, 2018). The head of the federal water utility association also observed *‘[utility staff] are exhaustively busy with day-to-day operation’* (pers. comm. Ahmed, 2018). Because of this, time to process, analyse and use data for strategic decision-making is limited. Based on staffing challenges, and lack of time of utility management and staff to engage with processes beyond day-to-day operations (and reporting), the organisational human resource capacity for data use for informing operational decision-making is rated as moderate, and low for strategic planning and tariff setting.

Financial resource capacity: Town water utilities generally struggle with their financial resources and capacity. It is not uncommon for town water utilities in Ethiopia to run at an operational loss. The Wukro utility reported an operating cost coverage ratio above 1 for three of the four years of UNICEF’s ONEWASH Plus programme (Adank et al., 2019a). Almost a third of utilities in the IBNET database had an operating cost coverage ratio lower than 1. Data from NWI1

even revealed that a quarter of utilities did not manage to cover expenditures by their revenues. Local government was observed to often contribute to filling the operational funding gap, for example by covering the costs of electricity or taking up part of the utility staffing on its payroll.

Utilities routinely undertake tasks related to operation. Financial requirements for data use for informing these processes are not very high. Therefore, despite the low financial capacity of utilities, their organisational financial capacity in operational decision-making is rated as moderate.

More occasional processes, such as strategic planning, tariff setting, require additional financial resources, generally beyond the capacity of utilities. Development partners often fill this gap through financial (and technical) support to such processes. Examples include UNICEF's utility systems strengthening project and the World Bank's Second Urban Water Supply and Sanitation Programme. Organisational financial capacity is rated as low for data use in planning and tariff setting, but moderate for utilities supported by development partners.

Information systems and decision support tools: Utilities generally do not have strong data management systems in place, as described in Chapter 5. It will therefore not come as a surprise that they do not have decision support tools in place either.

Wukro and Jinka were found not to have integrated Utility MIS and decision support tools. The Wukro planning head stated *'We have segregated clean data. But they are all thrown away in different trays. We do not have one consolidated database. We do not have computerised data. [...] We have raw data, but this is not compiled into one document. For example, the finance team does have their own finance software to manage the data. But there is no software that integrated everything together.'* (pers. comm. Behalu, 2018). He also mentioned *'We are not doing scientific analysis. We need software for that.'* Unlike Jinka utility, the Wukro utility does have access to a considerable number of computers, mostly procured through or donated by development partner projects. However, at the time of data collection, several of these computers sat unused covered in plastic, due to lack of software and capacity to use the computers.

The Jinka data management system was observed as weak, with the Jinka utility manager mentioning he would score the data management system of the utility as low at a 4 out of 10.

Tesfaye et al. (2021) found that only one (the large town Adama) of 19 assessed towns had a functional integrated management information system in place. Four towns had integrated billing and financing systems, and the rest only had computerised billing systems.

Software packages have been locally produced, including DafTech, ENTABS, YAYBe, PUT, DZ and Peachtree. However, lack of skills and training to operate these systems, as well as lack of professional customer-support services from software providers are commonly expressed challenges. Under the second Urban Water Supply and Sanitation Programme of the World Bank, the 23 participating utilities are supposed to benefit from implementation of integrated MIS systems, with the vision to scale this up to other utilities (Tesfaye et al., 2021).

The organisational capacity related to information systems and decision support tools is rated as low for all data uses.

9.2.1.4 Sectoral opportunities for data use

This section presents the sectoral opportunities for data use by utility staff and management, in terms of the strength of 'data-use systems', including asset management (for data use in operational decision-making and strategic planning), finance (for data use in tariff setting), and

planning systems (for data use in planning), and the incentives these provide for data use. In general, these systems and incentives for data use are weak.

For operational decision-making: As presented in Chapter 4, and as referred to throughout this thesis, guidelines on utility operation and maintenance are in place, but hardly referred to or used. Asset ownership was relatively well defined, but asset management was (at the time of writing) hardly operationalised through standard tools, guidelines, trainings, etc.

There are no clear incentives for data use for informing operational decision-making. Staff are not rewarded or penalised for the level of data use in informing their decisions. Strength of the data-use system related to operational decision-making was therefore rated as low.

For tariff setting: Tariff setting guidelines are in place, but hardly known or followed by utilities. Incentives for data-based tariff setting are weak, as tariff proposals are often rejected, as presented in Chapter 6. Strength of the data-use system related to tariff setting was therefore rated as low.

For strategic planning: As presented in Chapter 4, there are relatively strong frameworks and mechanisms for multi-annual planning at national level, which include the setting of targets. However, these macro-level multi-annual plans do not provide strategic directions on how to achieve sustainable and equitable service delivery in line with the set targets, nor are they (strongly) linked to budgeting processes (Defere, 2017). There are no (national) guidelines in place for guiding business planning by utilities in Ethiopia.

Having a solid business plan was a condition for utilities for accessing loans from the Water Resource Development Fund (Italian Development Cooperation, 2010; Tesfaye et al., 2021). In order for the business plan to be solid and robust, it needs to be based on available utility data. This provided an incentive for utilities to use data for strategic planning. Some 104 utilities, including Wukro, have received loans from the Water Resource Development Fund since its establishment in 2002 (MoWIE, 2021). However, the criterion of having a solid data-based business plan in place has hardly been enforced. Based on this, the strength of the data-use system for planning is rated as low.

9.2.1.5 General contextual opportunities for data use

This section presents the contextual opportunities for data use by utility staff and management, in terms of national culture and political-economy context.

For operational decision-making: The operational decision-making power lies with utility staff and management. As shown in Chapter 8, their operational decisions can be influenced by personal interest of water users, which they enact through their relationship with utility staff and management, or through local government. Power dynamics and leadership that stimulate data use in operational decision-making are thus only partially in place. The political economy for enabling data use in operational decision-making is therefore rated as moderate.

The national culture of Ethiopia is characterised by:

- High level of power distance;
- Low level of individualism;
- Moderately high level of motivation towards achievement and success;
- Moderate level of uncertainty avoidance;
- Low level of long-term orientation; and
- Moderate level of indulgence (Hofstede et al., 2010).

The low level of individualism implies that not all customers get the same treatment. This has indeed been observed in Ethiopia, with customers with a high socio-economic status influencing operational decision-making as well, e.g. by asking an operator to make changes to water rotation schedules (pers. comm. Defere, 2018). The moderately high uncertainty avoidance and low long-term orientation, however, imply an emphasis on operational decision-making. Therefore, the culture for operational data use is rated as moderate.

For strategic planning: The decision-making power for strategic planning lies in principle with utility management. However, development partners, consultants and Regional Water Bureau influence these processes as well. Utilities in Ethiopia do not tend to be strong power players in the sector. As they struggle with often poor and aging infrastructure, poor service provision, lack of human and financial resources, they rely strongly on (local) government and its development partners for asset and performance improvement. This provides them with little agency to take charge of data-based planning and tariff setting. The political economy for data use in these processes is therefore rated as low.

The high-power distance culture implies that managers are more likely to base decisions on orders from superiors, rather than on their own and subordinates' experiences. Target setting on key utility performance indicators in Ethiopian utilities is influenced by nationally and regionally set targets and norms and standards, rather than by data on the actual current and required situation. Also the relatively high level of uncertainty avoidance and low long-term orientation imply a focus on short term decision-making, rather than on longer term strategic planning processes. Therefore, the national culture for data use for informing strategic planning at local level is rated as low.

9.2.1.6 Summing up utility capacity, motivation and opportunities for data

The section demonstrated moderate capacity, high motivation and mostly moderate rating opportunity factors for utilities' use of data for operational decision-making.

Utilities are motivated to use data from the Utility MIS for informing strategic planning decisions and tariff setting, but capacities to do so vary and depend especially on availability of support to co-develop such plans. Opportunities for enabling these data uses are limited. Section 9.3 assesses how these factor strengths and weaknesses align with the observed degree of actual data use.

9.2.2 Water Board: Capacity, motivation and opportunities for data use

As shown in Chapter 5, Water Boards are expected to use utility data to inform operational and regulatory decisions. This section describes and assesses the capacities, motivations and opportunities for these data uses. Table 9-2 presents an overview of capacities, motivations and opportunities for data use by Water Boards across different data use cases.

Table 9-2: Level of capacity, motivation and opportunities for data use by the Water Board

Factors			Water Board data use case	
			Operational decision-making	Regulatory decision-making
Individual capacity for data use			Operational data: M	Performance data : L
Motivation for data use			M	L
Opportunities for data use	Organisational context	Human resources	M	M
		Financial resources	L	L
		Decision support tools	L	L
	Sectoral context	Data-use systems	L	L
		National culture for data use	M	M
	General context	Political economy for data use	M	M

Rating of COM factors: L = low; M= moderate; H = High

9.2.2.1 Capacity for data use

In general, knowledge, insights and skills related to overseeing utilities are often limited, as are initiatives to build such capacities (Ministry of Water and Energy; 2013, pers. comm. Ahmed, 2018; pers. comm. Berhane, 2018). Stolz, Abdi and Yemane (2013) assessed the capacity of the Water Boards in SNNPR to be practically non-existent.

High turnover rates of Water Board members, especially of the government representatives, are a challenge for ensuring capacity for effective oversight (Ministry of Water and Energy, 2013d). High turnover rates mean a potential capacity-drain in cases in which capacity of Water Board members was built. Tenure lasts for two years, with the possibility of multiple tenures (National Regional State of Tigray, 2014). Jinka Water Board had seen turnover of 5 (of 10) persons over 3 years.

The co-chair of the Jinka Water Board believed that Water Board members generally have the capacity to understand the reports and data presented by the utility. According to him *‘Even a lay man knows about the advantages for water. Board members are representing not only as a board member but also as users. They are very clear.’* (pers. comm. Tariku, 2018) According to the Jinka Utility manager, most Jinka Water Board members do indeed have the capacity to understand the financial data which is presented by the utility on a quarterly basis, but needed support from the utility to understand the technical points raised in the reports. As mentioned by the Jinka utility manager in reality *‘There are no consequences to poor performance. [] The board has authority, but does not really use its authority. We are mostly ahead of them’* (pers. comm. Teko Zebo, 2018). Board members understand financial (operational) data, but struggle understanding and using utility performance data.

The Water Board's capacity for using operational (financial) data for informing operational decision-making is thus rated as moderate, while it is rated as low for using utility performance data.

9.2.2.2 Motivation for data use

The majority of Water Board members are not water supply experts, but representatives of water users and government offices. They are often perceived as uninterested in water supply issues (pers. comm. Defere, 2018; pers. comm. Berhane, 2018). As mentioned by an interviewed national level stakeholder (pers. comm. Berhane, 2018), *'If the board was managing the production of beer, they would be counting the bottles. But water is not beer. They perceive water as a gift of God.'*

Water Boards regard appointment of the utility manager and approving budgets and procurements of the utility as one of their main roles (pers. comm. Defere, 2018). Therefore, they do have an interest in financial data reported by the utility. Furthermore, Water Boards have shown (increasing) interest in data on NRW and consider that an important key performance indicator (pers. comm. anonymous (WaterBoard member Wukro), 2018). This is probably due to setting of goals and targets at national level and emphasis on this indicator from national level.

The motivation of Water Board members for using operational (financial) data for informing operational decisions was therefore rated as moderate, while motivation for using utility performance data for informing operational and regulatory decision-making is rated as low, although it seems to be increasing.

9.2.2.3 Organisational opportunities for data use

This section focuses on organisational capacity for data use, in terms of human and financial resources, and presence of decision-making tools.

Organisational human resource capacity: Water Boards do not have challenges with human resource capacity in terms of having sufficient representatives filling the Board positions. In both Jinka and Wukro, a Water Board was in place, with 11 and 7 members respectively.

The Jinka Water Board was chaired by town administration and co-chaired by a representative from the Zonal Water Office. Other members include representatives from Ministry of Trade, Town Finance Office, Town Health Office, Town Business Office, 3 representatives from the utility, including the utility manager, and 2 community representatives (pers. comm. Tariku, 2018).

The Wukro Water Board consisted of representatives from the town administration (as chair), health, education, water, women and children affairs, and finance offices, with one male and one female representative from community and the utility manager as non-voting secretary (pers. comm. anonymous (Water Board Wukro), 2018).

Human resource capacity in terms of number and mix of people represented in the Water Board was thus satisfactory. However, neither of the Water Boards was gender-balanced, with more men than women in the board.

The Human resource capacity of the Water Board for using data for operational and regulatory decision-making was therefore rated as moderate.

Organisational financial capacity: As a structure, Water Boards do not have dedicated financial resources at their disposal, but they can play a key role in approving procurement by the utility and in determining possible allocation of funds from local government to the utility. However, the financial capacity of local government is often low. The Jinka utility manager

considered budget constraints of local government as a key reason for local government (town and zone administration) neither reacted nor acted on monitoring reports indicating financial challenges of the utility. Financial capacity of the Water Board for using and action on data was therefore rated as low.

Information systems and decision support tools: There are no decision support tools to support Water Boards in decision-making. This factor was therefore rated as low.

9.2.2.4 Sectoral opportunities for data use

As mentioned in Chapter 4, regulatory tasks are divided over multiple institutions, including the Ministry, Regional Water Bureau and Water Boards. However, operational and regulatory responsibilities of the Water Boards are not well defined. There are no direct incentives for Water Board members to use data for informing their operational and regulatory decision-making. As mentioned above, signed performance contract agreements with the utility could serve as such incentives, but were not in place in practice. The strength of the data-use system for regulation was therefore rated as low.

9.2.2.5 General contextual opportunities for data use

This section presents the contextual opportunities for data use by Water Boards, in terms of national culture and political-economy.

A crucial way in which Water Boards can regulate the performance of a utility, is through hiring and firing of the utility manager. However, consistent with the low level of individualism, hiring and firing was not informed by skills (and reported performance), but rather by political merit. However, the high-power distance implies a high level of power of Water Boards over utility managers, which could enable data use for regulatory decision-making. Also, the moderately high uncertainty avoidance implies that laws (and norms, standards and targets) need to be followed, which could enable data use on performance data for regulatory decision-making. Therefore, the national culture and political economy for data use for informing regulatory decision-making by Water Boards are rated as moderate.

9.2.2.6 Summing up Water Board capacity, motivation and opportunities for data use

The national culture and political economy are moderately favourable for Water Board data use in operational and regulatory decision-making. However, financial resources for acting on data are low, there are no decision support tools, and data-use systems are weak. Water Boards were found to have capacity and motivation to use operational data, but not utility performance data. Section 9.3 assesses how these factor strengths and weaknesses align with the observed degree of actual data use.

9.2.3 Regional Water Bureau: Capacity, motivation and opportunities for data use

As shown in Chapter 5, The Tigray Regional Water Bureau was expected to use coverage data and TUMS, PI&BM and NWI utility performance data for informing planning. In addition, they were expected to use utility performance data for informing regulatory, planning and operational decision-making. This section describes and assesses the capacities, motivations and opportunities for these data uses. Table 9-3 presents an overview of capacities, motivations and opportunities for data use by the Regional Water Bureau across different data use cases.

Table 9-3: Level of capacity, motivation and opportunities for data use by Regional Water Bureau staff

Factor			Regional Water Bureau data use case							
			Operational decision-making		Planning		Economic regulation		Performance regulation	
Individual capacity for data use			H		M		H		H	
Motivation for data use			TUMS : H	PI&BM, NWI, Utility MIS: L	TUMS: H	PI&BM, NWI: L	L		TUMS: H	PI&BM, NWI: L
Opportunities for data use	Organisational context	Human resources	L		M		M		M	
		Financial resources	L		M		M		M	
		Decision support tools	TUMS : H	PI&BM, NWI: L	TUMS: H	PI&BM e, NWI: L	TUMS : H	PI&BM, NWI: L	TUMS: H	PI&BM, NWI: L
	Sectoral context	Data-use systems	L		Coverage data: M	Performance data: L	L		L	
		National culture for data use	H		M		H		H	
	General context	Political economy for data use	TUMS: H	PI&BM, NWI: L	TUMS: M	PI&BM, NWI: L	L		TUMS: H	PI&BM, NWI: L

Rating of COM factors: L = low; M = moderate; H = High

9.2.3.1 Capacity for data use

The level of education, skills and experience with data-use for decision-making is generally higher for Regional Water Bureau staff than for utility staff and Water Board members.

For operational decision-making and regulation: The head of the Tigray MSMSP had taken the initiative to develop an MS Excel-based benchmarking system, which he used to inform annual benchmarking of utilities, with rewarding the best performing utilities. He also intended to use these data for informing operational decisions related to technical support provision to utilities. He had been the regional focal person for a utility capacity building programme undertaken by WaterAid in 20 towns, including three in Tigray region. As part of this programme, annual reporting and benchmarking was practiced by utilities (pers. comm. Dinku, 2020). His involvement in these processes was likely to have built his capacity, which has enabled the production and use of benchmarking data in the region. Capacity of Tigray Water Bureau staff to use data for informing operational decisions and regulation was therefore rated as high.

For planning: Given the above, capacity for data use in planning was also expected to be in place. However, Stolz, Abdi and Yemane (2013) identified the lack of skills of Regional Water Bureau staff to undertake strategic planning as key capacity constraints. Capacity of Regional Water Bureaus for use of data for informing planning was therefore assessed as moderate.

9.2.3.2 Motivation for data use

For operational decision-making and planning: The head of the MSMSP expressed his team's interest in the use of TUMS data in informing operational decisions related to provision of technical support to utilities and informing regional level planning.

There is also high interest of the Regional Water Bureau in using the coverage data it produces for informing planning decisions.

For regulation: In Tigray, the head of the MSMSP was highly interested in use of the data for informing performance regulation. He demonstrated this by having developed a benchmarking system (TUMS) on his own initiative, compiling and processing submitted utility monitoring data, used for informing operational and regulatory decision-making. He mentioned he had done so to address the challenge of the lack of Water Board in fulfilling their regulatory roles (pers. comm. Zeruu Haile, 2018).

It is likely that he had also been inspired by other initiatives rewarding well-performing utilities that had started around that time, including by the WaterAid 20 town project and the Federation of Utilities.

Motivation for the use of TUMS for informing performance regulation, was therefore rated as high. However, there was no interest in use of other performance data (PI&BM) and motivation for doing so was therefore rated as low. Interest in use of data for economic regulation (approving tariffs) was also not observed and rated as low.

9.2.3.3 Organisational opportunities for data use

This section focuses on organisational capacity for data use, in terms of human and financial resources, and presence of decision-making tools.

Organisational human resource capacity: Use of data for informing operational decision-making requires sufficient staff to act on this. However, Regional Water Bureaus are generally understaffed. The Water Supply Core Process of the Tigray Water Bureau included a total of 146 approved personnel posts (110 technical staff and 36 support staff), with an actual total technical staff of 83 (75% of the required) in 2011 (Admasu et al., 2011).

A considerable part of staff are involved in activities related to scheme development and expansion, rather than in activities related to regulating and supporting utilities. In 2018, the MSMSP team consisted of 56 staff (including the zonal maintenance crew), of whom seven were involved in monitoring and supporting utilities. The MSMSP head considered this insufficient for monitoring and supporting the 69 utilities in the region on a regular basis (pers. comm. Zeruu Haile, 2018).

The HR capacity challenges at regional level have contributed to the development of the utility clusters, with strong utilities supporting and mentoring a cluster of smaller and weaker utilities (pers. comm. Zeruu Haile, 2018; pers. comm. Dinku, 2022).

As there is a lack of human resources, especially related to provision of support to utilities, the HR capacity for data use for informing operational decision-making is rated as low.

As planning and regulation are by a small number of staff with dedicated time for these tasks, the HR capacity related to data use for regulatory decision-making is rated as moderate.

Financial capacity: Regional Water Bureaus face challenges with their financial capacity. The Tigray MSMSP head estimated that the department required 554,400 ETB (about 20,000 USD) for travel allowances in 2018, in order to act on the data and support utilities accordingly. He stated that they rarely receive sufficient funding from central government, with only 30% of the required budget disbursed in the previous year. This was especially a challenge for using data for informing technical support (pers. comm. Zeruu Haile, 2018).

Required financial resources for informing technical support to utilities are considerably higher than for other uses. Therefore, the financial capacity of the Regional Water Bureau for enabling use of and acting on data for informing technical support, is rated as low, while it is rated as moderate for the other uses.

Information systems and decision support tools: In general, Regional Water Bureaus lack dedicated decision support tools. In principle, the PI&BM data are available on the IBNET dashboard that serves as a decision support tool, allowing for comparison and ranking of utility performance. However, language barriers, internet connectivity and technical capacity prevent access to and use of IBNET as a decision support tool by most Regional Water Bureau staff. The TUMS developed by the Tigray Regional Water Bureau can be considered a rare example of a regional decision support tool.

The TUMS helped to identify well-performing utilities and poorly performing utilities, informing regulatory decisions in terms of rewarding well-performing utilities and operational decisions in terms of provision of technical support to utilities. Furthermore, this tool could inform planning related to capacity and performance improvement of TWUs, and economic regulation. The presence of decision support tools of the Regional Water Bureau was therefore assessed as high for the use of TUMS data for informing operational decision-making, planning and regulation, but low for the use of any other data sets.

9.2.3.4 Sectoral opportunities for data use

For regulatory and operational decision-making: Responsibilities of the Tigray Water Supply Core Process include development and expansion of water schemes, water quality testing, support preparation of business plans for towns, assess technical gaps and arrange capacity building accordingly, ensure the overall sustainability & quality of the scheme services (Admasu et al., 2011). The Water Bureau did not have the explicit mandate for performance regulation of town water utilities, though it could be considered implicit to some degree related to the mandate of ensuring sustainability and quality of services and assessment of technical gaps.

Economic regulation, in terms of tariff setting, was mentioned in regional proclamations, but these did not provide guidance if and how data from utilities should inform this process. Guidelines on use of data in operational decision-making and regulation, were not in place.

Therefore the strength of the data-use system related to operational decision-making and regulation are rated as low.

For planning: There are relatively strong sectoral systems for the use of coverage data in strategic planning at regional level. These are therefore rated as moderate. Systems and incentives for the use of utility performance data in regional strategic planning are however very weak and therefore rated as low.

9.2.3.5 General contextual opportunities for data use

This section presents the contextual opportunities for data use by the Tigray Regional Water Bureau, in terms of national culture and political-economy context.

For operational decision-making: As discussed in Section 9.2.1.5, the moderately high uncertainty avoidance and low long-term orientation imply an emphasis on content of operational decision-making, which is likely to be informed by data. Therefore, the national

culture for data use for informing operational decision-making by the Regional Water Bureau is rated as high.

The regional level power of operational decision-making related to utility performance lies with technical staff of the Regional Water Bureau. Ideology or vested interests do not seem to have played a role in operational decision-making by Regional Water Bureau staff. However, although the Regional Water Bureau show leadership and vision on the use of TUMS data, this is not the case for PI&BM and NWI data use. Therefore, the political economy for data use for informing operational decision-making by the Regional Water Bureau are rated as high for the TUMS data and low for the PI&BM and NWI data.

For performance regulation: As discussed in Section 9.2.1.5, the high-power distance in Ethiopian culture implies a high level of power of the Regional Water Bureau over the utility (manager), which could enable data use for regulatory decision-making. Also, the moderately high uncertainty avoidance implies that laws (and norms, standards and targets) need to be followed, which could enable data use on KPIs for regulatory decision-making. Therefore, the national culture for data use for informing performance regulatory decision-making by the Regional Water Bureau is rated as high.

The regional level power of regulatory decision-making related to utility performance lies with technical staff of the Regional Water Bureau. There do not seem to be ideological or vested interests that play a role in regulatory decision-making by the Regional Water Bureau staff. This presents an opportunity for data use. However, as mentioned above, the Regional Water Bureau show leadership and vision on the use of TUMS data, but not for the use of PI&BM and NWI data. Therefore, the political economy for data use for informing performance regulatory decision-making by the Regional Water Bureau, is rated as high for the TUMS data and low for the PI&BM and NWI data.

For economic regulation (tariff approval): The decision-making power related to tariff approval (economic regulation) lies with the Regional Water Bureau. However, as seen in Chapter 5 and 8, political and social interests have considerably more influence on tariff approval than monitoring data. Regional Water Bureaus are under pressure from the regional political administration to keep tariffs low, based on ideology and partisanship. In Wukro for example, the Regional Water Bureau did not approve an increase in the water tariff, despite the fact that various data sources had shown a necessity and possibility to do so.

Therefore, although national culture for economic regulation is rated as high, the political economy is rated as low.

9.2.3.6 Summing up Regional Water Bureau capacity, motivation and opportunities for data use

This section showed moderate to high Regional Water Bureau capacity for data use. Motivation for using regionally produced data was generally high. An exception was the low motivation for using data for economic regulation, linked to weak data-use systems and the lack of an enabling political economy for this, which can hamper this data use. Motivation for the use of nationally produced data was also low.

This section highlighted TUMS as a decision support tool, with the ability to enable regulatory and operational decision-making. However, lack of human and financial resources

and weak data-use systems for data use in operational decision-making could hamper this data use. Also, weak data-use systems for performance regulation could hamper regulatory data use. Section 9.3 assesses how these factor strengths and weaknesses align with the observed degree of actual data use.

9.2.4 The Ministry: Capacity, motivation and opportunities for data use

As shown in Chapter 5, the Ministry could use JMP and the Ministry's coverage data to inform policy-making and macro-level planning related to coverage. It could also use NWI and PI&BM utility performance data to inform policy-making and macro-level planning for utility performance improvement. These could also be used by the Ministry (or another regulatory body) to inform national level regulation of utility performance.

As shown in Chapter 8, consultants and development partners were involved with Ministry staff in the co-production of macro-level plans. The assessment of the capacities, motivation and opportunities for data use, will therefore include these co-producers. Table 9-4 presents an overview of capacities, motivations and opportunities for data use by the Ministry and its co-producers in different data use cases.

9.2.4.1 Capacity for data use

The high and middle management staff of the Ministry are generally highly educated, with university degrees and years of sector experience.

Use of coverage data: The capacity of Ministry staff and co-producers of macro-level plans in understanding and using coverage data, has evolved over time. In phase 1 of the development of the National M&E MIS, there was frequent sector debate and discussion on discrepancies between JMP and Ministry coverage data. A series of studies and workshops organised by the DFID-funded RiPPLE project at the time, contributed to improved understanding of coverage data. It is now well understood in the sector that this discrepancy is due to differences in indicator definitions and data sources. However, since the introduction of the higher GTP2 norms and standards, national stakeholders, including senior ministry staff were found to struggle explaining the basis of coverage calculations based on these standards. Coverage calculations are commonly done by national consultants, based on (rather untransparent) algorithms in order to adjust for the GTP2 norms. The capacity of Ministry staff and co-producers of macro-level plans for use of coverage data was therefore rated as moderate.

Use of utility performance data: The capacity of Ministry staff and co-producers of macro-level plans in understanding and using utility performance data, has not evolved considerably. With the workshop on utility performance indicators in 2012, a start was made to enhance the capacity of Ministry staff for understanding and use of utility performance data in policy-making, macro-level planning and reporting. However, capacity in understanding and using utility performance data, was mainly built in the dedicated Ministry staff member and national consultant involved in the initiative. An interviewed senior staff member for example repeatedly stated he believed data on NRW were produced by JMP. The understanding of utility performance data and capacity of senior Ministry staff and co-producers of macro-level plans, was thus rated as low.

Table 9-4: Level of capacity, motivation and opportunities for data use by Ministry staff

Factor			Ministry data use case							
			Coverage-related policy-making,		Performance-related policy-making		Regulation		Coverage-related macro-level planning	
Capacity for data use			M		L		L		M	
Motivation for data use			JMP : L	Ministry's coverage : H	M		L		JMP : L	H
Opportunities for data use	Organisational opportunities for data	Human resource capacity	M		M		L		M	
		Financial capacity	M		M		L		M	
		Presence of DST	JMP : H	Ministry's coverage data: L	NWI : L	PI&BM: H	L		JMP : H	Ministry's coverage data : L
	Sectoral opportunities	Strength of data-use systems	M		M		L		M	
		National culture	M		L		H		M	
	Contextual opportunities	Political economy for data use	M		L		L		M	

Rating of COM factors: L = low; M = moderate; H = High

9.2.4.2 Motivation for data use

Use of coverage data: Interest by Ministry staff in the use of the Ministry's coverage data for reporting and informing macro-level planning was observed. As mentioned by a national level stakeholder: *'A large proportion of the federal government budget, including grants from development partners is sent to the regions through the (MoFED) [Ministry of Finance and Economic Development]. There is an interest in monitoring of the effectiveness and efficiency of these funds as per the physical and financial action plan. We monitor these constructed schemes. We calculate our access [coverage].'* (pers. comm. Gossa, 2018).

Interest by the Ministry in JMP coverage data for reporting is mostly related to its use as a reference source for sector reports (pers. comm. Gedefa Wami, 2022). Interest in this was especially high in 2015, when it presented the positive message that Ethiopia had met the Millennium Development Goal (MDG) related to water supply. Based on interest of Ministry staff, motivation for the use of coverage data is thus rated as high. However, as JMP coverage definitions did not align with the Ministry's ones, interest in use of JMP data for informing policy-making and macro-level planning was low.

Use of utility performance data: As part of GTP2, the Ministry set goals and targets related to utility performance. This is an indication of interest of the Ministry in the use of utility

performance data in policy-making, and therefore rated as moderate. However, interest in these data for macro-level planning was observed to be low.

9.2.4.3 Organisational opportunities for data use

This section focuses on organisational capacity for data use, in terms of human and financial resources, and presence of decision-making tools, and the presence of organisational incentives for data use.

Organisational human and financial resource capacity: Data use for macro-level planning requires dedicated human and financial resources. Macro-level planning processes, like the development of the OWNPs, involve committees or task forces, consisting of Ministry staff, often complemented by consultants, as described in Chapter 8. In some cases (e.g. the development of the second phase of the OWNPs) the planning process is primarily undertaken by (international and national) consultants, funded by development partners (UNICEF in the case of the second OWNPs phase plan).

Reporting on progress on the OWNPs, informed by data from different sources, has only taken place twice, spearheaded by (international and national consultants) funded under the DFID-monitoring system strengthening programme. The Ministry mainly reports on its coverage figures. Human and financial resource capacity for data use in macro-level planning of the Ministry (and its co-producers), were thus rated as moderate.

Information systems and decision support tools: The Ministry lacks decision support systems related to town water macro-level planning. As described in Chapter 5, it has been struggling to develop an MIS, intended to support decision-making at different institutional levels. JMP and PI&BM data are available in online databases, which allow for data visualisation in the form of tables and graphs. As such, the presence of decision support tools related to these data sets is rated as high, but rated as low for the nationally produced NWI and Ministry's coverage data.

9.2.4.4 Sectoral opportunities for data use

This section presents the sectoral opportunities for data use by utility staff and management, in terms of the strength of 'data-use systems'.

For policy-making: There are systems in place for enabling policy-making and the use of coverage and utility performance in this. Updating of the water policy has however taken years. Therefore, systems and incentives for use of monitoring data in policy-making is rated as moderate.

For planning: There are relatively strong frameworks in place for multi-annual planning at national level, which include the setting of norms and standards, and targets. These plans mainly focus on asset development for increasing coverage, with less emphasis on achieving sustainable and equitable service delivery, nor are they (strongly) linked to budgeting processes (Defere, 2017). Macro-level plans are used to advocate for resources allocation for investments from government and development partners. This serves as an incentive for coverage data use for macro-level planning. The strength of the data-use system related to planning for asset development was therefore rated as moderate.

Sectoral systems for use of utility performance for informing utility performance and service

improvement, are much weaker. Interest in utility performance indicators from government and development partners for holding the Ministry accountable was hardly observed. Although the Ministry set targets on utility managed performance indicators as part of its sectoral GTP2 (Ministry of Water Resources, Irrigation and Electricity (MOWIE), 2015), none of these utility performance goals and targets were prioritised as part of the overall combined framework put in place by National Planning Commission, which focused on coverage and number of newly constructed schemes only (NPC, 2016b). The Ministry is only been held accountable for reporting to the World Bank on specific utility performance indicators (Operation cost recovery ratio and collection efficiency) from 22 secondary towns under the second urban water supply and sanitation project. Therefore the systems and incentives for use of utility performance data in planning, are rated as low.

For policy-making and regulation: As mentioned in Chapter 4, the regulatory role of the Ministry has not been defined. Although the Ministry has set standards and targets related to utility performance indicators under GTP2 and the OOWNP, it lacks reporting processes and mechanisms to report on progress on these.

The Minister, parliament and development partners, as rights holders, are mostly interested in coverage reports. This interest and the resulting demand for these data acts as an incentive for the Ministry to produce and use coverage data. Despite the ambition of having one plan, one budget and one report of the OOWNP, and in spite of goals and targets having been set beyond coverage, the demand for data-based progress reports from the OOWNP partners has been limited. Following the (rather low key) publication of the two OOWNP progress reports in 2016 and 2018, there has not been clear and strong demand for such a report from the OOWNP partners.

The strength of the data-use system for regulation was therefore rated as low. It is rated as low for policy-making related to utility performance, but moderate for policy-making related to coverage.

9.2.4.5 General contextual opportunities for data use

This section presents the contextual opportunities for data use by the Ministry (and its co-producers), in terms of national culture and political-economy context.

For policy-making and planning: As mentioned in Chapter 4, the national culture of moderately high uncertainty avoidance and low long-term orientation imply an emphasis on operational decision-making. This is in line with the observed culture of the Ministry, focused on instrumental (and arguably symbolic) use of coverage data in informing macro-level planning decisions. Therefore, the culture and political economy for use of coverage data use for informing short term solutions, including asset development for increasing coverage, are rated as moderate.

Macro-level planning for improving utility performance involves more strategic and longer-term planning. However, the high uncertainty avoidance and low long-term orientation which are part of Ethiopia's national culture, do not necessarily support this. Government interest, political leadership, and vision for strengthening utility performance utility performance have been low. Therefore, the culture and political economy for use of utility performance data for informing policy-making and long-term macro-level plans related to service performance improvement, are rated as low.

For regulation: The national culture with a high degree of power distance, as mentioned in Chapter 4, provides opportunities for data use for regulation, which was therefore rated as high. However, political leadership and vision for regulation have been weak. As described in Chapter 4, the development of the national regulatory framework has been on the national agenda for many years. The political economy is more focused on asset development than on improving utility performance and services. This could be due to the largely rural context of Ethiopia, where coverage rates are considerably lower than in urban areas, with higher need for asset development. The political economy for regulatory data use is therefore rated as low.

9.2.4.6 Summing up the Ministry's capacity, motivation and opportunities for data use

The Ministry showed to have moderately strong capacity, motivation and opportunities for the use of the coverage data it produces.

Decision support tools are in place for the globally- but not for the nationally produced data sets. Although decision support tools are in place for using JMP data, the motivation to use these data is low.

The capacity to use utility performance data is considerably lower. Motivation to use these data for macro-level utility performance improvement planning is also low. This is linked to the weak enabling national culture and political economy for this data use.

The national culture for regulatory data use is relatively strong. However, individual capacities, motivation, organisational capacity, data-use systems strength and the political economy are weak and could hamper this data use.

Section 9.3 assesses how these factor strengths and weaknesses align with the observed degree of actual data use.

9.2.5 Summing up capacity, motivation and opportunities for data use

This chapter has provided insight into the capacities, motivations and opportunities for different uses involving different actors across the three institutional levels. Quantitative scores were assigned to the factors in each of the 51 data use cases, with high scored as 2, moderate scored as 1, and low scored as 0. Table 9-5 displays the average factors ratings per type of data use case and per data user. The full rating table can be found in Annex 12.

The table shows that on average the capacities, motivations and especially the opportunities for data use did not rate high. Policy-making, regulatory and operational decision-making were the data use cases with the highest average rating on the behaviour systems factors, while planning and tariff setting scored lowest. Regional Water Bureaus were the actors with the highest average rating on the behaviour systems factors, while utilities had the lowest average rating.

The table also shows that capacities for data use and national culture rate relatively well, while the presence of decision support tools and data-use systems rate very low. Decision support tools were only in place for TUMS, JMP and PI&BM. Moderately strong data-use systems with incentives for data use, were only in place for data use cases concerning policy-making and macro-level planning for asset development.

Individual capacity for data use is rated as highest for operational and regulatory decision-making. It is rated as highest for the (Tigray) Regional Water Bureau and relatively low for other data users.

Table 9-5: Average rating of capacity, motivation and opportunities for data use

Factors	Data use cases					Data users				Grand Total
	Policy-making	Planning	Tariff setting	Operational decision-making	Regulatory decision-making	Utility	Water Board	Regional Water Bureau	Ministry	
Opportunities for data use	Individual capacity for data use	0.5	0.6	0.5	1.4	1.4	0.6	1.7	0.4	1.0
	Motivation for data use	1.0	0.9	1.0	0.3	1.2	0.7	0.5	0.7	0.8
		1.0	0.6	0.0	0.9	0.2	1.0	0.7	0.9	0.6
		1.0	0.8	0.5	0.7	0.6	0.0	0.7	0.9	0.7
	Organisational context	1.0	0.4	0.0	0.3	0.0	0.0	0.5	0.9	0.4
		1.0	0.2	0.0	0.0	0.0	0.0	0.1	0.7	0.2
	Sectoral context	0.5	0.4	1.0	1.5	0.5	1.0	1.7	0.7	1.1
		0.5	0.3	0.0	1.0	0.2	1.0	0.5	0.4	0.4
	General context	0.8	0.5	0.4	0.7	0.4	0.5	0.8	0.7	0.6
		Average rating								

Motivation for data use is rated as low for regulation.

For the organisational context factors, presence of decision support tools had low average rates. Organisational human resources for data use are rated as highest for Water Boards, and lowest for utilities. Financial resources and the presence of decision support tools had the lowest average rates for the local level data users (utilities and Water Boards).

National culture is rated as high for data use for regulation and operational decision-making, but low for data use for tariff setting and informing long term strategic plans. Because of the short-term focus of the national culture, it is rated as low on data use cases involving longer-term strategic planning.

Section 9.3 assesses how these factor strengths and weaknesses align with the observed degree of actual data use.

9.3 Behaviour systems factors and actual use of data

This section assesses how capacity, motivation and opportunities for data use enable or hamper actual data use for decision-making. It does so by analysing how the strength of the different factors, as rated in this chapter, align with the actual level of data use, as assessed in Chapter 6. A complete overview of the factor rates and the assessed degree of actual data use for the 39 decision-making data use cases, can be found in Annex 12.

9.3.1 Individual capacity and motivation and data use

In data use cases with actual data use, individual capacity and motivation for data use are rated at least moderate. Only one data use case was observed with at least moderate individual capacity and motivation, but without actual data use: the use of asset data in operational decision-making. The low accessibility of these data, as assessed in Chapter 6, explain the lack of data use in this case.

Few data use cases were observed with at least moderate motivation for data use, but without actual data use. Low individual capacity for data use may have played a role in hampering actual data use in these cases. These included:

- Process use of PI&BM and NWI data in policy-making
- Referencing, but no actual use of PI&BM data in the annual rewarding of utilities by the Federation; and
- Lack of use of utility performance data in operational decision-making by Water Boards.

Several cases were observed with at least moderate individual capacity for data use, but low motivation and no data use. Lack of motivation in these cases was related to political and social interests competing with data in the case of economic regulation, and to strength of relationships and data flows in the second group of cases mentioned above. These cases included:

- Data use for economic regulation;
- Use of data which was not produced by the user, including PI&BM and NWI data by utility and Regional Water Bureau, use of TUMS data by utilities, use of JMP data by the Ministry.

Individual capacity and motivation for data use are thus strong enablers for data use, and disable use of data when they are not in place. However, having both of these factors in place, does not guarantee data use (but does make it more likely).

9.3.2 Organisational opportunities and data use

Only few data use cases were observed with at least moderate organisational capacity factors. Decision support tools were only in place in data use cases involving TUMS, JMP or PI&BM data. Of these cases, actual use was only observed of TUMS data in regulatory and planning decision-making by the Tigray Water Bureau.

In data use cases with low human and / or financial resources, actual data use was found to be low or lacking. However, moderate actual data use was observed in several data use cases without decision support tools.

Having organisational opportunities in place is thus not a guarantee for data use. Lack of organisational human and financial capacity does not disable actual use, but does strongly hamper it. Lack of decision support tools does thus not disable data use, but its presence can stimulate and enable it.

9.3.3 Sectoral opportunities and data use

Strength of data-use systems was the lowest scoring factor, with such systems found not to be in place for the majority of data use cases.

In the majority of the data use cases where such systems were in place, actual data use or process use was observed. However, despite the moderately strong data-use systems for use of JMP data for informing macro-level planning, actual use of these data was not observed. This lack of use was explained by the low motivation of the Ministry for this.

In several data use cases with weak data-use systems and incentives for data use, actual data use was observed.

The strength of data-use systems was thus found to not disable actual data use when not in place, but where in place, it was found to be a strong enabler of data use.

9.3.4 Contextual opportunities and data use:

In several use cases with at least moderately rated national culture, actual data use was observed, while that was not observed in others.

In most cases with low national culture for data use, actual data use was not observed. An exception was the case of strategic planning by utilities, where despite low rated national culture, actual data use was observed. Similar correlations were observed between political economy related to data use cases and observed degree of actual data use. **Low rating national culture and political economy therefore do not disable data use, but moderate to high rating ones do seem to stimulate and enable it.**

9.4 Indirect influence of factors on data use

Section 9.3 provided insight into the direct influence of individual capacity, motivation and opportunities for data use on actual data use. The COM-B model, which guided the analysis presented in this chapter, acknowledges the influence of these factors on data use, but also the influence of data use on these factors. In addition, it acknowledges that capacity and opportunities can influence motivation. Through their interrelations, factors can thus not only directly, but also indirectly influence actual data use. This section explores the interrelationships between the factors.

The factor interrelationships are displayed in the cross-impact matrix presented in Table 9-6. Each cell of the matrix indicates the observed or assumed strength of the influence of the influencing factors, displayed in the first column, on the influenced factor, displayed in the first row. In the matrix, 0 indicates no relationship, 1 indicates a weak influence, and 2 indicates a strong influence. Chapter 3 presents a more elaborate description of the methodology. This section describes the observed or assumed interrelationships between the factors, based on empirical evidence from the data use cases presented in this thesis.

9.4.1 Influence of capacity for data use on other factors

Individual capacity strongly influences individual motivation for data use. For example, the capacity of the head of the MSMSP team influenced his motivation for using data for regulation of utility performance. This capacity was built through his involvement in a project which used data to track utility performance. Also, the lack of capacity of Ministry staff in understanding and using utility performance data may have contributed to low motivation for use of these data by Ministry staff.

Individual capacity and motivation weakly influence presence of decision support tools. This was illustrated by the case of the development of TUMS, driven by individual capacity and motivation for regulatory data use by Regional Water Bureau staff. However, the presence of other decision support tools, including the JMP and IBNET online databases, have not been influenced by capacity and motivation for data use. Therefore, the influence of capacity and motivation on decision support tools is rated as weak.

9.4.2 Influence of motivation for data use on other factors

Individual motivation weakly influences individual capacity for data use. Although individual capacity for data use can influence individual motivation for data use, motivation is likely to have less influence on individual capacity. When there is high interest in use of data, capacity building opportunities for increasing capacity for data use are more likely to be sought, resulting in increased capacity.

For example, the Ministry's interest in using utility performance data in 2012, led to the Ministry engaging WSP/World Bank to strengthen sector capacity in the production and use of utility performance data. However, this was focused on production rather than on use of data.

Also, even when there is interest in data use, the resources may not be available to ensure building capacity for production and use of data. For example, in Wukro and Jinka, although utility management was interested in using data for informing reporting and decision-making processes, the lack of human and financial resources for capacity building prevented a strong positive influence of motivation on capacity.

Table 9-6: Cross influence matrix, behaviour systems perspective

Influencing factors		Influenced factors								
Influencing factors	Individual capacity	Individual motivation	Organisational opportunities			Sectoral opportunities	Contextual opportunities		Data use	
			Organisational human resource capacity	Organisational financial capacity	Presence of DSTs	Strength of data-use systems	Political economy	National culture		
Individual capacity	x	2	0	0	1	0	0	0	2	
	1	x	1	1	1	1	0	0	2	
	2	2	x	0	0	0	0	0	2	
	0	2	2	x	2	0	0	0	2	
Organisational opportunities	0	2	2	x	2	0	0	0	2	
	0	2	0	0	x	0	0	0	2	
	0	2	2	2	2	2	2	2	2	
Sectoral opportunities	0	2	2	2	2	x	0	0	2	
	0	2	2	2	2	2	2	2	2	
Contextual opportunities	0	2	2	2	2	2	2	x	2	
	0	2	2	2	2	2	2	2	2	
	2	2	0	0	0	2	0	0	x	
Influence rating: 0= no influence; 1= weak influence, 2= strong influence										

Influence rating: 0= no influence, 1= weak influence, 2= strong influence

Individual motivation also weakly influences organisational and sectoral opportunities for data use. When there is interest in data use, it is likely that human and financial resources will be allocated towards data-driven decision-making and action, and that decision support tools will be developed or put in place. For example, in Tigray, the interest in using data for regulating utilities resulted in human and financial resources being allocated and made available for doing so by the Tigray Water Bureau. This interest also sparked the development of TUMS as a decision support system.

9.4.3 Influence of organisational opportunities for data use on other factors

Organisational human capacity strongly influences individual capacity for data use. When sufficient human resources are available, it is more likely that staff have time to engage in capacity building. For example, due to lack of human resource capacity, utilities have focused on operations and corrective actions, making it feel like 'working for a fire brigade' (as remarked by the Wukro Utility Manager in Section 9.2.1.3), with little room for staff capacity development.

Organisational human and financial resource capacity strongly influence motivation for data use. When data cannot be acted on because of human or financial resource constraints, then interest in data use is likely to be low. For example, utilities in Ethiopia generally lack financial capacity to undertake major repairs, rehabilitation and renewal of assets. Many depend on Regional Water Bureaus and external development partners for this. Therefore, their interest in keeping and using up-to-date asset data for informing asset management is low. Another example is the Tigray Water Bureau's low motivation for data use for operational decision-making due to lack of financial and logistical resources to act on the decisions.

The presence of decision support tools influences individual motivation for data use. The presence of the TUMS for example, which can be considered a decision support tool for informing regulatory decisions, resulted in motivation of Tigray Regional Water Bureau staff to use these data.

Organisational financial capacity strongly influences other organisational opportunities for data use. Lack of financial capacity of the Jinka Utility has for example contributed to the lack of decision support tools and lack of human resources for interpreting and using data.

9.4.4 Influence of sectoral opportunities for data use on other factors

Strong data-use systems (for planning, regulatory and accountability, financing etc.) provide clarity on roles and responsibilities, mechanisms and processes for data use. However, as shown in Chapter 4, data-use systems related to town water supply in Ethiopia are generally weak. It is therefore difficult to present examples of the influence of strong data-use systems on other factors from the data use cases discussed in this thesis. Rather, the data use cases show examples of the influence of weak data-use systems on other factors.

Sectoral opportunities strongly influence motivation for data use. There are various examples of weak data-use systems leading to low motivation for data use. These include:

- Weak asset management systems with poorly defined roles and responsibilities have led to lack of motivation of utilities to use data for asset management.

- Lack of accountability mechanisms and regulatory systems is a key reason for low interest in data use by the Ministry.
- Lack of clear data-use systems and incentives for the use of PI&BM and NWI utility performance data at all levels may have contributed to the low interest in use of these data.
- A business plan as a requirement for accessing funding from the Water Resource Development Fund, could have been a strong incentive and motivator for evidence-based strategic planning by utilities. However, systems and mechanisms for enforcing this were weak, leading to low interest of utilities in evidence-based strategic planning (unless supported by a project).

Sector opportunities strongly influence organisational opportunities for data use. Where strong data-use systems are in place, organisations are more likely to allocate human and financial resources to data use, and acquire or develop decision support tools. Where such systems are not in place, as was the case in Ethiopia, organisational opportunities for data use are less likely to be in place.

9.4.5 Influence of contextual opportunities on other factors

Contextual opportunities strongly influence motivation for data use. At the local level, a political economy favouring political interests and affordability above data-based decision-making in tariff setting, decreased the motivation of utility staff in using data for this purpose. Also, power relations between utility staff and influential customers, rather than operational data, were found to occasionally influence operational decision making by utility staff, leading to lack of interest in these data.

The low government interest, political leadership, and vision for improving utility performance, as assessed in Chapter 9, contributes to low motivation of actors at different levels to use utility performance data. An interviewed urban specialist of the Ministry, for example, did not consider utility performance reports useful, unless there were infrastructure projects ongoing (pers. comm. Woldemariam Bashira, 2018), like the second urban water and sanitation project.

Also, the national culture, focused on shorter-term planning for asset development rather than on utility performance improvement, contributed to a lack of interest of the Ministry in the use of utility performance data for macro-level planning.

Contextual opportunities strongly influence organisational and sectoral opportunities for data use. For example, the political leadership and power relations plays an important role in determining allocation of organisational funding and can thus highly influence organisational financial and human resources and decision support tools for data use. Political leadership and power relations can also play a role in influencing human resource capacity for data use and decision support tools. The political economy and national culture also influence whether incentives and strong data-use systems are in place.

9.4.6 Influence of data use on behaviour system factors

The actual use of data strongly influences individual capacity, motivation and sectoral opportunities for data use. As seen in the case of the TUMS development, when data are

actually used, this increased people's experience and thereby their capacity for doing so. Actual use of data also strongly influences individual motivation and sectoral incentives for doing so.

9.5 Summing up the behaviour systems perspective

This chapter explored the factors that enable and hamper data use from the behaviour systems perspective. It described and assessed the capacities, motivations and opportunities for data use of different data users across institutional levels. Capacities, motivations and especially the opportunities for data use were found to be generally weak, with low organisational financial capacity, lack of decision support tools, and especially weak data-use systems and incentives for data use.

Comparing the strength of the behaviour system factors, as rated in this chapter with the level of observed actual use, as assessed in Chapter 6, provided additional insight into the factors that enable and hamper actual data use. It succeeded in using factors from the behaviour systems perspectives to explain actual use in data use cases, which were not explained by the factors from the linear perspective, focused on data attributes (Chapter 7), and the relationship perspective, focused on quality of relationships between data producers and users (Chapter 8). These included:

- The lack of utility performance data use by Water Boards, despite relatively strong data attributes and relationship between data producers and users. The behaviour systems perspective explained this through the low capacity and motivation of the Water Board for this data use.
- The lack of TUMS data use for informing tariff approval, despite the relatively strong data attributes and relationship between data producers and users. The behaviour systems perspective explained this through the low motivation of the Regional Water Bureau to do so, the weak data-use systems without clear incentives for data-based tariff approval, and the political economy favouring political and social interests above data to inform these decisions.

Comparing the strength of the factors with the degree of actual observed data use on all 39 data use cases, the chapter demonstrated that:

- Weak individual capacity and motivation have a strong disabling effect on actual data use;
- Weak human and/or financial resources have a strong hampering effect on data use;
- Presence of decision support tools has a weak enabling effect on actual data use.
- Strong data-use systems, with clear incentives for data use are strong enablers for data use;
- National culture and political economy can hamper or enable data use.

The chapter showed that, in line with the behaviour system introduced in Chapter 2 (COM-B model), capacities and opportunities influence motivation. Motivation seems to be especially influenced by whether the political economy is supportive of data use, and whether decisions are influenced by other (non-data-based) factors. Although not captured explicitly in the COM-B model, this chapter did observe influence of individual capacity on opportunities for data use, particularly the capacity of the Regional Water Bureau staff in Tigray for using utility performance data for performance regulation, which was found to have a positive effect on the evidence-based decision-making culture in the region.

9.6 Way forward

This chapter added several factors for enabling and hampering the use of data, to the ones already explored in Chapter 7, which took a linear perspective, focused on data attributes, and Chapter 8, which took a relationship perspective, focusing on the quality of relationships between data producers and users. Throughout this and the preceding chapters, it was observed that these factors do not function in isolation, but interact with and influence each other. The chapter that follows, Chapter 10, brings the factors from the three perspectives together in a fourth, comprehensive systems perspective. It focuses on how the different factors influence and depend on each other. Furthermore, it explores which of these factors have the strongest leveraging power within the system of factors enabling and hampering data use.

10 COMPREHENSIVE SYSTEMS PERSPECTIVE

10.1 Introduction

The previous three chapters each looked at data use from a different perspective, with emphasis on specific sets of enabling and hampering factors. Chapter 7 explored the role of the data attributes in enabling and hampering their use, taking a linear perspective. Chapter 8 looked at the quality of relationships between data producers and users and the networks in which they operate, taking a relationship perspective. Chapter 9 addressed political, organisational, socioeconomic, and attitudinal issues by looking at how individual capacity and motivation for data use and organisational, sectoral and contextual opportunities influence actual data use, taking a behaviour systems perspective. An overview of these factors is provided in Table 10-1.

Table 10-1: Overview of factors influencing data use

Grouping of factors		Factor
Data attributes		Relevance of data for use
		Timeliness of data
		Credibility of data
		Data comprehensiveness
		Physical accessibility of data to users
		Availability of data in accessible formats
Relationships		Quality of relationship between data producers and users
Behaviour system	Individual capacity for data use	Individual capacity for data use
	Individual motivation for data use	Personal interests in and motivation for data use
	Organisational opportunities for data use	Human resource capacity
		Financial capacity for data use
		Presence of decision support tools
	Sectoral opportunities for data use	Strength of data-use systems
	Contextual opportunities for data use	Political economy
		National culture

The preceding chapters have shown that these factors play a role in enabling or hampering actual data use. However, merely defining the direct influence of the factors on actual data use, provides limited insight into their relative significance, or the ways in which different factors might interact (Nutley et al., 2007). This chapter, therefore, focuses on the interrelationships between the factors in the data use cases explored in the previous chapters. This provides insights into the answer to the fourth research question of this thesis: *‘What conditions need to be in place to ensure the use of monitoring data? What are the leverage points to ensure the use of monitoring data?’* This chapter addresses this question by answering the two detailed research questions presented in Chapter 3:

- How do the different factors identified under perspectives 1 to 3 relate to each other? How do they influence and depend on each other?
- What are the possible leveraging factors which have the largest potential influence on enabling data use?

The first question is addressed in Section 10.2. It presents an analysis of the strength of the influence that factors have on each other: no influence, weak influence, strong influence. These are presented in a cross-impact matrix, with strong influence of a factor on another one indicated with a value of 2, (weak) influence with a value of 1, and no influence with a value of 0. The assessment of the factor influence was done by the author, based on insights from the data use cases presented in this thesis. Linking each factor to the factors they influence results in a network of factors that together, directly and indirectly, influence data use.

The second question is addressed in Section 10.3. In this section, the factor network created through the analysis in Section 10.2 is explored further, to get insight into the factors that can play a leveraging role in influencing use of data. This section presents an overview of the active and passive sums of the cross-influence matrix of Section 10.2 and maps these in a direct and indirect influence and dependencies matrix. The chapter concludes with a summary of the main findings.

It should be noted that the analysis presented in this chapter is a semi-quantitative interpretive exploration of factors within the data-use system that could have a leveraging effect, rather than a fully objective, positivist assessment. For more information on the methodology, see Chapter 3.

10.2 Factor influence and dependency

The first step towards understanding how the factors of the different perspectives relate to each other, is an assessment of the assumed influence of the factors on each other, in the form of factor influence scores. Figure 10-1 presents an overview of the factor influence scores in a cross-impact matrix. Parts of the matrix were discussed in Chapter 7 (on interrelations among data attributes) and Chapter 9 (on the interrelations among factors of the behaviour system on each other), as indicated in Figure 10-1. The sections that follow each present the rationale for the assessed influence scores for a specific part of the matrix, as indicated in the figure. These sections only discuss the factors that influence each other. Factors that do not influence each other, indicated with a 0 score in Figure 10-1, are not discussed. Section 10.2.7 presents the factor network, constructed based on the factor interrelations.

10.2.1 The influence of data attributes on the quality of relationships

Data credibility, physical accessibility and availability of data in accessible formats weakly influence the quality of relationships. For example, the low credibility of utility performance data to national actors, as potential users of these data, may have contributed to lack of trust between national actors and utilities and hence to low-quality relationships.

Physical accessibility of data can enable network ties between data producers and users, which can contribute to higher quality relationships between the two. However, the presence of highly accessible data does not always result in strong relationships between data producers and users. For example, although the PI&BM data were publicly accessible on the IBNET website, this did not lead to stronger relationships between producers and (potential) users of these data.

Lack of accessibility of data in appropriate formats for reporting for downward accountability to water users may have contributed to mistrust between utilities and water users.

Figure 10-1: Cross-influence matrix

Influenced factors														
Influencing factors	Data attributes					Quality of relationship between data producers and users			Behavioural system				Contextual opportunities	
	Data attributes			Physical accessibility		Accessible formats		Individual capacity	Organisational opportunities		Individual motivation	Strength of data-use systems		National economy/culture
	Relevance	Timeliness	Credibility	Comprehensiveness	Physical accessibility	Accessible formats	Individual capacity		Human resource capacity	Financial capacity		Presence of DSTs	Political economy/culture	Data use
Relevance	x	0	0	0	0	0	0	2	0	0	0	0	0	2
Timeliness	0	x	0	0	0	0	0	2	0	0	0	0	0	2
Credibility	0	2	0	0	0	2	0	2	0	0	0	0	0	2
Comprehensiveness	1	2	0	x	0	0	0	2	0	10.2.2	0	0	0	8
Physical accessibility	0	0	0	0	x	0	0	2	0	0	0	0	0	7
Accessible formats	0	0	0	0	0	x	0	2	0	0	0	0	0	2
Quality of relationship between data producers and users	1	2	2	10.2.3	1	0	0	2	0	10.2.4	0	0	3	9
Individual capacity	2	2	2	2	2	2	2	2	0	0	1	0	0	8
Individual motivation	2	2	2	2	2	2	2	x	1	1	1	0	0	2
Human resource capacity	0	0	0	0	0	0	2	2	x	0	0	0	0	2
Financial capacity	1	2	0	2	2	2	2	2	2	x	0	0	0	2
Presence of DSTs	2	0	2	0	2	2	0	2	0	0	x	0	0	2
Strength of data-use systems	2	2	2	2	2	2	2	2	2	2	2	x	0	24
Political economy	2	2	2	2	2	2	0	2	2	2	2	2	x	28
National culture	2	2	2	2	2	2	0	2	2	2	2	2	x	28
Data use	2	2	2	2	2	2	2	2	0	0	0	0	0	28
Passive sum	17	10	14	13	15	15	5	30	9	7	10	7	3	0

0= no influence; 1= weak influence, 2= strong influence

10.2.2 The influence of data attributes on the behaviour system factors

All data attributes strongly influence motivation for data use. The use of the JMP data for reporting on achievement of the water supply MDG described in Chapter 6 was enabled by the fact that the data were highly relevant, which led to high interest of government (and its development partners) in using these data for this purpose.

Decision makers are generally not motivated to use data that are not available in a timely manner and out-of-date. This was for example observed by the low interest in the use of PI&BM data and NWI utility performance data, which were made available several years after being collected, especially by sub-national decision makers.

Several national actors expressed lack of interest in utility performance data because of the perceived lack of credibility of these data.

When data are not comprehensive, it may decrease interest in use of the data.

Greater physical accessibility of data is assumed to lead to higher interest in use of these data. However, this has not been observed in the Ethiopia data use cases discussed in this thesis. The fact that PI&BM data are freely accessible online in the IBNET database, and JMP data in the JMP database, has not led to increased interest in use of these data in Ethiopia. This could be due to challenges related to other factors in the data-use system, e.g. lack of individual capacity to use the data.

Data use cases discussed in this thesis have shown that lack of processing of data into accessible formats for data use has led to lack of interest in these data.

10.2.3 The influence of the quality of relationships on data attributes

Relationships strongly influence data timeliness and credibility. For example, the high-quality relationships between utility staff and managers as data producers and users may have contributed to timely production of utility operational data, used for operational decision-making.

Trust between data producers and users, an important element of the quality of the relationship between the two, can play an important role in influencing data credibility. As shown in Chapter 7, even when accuracy of data is questionable, strong and high-quality relationships between data producers and users can lead to high credibility of produced data.

The thesis observed weaker influence of the quality of the relationships on relevance and physical accessibility. The relatively weak relationship between data producers involved in the design of the National M&E MIS and the intended data users may have contributed to inclusion of many variables, which were not all relevant for intended data use. However, the weak relationship between PI&BM data producers and potential users did not hamper the relevance of the data. Therefore, the influence of relationships between data producers and users and data relevance is assumed to exist, but to be weak.

High-quality relationships between data producers and users can contribute to high physical data accessibility, while low-quality relationships, with lack of structural links, low level of trust and non-alignment of goals and objectives can lead to low data accessibility.

10.2.4 The influence of the quality of relationships on behaviour system factors

Relationships strongly influence motivation for data use. Involvement of dedicated data collectors in the NWI1 and 2 data collection exercise (rather than annual data collection by

Regional Bureau staff in coordination with towns, as suggested by the 2008 manual), posed a challenge for data ownership and individual motivation to use data.

Weak relationships between data producers and (potential) users can lead to weak motivation for use of the data. For example, JMP does not have a strong relationship with the Ministry, as a potential user of JMP data. This may have played a role in the low observed motivation of the Ministry in use of these data, especially when compared with its interest in the use of the coverage data it co-produces.

Relationships weakly influence political economy. For example, the weak relationship between PI&BM data producers and potential users is likely to have contributed to lack of leadership and vision for the use of these data.

10.2.5 The influence of behaviour system factors on data attributes

10.2.5.1 The influence of individual capacity for data use on data attributes

Capacity for data use strongly influences data relevance and timeliness. Use of utility data for development of business plans supported and facilitated by consultants with the capacity to interpret and use data for this purpose, led to compilation of highly relevant data, available at the time of the business plan development process.

Capacity for data use weakly influences data credibility, comprehensiveness, and data availability in appropriate formats. As shown in the case of the production and use of the TUMS and PI&BM data, the capacity for data use ensured that data were sufficiently cleaned, with relatively high credibility levels. However, lack of individual capacity has also been observed to lead to high credibility of data, despite low data accuracy. As one of the interviewees stated, *'A problem of government is that everything is believed from reports, without verification of reliability of data.'* (pers. comm. anonymous, 2018). Therefore, although individual capacity for data use seems to highly influence data accuracy, its influence on data credibility was assessed as less strong.

When there is high individual capacity to interpret and use data, it is more likely that comprehensive data will be produced, but this is not a guarantee, as observed in the TUMS case.

Actors with high individual capacity to use data are more likely to request, stimulate and facilitate the production of data in appropriate formats, increasing format accessibility of the data. On the other hand, limited individual capacity in interpreting and using data could be mitigated by having data available in appropriate formats. For example, when policy makers lack individual capacity to interpret and use utility performance data, data producers could be stimulated to make data accessible in clear and suitable format (e.g. with clear policy recommendations).

10.2.5.2 The influence of individual motivation for data use on data attributes

Motivation for data use strongly influences all data attributes. In both Jinka and Wukro the utility managers showed keen interest in the data and were highly motivated to use these data for operational decision-making and reporting, and therefore stimulated the production of relevant, credible, comprehensive data and ensuring it is accessible to them in appropriate formats at the appropriate time.

The high interest of the Tigray head of the MSMSPP in data use for regulating utilities, resulted in production of relevant, comprehensive, timely, and accessible data for that purpose.

The Ministry was very interested in the use of coverage data, but less so in the use of utility performance data. The Ministry therefore put more effort into processing and analysing annual coverage data, resulting in highly relevant, timely, credible, comprehensive and accessible coverage data. It put considerably less emphasis on processing and analysing utility performance data, with a large part of collected data unprocessed and not relevant, timely, credible, comprehensive or accessible.

10.2.5.3 The influence of organisational opportunities for data use on data attributes

Organisational financial capacity for data use strongly influences data attributes. As shown in Chapter 8, the organisational financial capacity for data use in town water supply in Ethiopia is generally low. Utilities lack financial resources. This contributes to challenges with the production of timely, accurate and credible, comprehensive, accessible data and, to a lesser extent, relevant monitoring data. The Jinka and Wukro utilities for example lacked financial resources to put in place tools and procedures for producing relevant, accurate, timely, accessible and comprehensive data.

Decision support tools strongly influence data credibility, accessibility and availability in accessible formats. The TUMS, JMP and PI&BM data were the only data sets related to a decision support tool (of sorts). These decision support tools made these data accessible, both physically and in a format that enabled data use. They also enabled data processing and cleaning, resulting in more accurate and credible data.

In the case of the national MIS system, decision support tools were not available at the time of data collection, which contributed to a wide array of data being collected, with processing of only a very small proportion of these data into accessible formats.

10.2.5.4 The influence of sectoral opportunities for data use on data attributes

Data-use systems and incentives strongly influence all data attributes. The thesis observed strong influence of the strength of data-use systems on all data attributes. The lack of strong systems and incentives for enabling and stimulating data-based decision-making (Chapter 8) were likely to have influenced the lack of interest in the production of relevant, timely, credible, comprehensive and accessible data. For example, because of the absence of clear rules, regulation and contractual arrangements (institutional capacity) for contractors involved in asset development to make data available, utilities often do not have physical access to asset data from the construction companies involved in the construction and rehabilitation of the schemes.

10.2.5.5 The influence of contextual opportunities for data use on data attributes

The political economy strongly influences all data attributes. Arsano et al. (2010) found that political and institutional incentive-system for reporting on water coverage levels and targets at woreda and regional levels, including salary, funding and promotion opportunities, led to several instances of over-reporting progress against targets. On the other hand, they reason that over-reporting may lead to loss of technical (and financial) support from regional governments, which could in turn serve as an incentive for under-reporting. These examples show how political economy influences the actual use of data. This can influence the **credibility** of these data by other potential data users, e.g. at national level.

Political leadership and vision of the Ministry for the use of data for informing the on construction of new schemes is higher than that for improving utility performance, as presented in chapter 9. This has contributed to the high relevance of coverage data and considerably lower relevance of service performance data.

This thesis showed that the policy decision to introduce goals related to utility performance in GTP2 led to an increase in a demand for reporting on these indicators from service authorities (Regional Water Bureaus and Water Boards). In principle, this could have a positive influence on the producing of timely, credible, comprehensive and accessible monitoring data. However, utilities often lack tools and capacities to produce accurate utility performance data. As a result, they have been observed to report desirable figures, rather than using accurate data for reporting. A political economy which pushes for data use can, therefore, also have a negative effect on data attributes, especially data credibility. This was also observed with the push from development partners for the development of the WASH M&E MIS, which contributed to the production of irrelevant, untimely utility performance data with relatively low credibility.

National culture also strongly influences all data attributes. The lack of a data use culture has resulted in a lack of emphasis on the production of reliable, comprehensive, timely, accurate and credible data. There is, especially, a failure to process data into accessible formats and information products that can inform data use for policy-making, planning, regulation, operational decision-making and reporting, especially for downward accountability. There is little priority given to conversion of raw data into published information products, with many reports staying in draft stage for years (or forever). As mentioned by a national (at the time) actor, ‘the system does not prioritise properly formalising and publishing information products. A large part of reports is in draft stage and stays like that for years.’ (pers. comm. Butterworth, 2018). This seems to be an inherent part of the culture of the water supply sector in Ethiopia, which has influenced the lack of capacity and interest at Ministry level to publish information products and make these accessible in appropriate formats.

10.2.6 The influence of behaviour system factors on quality of relationships between data producers and users

10.2.6.1 The influence of individual capacity and motivation for data use on relationships

Individual capacity and motivation for data use strongly influence relationships. When decision makers have the individual capacity and motivation to use data, they are more likely to ensure high-quality relationships with data producers (with high structural, relationship and cognitive social capital between them).

10.2.6.2 The influence of organisational opportunities for data use on relationships

All organisational opportunity factors strongly influence relationships. When human and financial resources for data use are in place, these are likely to contribute to ensuring high-quality relationships between data users and producers. Low motivation (and capacity) to use data can lead to low-quality relationships between data producers and users. This was, for example, shown in the case of Jinka, where low motivation (and capacity) of the town administration (and Water Board) to use utility performance data for informing regulatory

decision-making led to a lack of trust of the utility manager in the Water Board *‘What is the point of taking the reports from us if you do not do anything?’* (pers. comm. Gedefa Wami, 2018).

The presence of decision support tools may also improve the quality of relationships between data producers and users. However, the presence of these decision support tools may also decrease the need for data users to engage directly with data producers. Therefore, the influence of the presence of decision support tools on the quality of relationships between data producers and users may not be very big.

10.2.6.3 The influence of sectoral opportunities for data use on relationships

Data-use systems and incentives for data use strongly influence relationships. Where incentives for data use are part of sectoral data-use systems, these are likely to result in high-quality relationships between data producers and users, with data users actively engaging in establishing and maintaining high-quality relationships with data producers. However, as strong data-use systems with clear incentives for data use were mostly absent in the Ethiopia town water sector, the influence of incentives on the quality of relationships between data producers and users could not be directly observed in the data use cases presented in this thesis. Strong data-use systems, with clear roles and responsibilities of different actors, including producers and users of data, are likely to contribute to high structural social capital between data producers and users, and with that, the high quality of their relationship. The absence of such strong systems, as was observed to be the case in Ethiopia, can lead to absence of high-quality relationships between data producers and users. For example, the weak systems related to asset management, with absence of clear roles and responsibilities, contributed to the lack of structural relationships with effective data flows between producers of asset data (e.g. contractors) and potential users of these data (e.g. utility staff and management).

10.2.6.4 The influence of contextual opportunities for data use on relationships

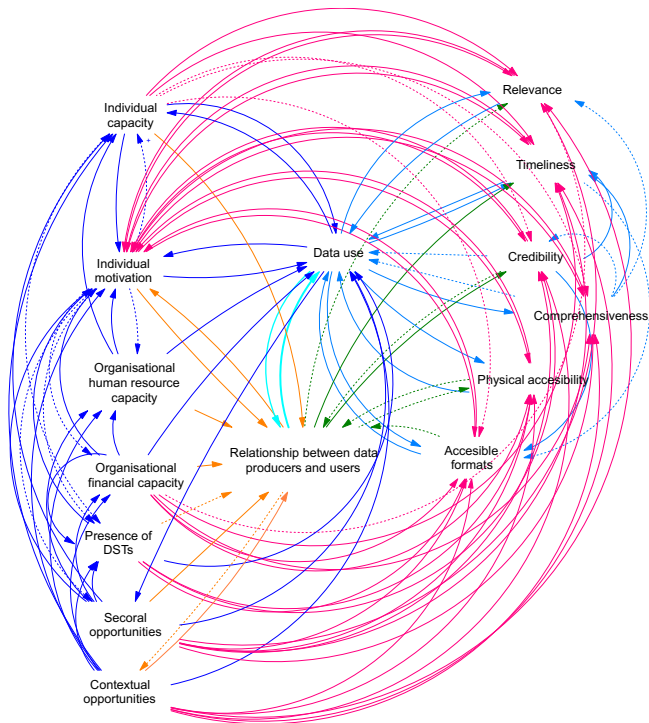
Political economy and national culture strongly influence relationships. As for example presented in chapter 9, the political economy related to data use for economic regulation is weak, with power structures that favour affordability and political concerns above data-based evidence for the need to increase tariffs. This has contributed to the lack of trust between utilities and Regional Water Bureaus as potential users of the data produced by utilities.

As presented in this thesis, the development of the national WASH M&E MIS and the PI&BM systems were facilitated and pushed by development partners, with the Ministry playing an important leadership role in the production of the data. However, political leadership and vision for the actual use of the produced data, was largely lacking. This contributed to a gap between data producers and data users at the local- and sub-national levels, and thereby low-quality relationships between the two.

10.2.7 Factor network

Figure 10-2 displays the above-identified and rated influence of the factors on each other, as a causal loop diagram of the data use factor system.

Figure 10-2: Feedback loops



Factor influence P1; Factor influence P2; Factor influence P3; Factor influence P1 and P2; Factor influence P1 and P3; Factor influence P2 and P3; Solid line = strong influence; Dotted line = weak influence

Figure 10-2 shows a dense network of factors influencing each other, with various causal loops. The factor with the highest betweenness centrality in this factor network is 'individual motivation', followed by 'quality of relationships', and 'political economy'. If these factors are weak or not in place, they can have a considerable negative influence on the other factors in the system and ultimately on actual data use. 'Individual motivation' was also the factor that was most prevalent in strong causal loops (comprising only of factors strongly influencing other factors). See annex 13 for details on the betweenness centrality and causal loop analysis methodology and results.

Table 10-2 presents how the factors that influence data use from the first three perspectives relate to each other. It presents the average influence score of the factors per perspective. It shows that the influence of the factors from the linear perspective on the factors from the other perspectives, was limited. Likewise, the influence of quality of relationships on the factors from the behaviour systems perspective, was limited. The behaviour systems factors strongly influence the quality of relationships, and, to a slightly lesser extent, the data attributes from the linear perspective. The factors from the behaviour systems perspective thus have the strongest influence on the factors in this factor network.

Table 10-2: Average influence scores of the factors from the three perspectives on each other.

Influencing factors	Influenced factors		
	Linear perspective (data attributes)	Relationship perspective	Behaviour systems perspective (capacity, motivation and opportunities for data use)
Linear perspective (data attributes)	x	0,50	0,29
Relationship perspective	1,00	x	0,38
Behaviour systems perspective (capacity, motivation and opportunities for data use)	1,46	1,88	x

10.3 Identifying leverage points

This section explores leveraging factors within the factor network presented above. It does so by presenting and discussing 1) The direct passive and active sums of the factors, based on the cross-matrix; and 2) The influence/dependency map, with plotted direct and indirect active and passive sums for each factor. The indirect active and passive sums are determined using the MICMAC method as described in Chapter 3. The indirect cross-influence matrix can be found in Annex 14. The influence/dependency map provides insight into the possible leverage factors.

10.3.1 Active and passive sums

The cross-influence matrix presented at the start of Section 10.2 gives a numerical representation of the assessment of influence of the factors on each other, with strong influence given a score of 2 and weak influence a score of 1. The sum of the influence scores per (horizontal) row is the active sum. This gives an indication of the overall influence of a factor on the other factors in the factor network. The sum of the scores per (vertical) column is the passive sum. It gives an indication of the dependency of the factor on other factors in the factor network. Table 10-3 presents the active and passive sum of each factor.

It shows that contextual and sectoral opportunities for data use have the highest active sum, implying that these factors play an important role in influencing other factors. Data attributes have the lowest active sum, implying these factors have the least influence on the other factors in the network. It also shows that individual motivation for data use has the highest passive sum, implying that this factor is highly influenced by (or highly dependent on) other factors. Data use is also highly influenced by other factors, as expected, as this is the outcome variable of interest for this factor network.

Table 10-3: Active and passive sum

Factor group		Factor	Passive sum (dependence)	Active sum (influence)
Data attributes	Relevance		15	4
	Timeliness		21	5
	Credibility		14	8
	Comprehensiveness		13	7
	Physical accessibility		15	5
	Accessible formats		18	6
Quality of relationship between data producers and users			20	11
Behaviour system	Individual capacity		5	14
	Individual motivation		30	21
	Organisational opportunities	Organisational human resource capacity	9	8
		Organisational financial capacity	7	19
		Presence of decision support tools	10	11
	Sectoral opportunities	Strength of data-use systems and incentives	7	24
	Contextual opportunities	Political economy	3	28
		National culture	2	28
	Data use			28

10.3.2 Influence/dependency mapping

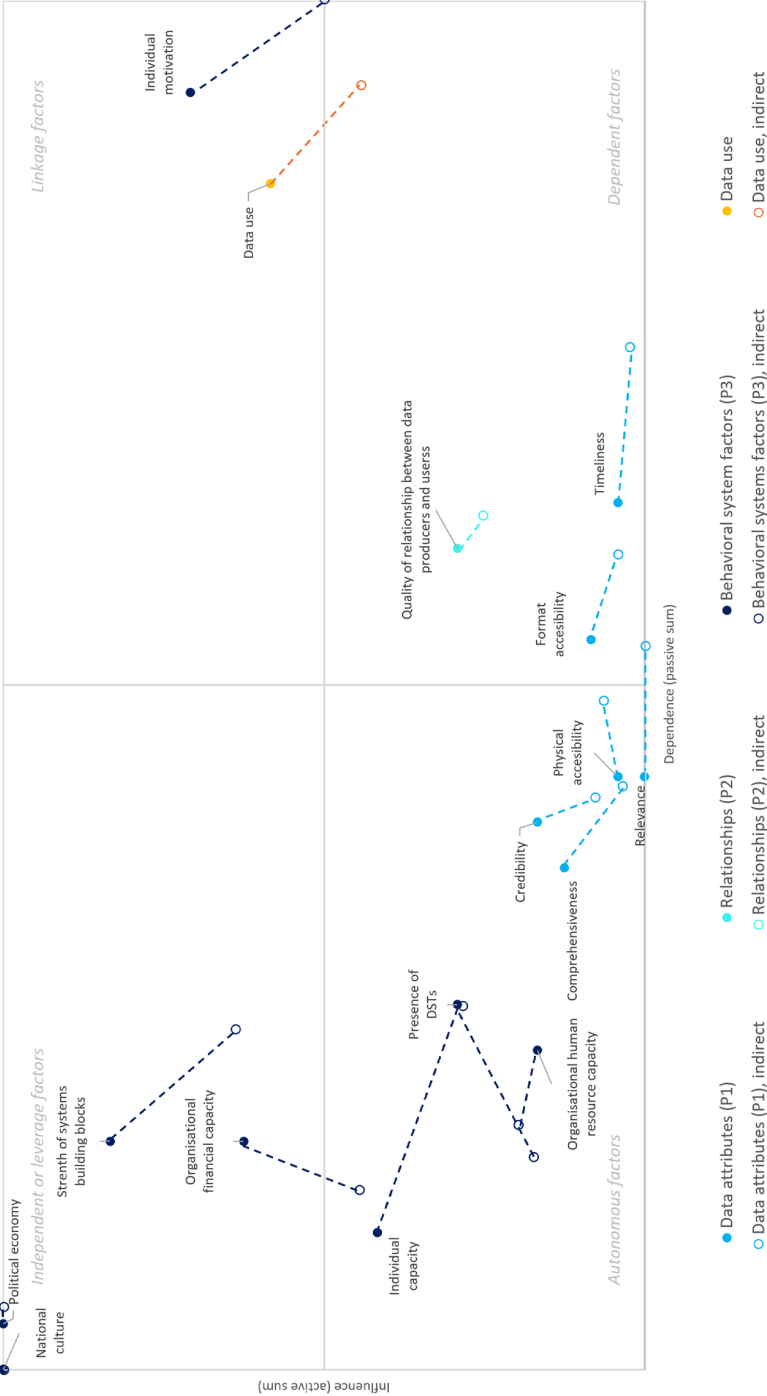
In addition to quantifying the direct influence and dependency of each factor, the indirect influence and dependencies can be quantified using the MICMAC method. This method applies a system of matrix multiplications to the cross-influence matrix, based on the classical properties of Boolean matrices (Godet et al., 1994). This allows for the assessment of the diffusion of impacts through reaction paths and loops. The results of this analysis are presented in Annex 14.

Plotting the direct and indirect passive and active sums for each factor on the x- and y-axes respectively, results in the influence/dependency map displayed in Figure 10-3. The factors in the upper left quadrant of the graph, with relatively high influence, but low dependency on other factors, can be considered the leverage points.

As shown in the figure, the leverage points are mainly the factors related to the contextual, sectoral and organisational opportunities: national culture, political economy, strength of data-use systems, and organisational financial capacity to use data. These factors have the highest power to change the system and influence the outcome of the system, which in the case of this thesis, is use of monitoring data.

The figure also shows that data use and individual motivation highly influence and in turn are highly influenced by other factors, making these factors volatile.

Figure 10-3: Direct and indirect influence/ dependency map



The data attributes have little influencing power within the data-use system. This does not mean that these factors are not important. As shown in Chapter 7, having reliable, credible, comprehensive, timely and accessible data is an important condition for data use. This chapter showed however that changes in data attributes by themselves are not likely to have a big influence on other factors in the system.

Differences between the direct and indirect influence/dependency scores are indicated in the figure with the dotted lines between the two data points. It shows that the contextual and sectoral factors can be considered leveraging factors through both the direct and the indirect factor mapping. Organisational financial capacity was found to move into the lower left quadrant, representing the autonomous factors. This indicated that over time (over multiple loops), the leveraging power of organisational financial capacity might decrease.

10.4 Summing up the comprehensive perspective and the leverage points

This chapter combined the data attributes from the linear perspective (explored in Chapter 7), quality of relationships between data producers and users from the relationship perspective (explored in Chapter 8) and capacities, motivations and opportunities for data use from the behaviour systems perspective (explored in Chapter 9) into a fourth perspective, the comprehensive systems perspective. This comprehensive perspective considers these factors as part of a complex network of factors that play a role in enabling and hampering data use, either directly, or through the influence on each other.

Individual motivation for data use was found to be the factor with highest dependency score. This factor was thus heavily influenced by the other factors. It also has the highest degree of between centrality and is the most prevalent factor in causal loops.

The factors with the highest influence and lowest dependency on other factor, and thus the highest leveraging potential, were all found to be factors related to opportunities from the behaviour systems perspective: the two contextual opportunity factors (national culture and political economy; the sectoral strength of data-use systems; and the organisational financial capacity for data use.

Strong leveraging factors are expected to have a strong influence on data use, through their influence on other factors. Strong national culture, political economy, data-use systems, and organisational financial capacity were indeed found to correlate with actual use of data. However, in some data use cases with relatively strong political economy and national culture, hampering factors remained. For example, although there was a relatively strong national culture and political economy for the use of utility performance data in operational decision making at sub-national level in Tigray, the low financial capacity of the Regional Water Bureau hampered the use of utility performance data in these processes. Weak leverage factors are expected to have a negative effect data use. Lack of a national culture and political economy that stimulate data use, weak data-use systems, and low organisational financial capacity have indeed contributed to weak individual capacity and motivation for data use, poor quality of relationships and production of data without appropriate attributes, contributing to low data use. However, weak leverage factors do not prevent data use. For example, in spite of weak (regulatory) data-use systems, regulatory use of TUMS data was observed. In this case, the strong individual motivation for this data use offset the weak data-use system.

10.5 Way forward

This chapter concluded the exploration of the factors that enable and hamper actual data use from four perspectives. The chapter that follows presents the main conclusions, discussions, reflections and recommendations of this thesis.

11 CONCLUSIONS, DISCUSSION AND RECOMMENDATIONS

Due to administrative and, especially, technological developments, growing amounts of data are produced. In the water supply sector in Ethiopia, these include monitoring data produced by utilities, authorities, and government. These data can inform learning and decision-making, and enhance accountability. However, how are these data actually used, and what factors enable and hamper this? This thesis aimed to answer these questions.

It examined how various sets of monitoring data are produced and used by actors at different institutional levels, and explored the factors that enable or hamper these uses (or lack thereof), through four perspectives:

- Linear perspective: Focused on data characteristics and attributes;
- Relationship perspective: Focused on the quality of relationships between data users and producers;
- Behaviour systems perspective: Focused on individual capacities, motivations, and organisational, sectoral and contextual opportunities for data use.
- Comprehensive systems perspective: This perspective integrated factors from the other three and focused on relationships between these factors, identifying leverage points for stimulating use of monitoring data.

This chapter discusses the findings and presents the conclusions and recommendations. Section 11.1 discusses the findings per research question. Section 11.2 presents the academic reflections on the methodology used and the key insights obtained in this thesis. Section 11.3 presents the recommendations for development partners and sector professionals, governments, and utilities. And finally, limitations of this study and recommendations for further research are presented in Section 11.4.

11.1 Conclusions and discussion on the research questions

The central research question of this thesis was ‘How is monitoring data used in town water supply in Ethiopia, and what are the factors that enable or hamper this?’ This question was broken down into four research questions:

- Research question 1: What are the different data use cases for monitoring data in town water supply in Ethiopia? And how have these been shaped?
- Research question 2: How and to what degree are monitoring data actually used?
- Research question 3: What factors enable or hamper the actual use of monitoring data? What conditions need to be in place to enable use of monitoring data?
- Research question 4: What are the leverage points for enabling the use of monitoring data?

This section summarises and discusses the answers to these questions as addressed in Chapters 5 to 10, while also reflecting on the relevance of these findings in other, less-resource constrained contexts beyond Ethiopia.

11.1.1 Research question 1: Identifying data use cases

What are the different data use cases for monitoring data in town water supply in Ethiopia? And how have these been shaped?

Chapter 5 explored Ethiopia's town water supply monitoring landscape, presenting a comprehensive overview of the monitoring systems, their intended and potential data use cases, their components, and how these were shaped over time. This section presents the main findings.

Several monitoring data sets related to town water supply are produced in Ethiopia, with partially overlapping intended data uses. These include asset, operational data, and utility performance data produced by utilities; utility performance data at regional and national level, produced by regional monitoring systems such as the Tigray Utility Monitoring Systems (TUMS), and national monitoring systems, such as the national WASH M&E MIS and Performance Indicator and Benchmarking (PI&BM); and coverage data, produced by JMP and the Ministry. Utility data were intended to inform operational and strategic decision-making, and reporting for upward accountability. TUMS data were intended to inform operational, strategic and regulatory decision-making at regional level and reporting for upward accountability. National WASH M&E MIS and PI&BM data were intended to inform strategic decision-making at different institutional levels and inform and report on progress on utility performance. Both the JMP and the Ministry's coverage data were intended to inform strategic decision-making at national level, and reporting on progress on coverage.

The study identified 20 groups of data use cases across six areas (policy-making, operational decision-making, tariff setting, planning, regulation, and reporting for accountability) and three institutional levels (national, sub-national and local). Many of these data use cases involved multiple data sets, resulting in a total of 52 unique data use cases, each concerning a specific type of data use (purpose), data set, and specific data users.

Although water supply literature has observed the presence of multiple monitoring data sets with overlapping objectives, this comprehensive overview of data use cases at different institutional levels within a single country is unique in the water supply literature. Most existing literature concerns documentation of data use cases of a single data set or use type (for example with a focus on water quality data in regulatory decision-making, as in Kumpel et al., 2020) or various unconnected data use cases in different contexts (e.g. Amjad et al., 2018; Boulenouar and Adank, 2022; Kimbugwe et al., 2022).

Development partners were found to play a strong role in the development of the monitoring system. National monitoring systems and their components (indicators, data collection formats and procedures, ICT platforms, financial frameworks) have been shaped over time by different development partners. The World Bank influenced the initial development of the PI&BM and the WASH M&E MIS in the early years, while UNICEF played a strong role in the operationalisation of the WASH M&E MIS through the first National WASH Inventory (NWI), and DFID supported further development of the WASH M&E MIS and the second NWI.

The considerable influence of development partners on shaping monitoring systems is not unique to the Ethiopian town water supply sector. Sandefur and Glassman (2014), for example, observed that development partners can substantially influence which data are collected and the methods used to capture national statistics in sub-Saharan Africa, as they tend to be the ones funding data collection processes. Development partners have an inherent need for showing return on investments to their constituents (the tax payers of the donor country), which generally means a strong interest in reporting on output and outcome indicators, like number of schemes or length of pipeline constructed or rehabilitated, and number of people served (Pichon, 2019). Support of development partners in developing monitoring systems may 'inadvertently privilege external priorities over domestic demand' (Custer and Sethi, 2017).

In Ethiopia (and beyond), funding of monitoring initiatives, have focused on (one-off) data collection, rather than on ongoing data collection, data processing, production of information materials and use. This is in line with the long-standing focus of the sector on construction of new infrastructure, rather than on putting in place the systems, processes and capacities to ensure sustainable service provision. Also, monitoring initiatives have often been managed as projects rather than as systems with institutionalised organisational and financial mechanisms and structures. The National WASH inventory was, for example, managed by a NWI Project Office. Also, although the 2012 guideline on the PI&BM initiative described the initiative as a continuous process, it consistently referred to it as a 'project', implying a limited timeline.

In high-income, non-development aid recipient countries, where emphasis is on monitoring and maintaining or improving quality of service, the development of monitoring systems has been driven by a desire of utilities to optimise operational efficiency and create transparency, and by regulatory requirements. Digitalisation and the introduction of Internet of things (IoT) have increased the amount of data produced and available (Sirkiä et al., 2017). Examples include the national benchmarking systems by VENLA in Finland (Sirkiä et al., 2017), ERSAR in Portugal, OFWAT in England (Marques et al., 2011), and utility benchmarking in the Netherlands (de Goede et al., 2016).

Although high-income countries are more likely to have national systems for tracking utility performance than middle- and low-income countries²⁵, not all high-income countries have centralised monitoring systems in place. The USA, for example, does not have a central data base with data from the more than 50,000 utilities in the country (Chini and Stillwell, 2017).

Despite the considerable investments made in the development of the monitoring system for supporting decision-making and accountability in (town) water supply in Ethiopia, it was found to be weak, as was also found by Beker and Kansal (2023). The indicator frameworks, data collection and processing procedures, and ICT systems, were found to not always enable intended data use (e.g. the National WASH M&E MIS data collection tools were not fully suitable for collecting data for tracking progress on nationally set goals related to

25. The 2022 UN-Water Global Analysis and Assessment of Sanitation and Drinking-water (GLAAS) survey found that 59% (of 17 participating) high-income countries reported to monitor urban performance indicators for quality of service, while this was only the case in 51% of (81 participating middle-income countries) and 32% (of 22 participating) low-income countries.

utility performance), while on the other hand, these monitoring system components enabled potential data uses beyond the intended use (e.g. the systems components of several monitoring systems implied potential data use for informing reporting for downward accountability). Data collection tools of the national M&E MIS included a large and growing number of variables, including variables on assets and operational data, many of which were not linked to indicators.

This phenomenon is also not unique to Ethiopia, nor to the water supply sector. It is widely recognised that country-based monitoring systems often include a lot of data on variables that are not related to national indicators, which means they cannot be used in a meaningful way (Cross, 2015). Especially with the development of mobile phone technology which enables mobile data collection, there have been several cases of development of national monitoring systems with a great number of variables, often not serving the set monitoring objectives of these systems. The expressed desire of the head of the National WASH Inventory office to be able to observe the functionality of each water facility from a computer at the Ministry in Addis Ababa (pers. comm. Hailu, 2018), echoes the famous adage from Aneurin 'Nye' Bevan, the politician credited with establishing the National Health Service in the UK, as mentioned in Mannion and Braithwaite (2012): *'if a bedpan is dropped in a hospital ward, I want the noise to reverberate through the corridors of Westminster.'*

Overall, development partners have played a role in development (and investment) of multiple sectoral monitoring systems involved in water supply in Ethiopia, some with overlapping and complementing data use cases. Nevertheless, these monitoring systems are generally weak.

11.1.2 Research question 2: Actual data use

How and to what degree are monitoring data actually used?

Chapter 6 addressed this question by describing and assessing the observed actual use of different sets of monitoring data at different institutional levels.

The degree of actual use of monitoring data in the identified data use cases was found to be considerably below the intended and potential use. This was the case for both the data produced by utilities themselves and the national monitoring data sets, such as the WASH M&E MIS data produced through the NWIs and the PI&BM. Moderate to high use was only observed by 1) utilities' use of operational data for operational decision-making and planning; 2) the Tigray Region's use of its TUMS in informing regulatory decision-making; and 3) the Ministry's use of its coverage data for informing macro-level planning.

This low use of produced data is not unique to the Ethiopian context, nor to low- and middle-income countries. A survey of Chief Information Officers from 50 of the largest water and wastewater utilities in the United States found that they only analyse and use about 10% of the data they generate (Kadiyala and Macintosh, 2018). Likewise, UK utilities are estimated to only use 10% of the data they produce (Mounce, 2021). A survey of 113 representatives from small and medium water utilities in Finland found that only 37% reported to use data from the national benchmarking system (Sirkiä et al., 2017).

However, there are also examples of relatively high degrees of data uses, many in contexts with strong capacities, systems and accountability relationships in place. For example, Safe Water

Network, a Safe Water Enterprise²⁶ operating dozens of water schemes in Ghana produces, uses data to inform operational decision-making and management. It puts considerable effort into building the capacity of staff to process, interpret and use the data. It also has strong accountability relationships in place between operational staff and management, and between management and its financiers (Boulenouar and Adank, 2022). Factors that enable actual data use were explored under research question 3 and are discussed in more detail below (Section 11.1.3).

Actual use of monitoring data was found to be a mix of conceptual, instrumental, process and accountability use. Some conceptual use of coverage data was observed in policy-making, but the majority of the observed data uses related to instrumental and accountability use.

This seems to contradict the studies in the 1970s and 1980s which identified conceptual use as the predominant form of data, information and knowledge use (Rich, 1977; Weiss, 1980). However, these studies mainly focused on the use of research findings in policy-making processes. Scientific research findings are more likely to be used conceptually, contributing to new insights and improved understanding, rather than instrumentally, directly informing decision-making (Bartram and Setty, 2021; S. M. Nutley et al., 2007). The same was observed for use of evaluation findings (Weiss et al., 2005). Decision makers in the private sector are more likely to instrumentally use data and information in informing decision-making (Beyer and Trice, 1982; Dunn, 1980).

Data use in policy-making was found to be mainly restricted to process use, with decisions influenced by the monitoring process, rather than by the produced data. For example, the introduction of the JMP and IBNET indicators (rather than the produced data on these indicators) informed the setting of national goals and standards.

Beyond Ethiopia, stronger use of monitoring data in policy-making has been observed. In the Netherlands, for example, utility benchmarking data showed a high performance of the public utilities. This informed the Dutch parliament's decision to protect water as a public good in 2003, rather than proceeding with the proposed privatisation of the water supply sector (De Witte et al., 2007). In Ghana, data showing poor performance by community-based service providers in towns informed the government's decision to move away from community-managed town water supply towards utility management, with the Community Water and Sanitation Agency (CWSA) transitioning from a facilitator and regulator of rural and town water supply to a utility (Kwadjo Siabi, 2019).

Monitoring data were found to be used for informing reporting, but rarely leading to the rights holder holding the duty bearer to account. In general, the emphasis on data use for reporting for accountability seems to be especially strong in the development sector. Custer and Sethi (2017) found, for example, the data use for reporting for upward accountability was the most frequently mentioned data use case by interviewees from Honduras, Timor Leste and Senegal. Likewise, Homer et al. (2016) also found that relevant development data were mainly reported under the assumption that someone at a higher level within an agency or government would use them.

26. Safe Water Enterprises are utilities managed by a private social enterprise, with asset development financially supported by development partners and individual donors

However, reporting duty holders are rarely held accountable based on their reports. Nevertheless, there are cases in which performance reporting did lead to accountability, and subsequently to service improvement. These cases typically involve robust systems for data use and accountability. In the Netherlands, for example, utilities began voluntary self-regulation through benchmarking in 1997, with the first benchmarking report published in 1999. The municipalities, as utility owners, were sensitive to public debate and therefore held utilities accountable, stimulating them to become more efficient. This led to improved decision-making by the utilities, leading to efficiency gains of 23% between 1997 and 2006, according to De Witte et al. (2007).

Monitoring for improvement and accountability may require different approaches and systems (Binnendijk, 2001), as the dual roles of monitoring for accountability and improvement can be at odds with each other, and tensions can arise around this ‘accountability– learning dichotomy’ (Hailey and Sorgenfrei, 2004). Binnendijk (2001) observed that government agencies often show a weakness in using monitoring data for improvement, as they emphasise monitoring for reporting for accountability, while giving little attention to applying the data and information in internal management and decision-making processes.

In their development of a ‘Data culture continuum’ for the education sector, Lasater et al. (2020) consider negative data cultures to focus on data use for compliance and accountability purposes, while they consider data use for improvement to be part of a positive data culture. Kimbugwe et al. (2022) regard a continuum from a ‘reporting culture’ to a ‘data use culture’ with evidence-based decision-making, and eventually to a ‘data-based accountability culture’, in which water users, as rights holders, hold water service providers and authorities, as duty bearers, accountable for provided services. This thesis, however, did not fully support the idea of a development process from a ‘reporting’ to a ‘data use culture’, but rather observed that these data use practices can exist in parallel.

Overall, actual data use was found to be considerably below intended use, with mainly observed instrumental data use in local-level operational decision-making, sub-national level regulation, and macro-level planning.

11.1.3 Research question 3: Factors influencing data use

What factors enable or hamper actual use of monitoring data? What conditions need to be in place to ensure use of monitoring data?

The exploration of literature on data, evidence and knowledge use, presented in Chapter 2, resulted in the identification of a number of factors from three theoretical perspectives: 1) data attributes, from a linear perspective; 2) relationships between data producers and users, from a relationship perspective; and 3) individual capacity and motivation, and organisational and institutional opportunities for data use, from a behaviour systems perspective.

Chapters 7, 8 and 9 showed that the three perspectives successfully explained the degree of actual use of data in several, but not all, data use cases described in Chapter 6. The factors of the three perspectives are brought together in a fourth, comprehensive systems perspective.

The sections that follow each address the research question posed above from one of the four perspectives.

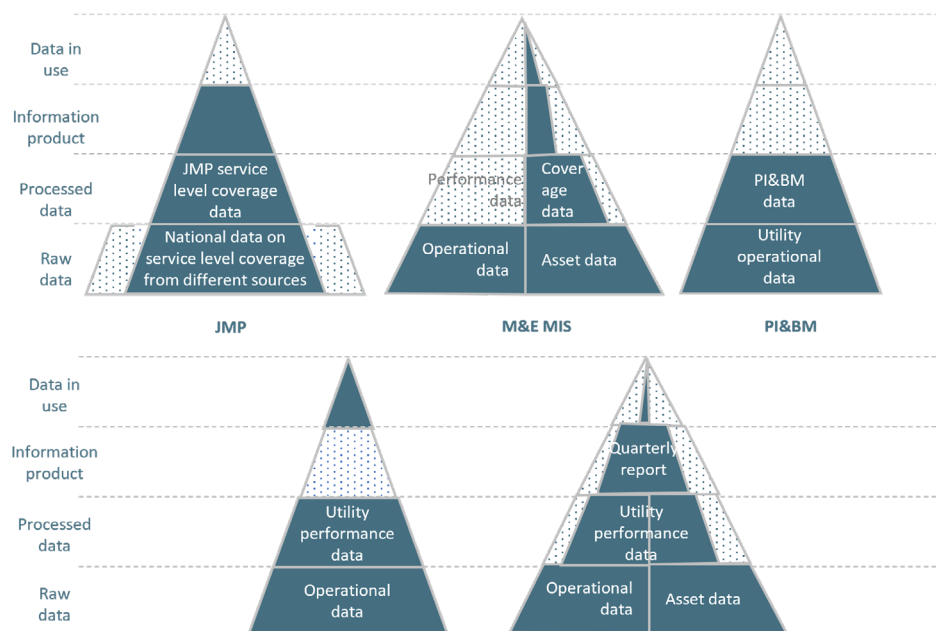
11.1.3.1 Linear perspective

Chapter 6, which focused on the data attributes of the linear perspective, found **credibility as the main attribute influencing actual data use**. Contradicting Brynjolfsson et al. (2011) and Davies (1994), who believed data accuracy to be a main enabler and barrier for data use, this thesis showed that data *credibility* is a more important factor for data use. Credibility of data was found to be influenced, but not determined, by data accuracy, with other factors, including the relationships between data producers and users, and the alignment of the data with the interests of potential users, also playing a role.

Availability of data in accessible formats was identified as a main data use challenge.

A large amount of the raw data compiled at national level was either not processed or barely transformed into usable information. Figure 11-1 illustrates this for different data sets. JMP source data also include data relevant for different sectors.

Figure 11-1: Raw data, processed data, information products and actual data use



Source: Author

The figure illustrates:

- JMP compiles and processes the relevant data on its indicators and makes them available in the form of tables, figures and reports, but (in Ethiopia) these data were hardly used.
- WASH M&E MIS data include asset data and operational data collected as part of the NWIs, intended to be processed into data on coverage and utility performance. However, only a small part of these data, mainly the coverage data, have been processed, presented in information products and actually used.

- PI&BM processed utility data and made these available on the online IBNET platform, but processed data were not made available in the form of information products, and no actual use of these data was observed.
- The Tigray Water Bureau processed operational and performance data from utilities into TUMS benchmarking data and used these to inform regulatory decision-making. The processed data were not presented in the form of information products.
- Utilities convert part of their operational and asset data into processed data on indicators, which they report in quarterly reports. However, while the use of information from the quarterly reports by Water Boards appeared limited, utilities were found to make actual use of both raw and processed data.

The lack of data processing into information products was a key barrier to the actual use of national data, compounded by weaker relationships between data producers and users.

This observation of the 'Data-Rich, Information-Poor (DRIP)' syndrome is not new, nor specific for the town water supply sector in Ethiopia. It was first described in the 1982 business management book 'In search of excellence' (Peters and Waterman, 1982). Since then, it has been observed and referred to in various sectors, including the water supply (Adank, 2017; Bartram, 1996; Norman and Franceys, 2013; Ward et al., 1986), water management (Timmerman et al., 2010; Ward et al., 1986), health (Eichler et al., 2019; Forte, 1994) and education sectors (Wilson, 2016). The water utility sector is generally perceived as a DRIP sector (Feliciano et al., 2021; Mounce, 2021; Sarni et al., 2019).

Chapter 6 showed that data attributes were shaped by the design of the monitoring system components (indicators, data collection tools, ICT platforms etc.), by other data attributes and a host of other factors. The DRIP syndrome, as a manifestation of lack of availability of data and information in accessible formats, was for example observed to be caused by the design of data collection tools that included many variables without a clear link to the indicators in the WASH M&E MIS.

Coffey and IRC (2015) found that many national level stakeholders in Ethiopia particularly struggled with identifying the data needed for their mandates. They commonly indicated that they needed a wide range of data, including data on assets, coverage, service providers and authority performance, and health impact. This contributed to over-collection and data not being used. It was also caused by doubts about the credibility of the collected data which can prevent data from being processed, as was found to be the case with PI&BM data.

Capacities and motivations of data producers and users were also found to have played a role in whether data are processed into information products. Finally, the absence of decision support tools for processing data and facilitating data analysis played a role in limiting data processing, analysis and use.

Data attributes of the linear perspective were able to explain both high levels of actual data use and instances of non-use across several cases. However, they could not (on their own) explain the moderate, low and non-use of data with strong data attributes. This could only be explained by the presence of alternative information, or by other limiting factors. Weiss (2001) recognises that other Information, Ideologies, people's and organisations (self-) Interests, and Institutional norms, traditions and practices (the four I-s) compete with the

introduction of new information in influencing policy processes and decision-making in general. In addition to possible political and administrative pressures resulting from ideologies, interests and institutional norms, traditions and practices, decision makers also have to take budgetary realities and pressures into account (Coburn et al., 2009), as highlighted under incremental decision-making models. These and other limiting and enabling factors for data use were explored under the other perspectives.

Overall, looking at the factors that enable and hamper data use from a linear perspective showed that relevant, credible, comprehensive, timely and accessible data are essential for the actual use of data, but having these data in place is no guarantee for actual use.

11.1.3.2 Relationship perspective

Chapter 8 looked at factors enabling and hampering the degree of actual use of data from a relationship perspective, focused on the quality of relationships between data producers and users.

It found that the quality of relationships between data producers and users varied, with low-, moderate- and high-quality relationships between actors at local level, between actors at national level, and between actors at different levels. The weakest relationships were found between actors with limited institutional and accountability ties, including between Water Boards and water users, researchers and Regional Water Bureaus, JMP and macro-level plan co-producers, and; PI&BM data producers and co-producers of macro-level plans. Where data producers and users were the same or very close to each other, quality of relationships was high, e.g. between the Ministry's coverage co-producers and the macro-level plan co-producers, utility management and staff, and Tigray Water Bureau staff involved in producing and using TUMS data.

Quality of the relationships was found to align with strengths of the data attributes. High-quality relationships aligned with strong (moderate to high) attributes, while low quality relationships aligned with data with low-rated attributes, especially in terms of data credibility, timeliness and availability in appropriate formats. However, as well known, correlation does not equal causation. Strong data attributes may contribute to stronger relationships, but strong relationships could also contribute to strong data. From the cases observed in this thesis, the latter seems more likely in most cases.

Some alignment was found between the degree of data use and the quality of relationships between data producers and users. However, good quality relationships did not necessarily guarantee actual data use. Alignment of the degree of data use and the quality of relationships largely corresponded with the alignment between degree of data use and data attributes. An exception was the lack of JMP data use, which was not explained by the linear perspective, but could be explained by the lack of strong relationships between the producers and (potential) users of these data.

There were also some observed cases with high-quality relationships between data producers and users, but with low or no data use. These included the lack of data use by utilities in setting tariffs and by Regional Water Bureau in tariff approval.

This adds some nuance to the often-held perception of the power of relationships between data producers and users as facilitators for actual data use.

Overall, the relationship perspective showed that the relationship between data producers and users contributes to the production of useable (reliable, credible, timely,

comprehensive, accessible) data and their actual use, but good relationships do not guarantee actual data use.

11.1.3.3 Behaviour systems perspective

Chapter 9 focused on how motivation, capacity and organisational, sectoral and contextual opportunities for data use influenced actual degrees of data use as observed in Chapter 6.

It found that weak individual capacity and motivation have a strong disabling effect, while weak human and financial resources have a strong hampering effect. Strong data-use systems, with clear incentives for data use were found to be strong enablers for data use and the presence of decision support tools was found as a weaker enabling factor. National culture and political economy can hamper or enable data use.

In their study on factors that influence and leverage the use of data in decision-making in the WASH sector, featuring case studies from Sierra Leone, Ghana, Colombia and Uganda, Boulenouar and Adank (2022) also found that motivation for data use is a key factor, which, when weak, can hamper or even disable actual data use. They also found that a lack of capacity for data use was one of the key factors hampering actual data use in the water service sector (Boulenouar and Adank, 2022). Punton (2016) came to the same conclusion in his literature review on capacity development for promoting evidence-based decision-making.

Although the presence of decision support tools in the Ethiopian town water supply sector was low, the presence and use of such tools is rapidly increasing and changing how utilities and municipalities monitor and manage their networks (Cahn et al., 2023), especially in contexts with higher levels of digital maturity. Digital technologies, including the use of big data, AI, and machine learning, are increasingly becoming available to utilities, including as part of Data-as-a-service (DaaS) arrangements (Baines and Lightfoot, 2014).

Although digitalisation in the water utility sector typically lags behind other sectors (probably due to data vulnerability challenges and the complexity of data silos) (Cassidy et al., 2021), such technologies are expected to play an increasing role in informing decision-making in the coming years and decades (Cahn et al., 2023; Feliciano et al., 2021). This is expected to contribute to overcoming the DRIP challenge in the sector (Allen et al., 2013; Sarni et al., 2019).

Garriga, de Palencia and Foguet (2015) identified inadequate decision-making support tools as a major challenge to the use of evidence for targeting and planning in the rural water sector in low- and middle-income countries. However, decision support tools are increasingly used in countries like Ghana, Rwanda, and Ethiopia to inform area-based planning, sometimes referred to as 'district WASH master planning' (Adank, 2025). These tools typically combine population and asset data (e.g. Garriga, de Palencia and Foguet, 2015; the planning tools developed by the Water Point Data Exchange (WPdx)) and were developed by iNGOs like IRC, WaterAid and Water For People, mainly on an ad hoc basis and for serving a specific context. They have been shown to enable data use in planning processes, e.g. in Ghana and Uganda, as shown by Boulenouar and Adank (2022).

Homer, Bhatia and Powell (2016) observed that in the health sector, technology (including decision support systems) is considered an important enabler for data use, although they do note that tools are often primarily designed for reporting, not for dynamic analysis, and analytical outputs are limited.

The importance of strong data-use systems, with clear roles and responsibilities and clear incentives for data use, echoes various other studies into the use of data. In their systematic review of barriers and facilitators of evidence use by policymakers in the health sector, Oliver et al. (2014) found a lack of effective (health care) systems, especially in developing countries, was considered a barrier for evidence use. WaterAid (2019) found that, in the case of the SIASAR system in Nicaragua, having clear roles and responsibilities (and therefore strong institutional and data-use systems) appeared to provide a sound foundation for data use, especially when stakeholders have a mandate to use the data in their decision-making processes. Kumpel et al. (2020) found the presence of weak regulatory environments a key challenge to data use for safe water management.

Various other studies referred to the strength of data-use systems in terms of incentives. For example, Custer and Sethi (2017) found that the absence of clear incentives for data use in decision-making related to the targeting of development activities in Honduras, Timor-Leste and Senegal, gives tacit permission to policymakers and practitioners to pay lip service to the importance of data, while allowing other considerations to crowd out data use in decision-making. Likewise, as part of their literature review on barriers to health data use in low- and middle-income countries, Li, Brodsky and Geers (2018) found there are inadequate incentives for the analysis and use of data, and few penalties for failing to do so.

Homer, Bhatia and Powell (2016) found little data use in the health sector in Ghana, Sri Lanka and Tanzania, due to a lack of incentives for using data, as analysis was not required, nor explicitly recognised or rewarded. As observed in the case of TUMS, they found that a lack of incentives did not disable data use by (a few) intrinsically motivated officials.

The assessment that political economy factors like political will, leadership, and vision for data use have played a role in actual data use in Ethiopia, was echoed by Temesgen (no date), who noted that data and evidence are often treated as secondary or even tertiary variables in decision-making processes in the water sector in Ethiopia.

WaterAid (2019) also found political economy factors played a strong role in enabling or hampering data use. They observed, for example, that in East Timor, rapid economic development based on oil revenue had led to the prioritisation of large-scale infrastructure over community-based infrastructure, such as rural water supply. This prioritisation was assumed to influence planning processes more than data on service levels and performance.

Porter and Feinstein (2014) also found that political economy conditions in several countries studied in Sub-Saharan Africa (including Ethiopia) affected both the demand for and supply of data, thereby influencing data use.

However, sectoral systems and incentives for data use, and a national culture and political economy that support and facilitate such use, can also lead to selective (symbolic) use of data, as also observed by Punton (2016), or even perverse data use.

Overall, the behaviour systems perspective showed that motivation and capacity are conditions for enabling data use and opportunity factors strongly influence actual data use.

11.1.3.4 Comprehensive systems perspective

Actual data use was not found to take place unless relevant, credible, timely, comprehensive and accessible data are in place, as well as good relationships between data producers and users, and individual capacity and motivation for data use. Together, these factors from the three perspectives were found to be the essential conditions for enabling actual data use.

The three perspectives succeeded in explaining some, but not all of the actual observed data use in the data use cases. However, the combined factors from the three perspectives did explain the level of actual use for all data use cases. Overall, 62% and 97% of the 39 data use cases related to decision-making (leaving out data use cases focused on reporting for accountability) were explained by perspectives 1 and 3, respectively. Half of the 22 data use cases explored in Chapter 8 were explained by the relationship perspective. The comprehensive perspective, taking all factors together, managed to explain actual observed data use in all (decision-making) data use cases.

For each data use case, the actual level of data use can be explained through (at least) one of the three perspectives, as shown in Table 11-1. However, the perspective that presents the strongest explanatory value differs per data use case. This supports the arguments of Best and Holmes (2010) and Bartram and Setty (2021) that there is no single best model for every circumstance, as different models may be more applicable to different data use cases.

Overall, the comprehensive systems perspective shows that taking the factors from the other three perspectives together enables explaining the observed degree of actual data use in all cases.

Table 11-1: Explanatory power of the perspectives on actual data use in different data use cases

Data use case	Summarised observed use of data	Perspective explaining the observed use		
		P1	P2	P3
Policy-making	Process use of JMP, NWI and PI&BM and low instrumental use of Ministry's coverage data	Partially	Not assessed	Yes
Planning	High use of Ministry's coverage data, low use of JMP coverage data in macro-level planning	No	Yes	Yes
	Low use of utility performance data in macro-level planning	Yes	Yes	Yes
	No use of PI&BM and NWI data and low use of TUMS and utility data in planning by utility	Yes	Yes	Yes
	Low to moderate use of data by utilities	Yes	Partially	Yes
Tariff setting	Low use of data in tariff setting	Partially	Partially	Yes
Operational	Low use of TUMS data and no use of utility performance data, PI&BM and NWI data in operational decision-making by Regional Water Bureau	Partially	Not assessed	Yes
	Moderate use of operational data but low use of asset data use in operational decision-making by utility	Partially	Partially	Partially
Regulation	No actual use for economic regulation, high for TUMS data use for performance regulation by regional Water Bureau	Partially	Partially	Yes
	Low use of data by Water Board in regulating utility	No	No	Yes
	No use of data for national level regulation	Yes	Not assessed	Yes

Source: author

11.1.4 Research question 4: Leverage points for use of data

What are the leverage points for enabling monitoring data use?

Based on an assessment of how the different factors influence and depend on each other in the data-use system, as presented in Chapter 10, the following factors emerged as possible leveraging factors:

- National culture
- Political economy
- Strength of data-use systems
- Organisational financial capacity for data use

11.1.5 Summing up the main research question

This section answers the main research question 'How is monitoring data used in town water supply in Ethiopia, and what are the factors that enable or hamper this?', by summarising the main conclusions and discussions on the research questions above.

Investments in monitoring systems have led to the production of large and growing amounts of data. However, the resulting monitoring data are underused.

Monitoring systems in Ethiopia, and many other development-aid recipient countries, display characteristics of what Pritchett et al. (2010) refer to as 'isomorphic mimicry'. These monitoring systems produce large data sets, largely pushed, shaped, facilitated and funded by development partners, without considering the intrinsic motivation for data use by potential data users, and its driving factors, especially the presence of strong data-use systems and the political economy.

Key conditions that need to be in place for overcoming underuse of data are:

- Accessibility of relevant, credible, comprehensive, timely data in suitable formats for specific data uses;
- Good relationships between data producers and users, e.g. through co-production of data and decisions;
- Capacity to use and act on data; and above all,
- Motivation to use data.

Organisational human resource and financial capacities, decision support tools, and, especially, strong data-use systems and incentives for data use can play a strong role in stimulating data use. All these factors need to be considered and understood within their complex network, in order to enable data use for informing decision-making and ensuring accountability for effective, efficient and legitimate water service provision for all.

However, first and foremost, motivation for data use is key. If data users do not have intrinsic motivation to use data for informing decision and ensuring accountability, then investing in production of data is a waste of money, time and effort. The rational perception that if data are produced, actors will be motivated to use these data, has proven incorrect.

Contextual factors, the national culture and the political economy, were identified as main possible leverage points, influencing all other factors without depending strongly on them. A national culture and political economy that enables and facilitates data use would stimulate motivation for data use and strengthen data-use systems and incentives. This would, in turn,

stimulate the allocation of human and financial resources for data use, the procurement and development of decision support tools, and enable good relationships between data producers and users. This would result in the production and use of relevant, credible, accessible, comprehensive, and timely data for informing effective and efficient decision-making and ensuring accountability, ultimately leading to reliable, safe, and accessible water services for all.

11.2 Reflections

This section provides academic reflections on the approach and the key insights of this thesis.

11.2.1 The use of a multi-perspective approach

The multi-perspective approach applied in this thesis enabled the exploration of a wide range of enabling and hampering factors. Rather than pieces of a puzzle, each perspective acted as a 'lens' through which the same data use cases were perceived and analysed. Each additional lens sharpened understanding of the factors that enable and hamper data use, not only by providing clarity on the factors specific to each lens/ perspective, but also by providing insight into how the factors from the different perspectives interact.

The multi-perspective approach taken in this thesis addresses a gap in existing literature on data, evidence, and knowledge use, which commonly takes a single theoretical perspective, or lacks explicit theoretical framing. Van Buuren (2006) and De Kool (2007) are notable exceptions. They both applied the rational perspective, as well as a social construct and pragmatic (Van Buuren) and political and cultural (de Kool) perspective to study knowledge use and monitoring. This thesis contributes to this body of work by adding a comprehensive systems perspective, bringing together the factors from the (rational) linear, (social-construct) relationship, and behaviour system (with elements of De Kool's political and cultural perspectives) perspectives, and focussing on the interrelations between these factors.

Although applied to provide distinct lenses for understanding data use, the linear, relationship and behaviour systems perspectives used in this thesis were found to be closely related to each other:

- Linear perspective: By focusing on socially constructed data attributes rather than on more positivist data characteristics, the first perspective could be argued to have gone beyond taking a fundamental rational, linear perspective. Data attributes were found to be shaped by the second and third perspectives.
- Relationship perspective: Although the focus of this perspective was on relationships between data producers and users, relationships between other actors in the data-use network were described and assessed. This provided insight into the institutional structure and power relations, which shape the political economy for data use.
- Behaviour systems perspective: Arguably, data characteristics of the first perspective and the relationships of the second perspective could have been considered as opportunities for data use in the behaviour systems model.

The factors from these three perspectives came together in the fourth perspective, the comprehensive systems perspective, which focused on the interlinkages between these factors. Although several authors stress the importance of the relationships between enabling and

hampering factors and data use, systematic analyses of such interrelationships remain rare. This thesis has provided a unique analysis of the interrelationships between the factors included in the comprehensive systems perspective, and, based on this, potential leverage points for data use.

11.2.2 Data use versus research use

This thesis has drawn on thinking and concepts from the literature on research use to examine use of monitoring data. However, the fundamental differences between the use of research (and evaluation) information and monitoring data could limit the applicability of research use thinking and concepts.

The first key difference concerns the degree to which data have been processed and are made available. In research use, data are processed into information products, such as research reports, journal articles, and policy briefs. The degree to which monitoring data are processed can vary considerably. Monitoring data may be available as raw data, tables, graphs, maps, or information products. Unlike research findings, which typically require full processing before they can be used, monitoring data processed to different degrees can inform specific decision-making processes (e.g. raw data can inform operational decision-making). Nevertheless, processing of monitoring data and making these available in accessible formats proved to be a key challenge to the use of monitoring data in the case of utility water supply in Ethiopia. Therefore, despite differences in emphasis on data processing between research use and use of monitoring data, research use thinking and concepts related to this were found to be relevant and applicable to the use of monitoring data.

The second key difference concerns the distance between data producers and users. Although the boundary between research producers and users has become somewhat blurred due to the increased emphasis on co-production of research, the distinction between producers and users of research is often sharper than between producers and users of monitoring data. However, as shown in this thesis, there can also be a considerable distance between data producers and (potential) users of monitoring data. Therefore, research use concepts like the two-community paradigm were found to be relevant and applicable to use of monitoring data. This is especially the case when processed monitoring data are required to inform decision-making processes, and when there is a considerable distance between data producers and users.

11.2.3 Key insights

The findings from this thesis confirm the suspected but largely under-documented low level of use of monitoring data in the water supply sector.

The rationalist assumption that more and better data means more and better data use is disproven by this thesis. This is not a revolutionary new insight, but confirms insights from academic literature on the use of research, monitoring and performance data. Nevertheless, the belief that more and better data will lead to better use still holds strong in the water supply sector, as evidenced by considerable investments in monitoring systems over the past decade. Therefore, this insight, substantiated with evidence from the water supply sector in Ethiopia, merits emphasis.

Chapter 2 presented the factors for enabling and hampering data use identified in literature. This thesis indeed confirms that these factors enable or hamper the use of monitoring data in town water supply in Ethiopia. However, it adds nuance to the common perception of the power of relationships between data producers and users as facilitators for actual data use. While strong relationships between data producers and users are generally considered a major facilitator of data use, this thesis demonstrates that they are not a guarantee for data use.

The thesis considers the political economy, in terms of political will, power relations, and vision for data use, as a factor enabling or hampering data use. Although political context has been shown to be a key, if not the most influential, factor determining the importance attached to evidence in policy-making (Court et al., 2005; Court and Young, 2006), until recently, the nature of politics has been largely missing from work promoting evidence use (Parkhurst, 2017). By identifying the political economy as a possible leverage point for data use, this thesis confirms the importance of political economy as a critical factor.

The identification of the national culture, the political economy, and the strength of data-use systems as potential leverage points for data use represents a unique contribution to the academic and practical discussion on data use. Only one comparable analysis of leverage points for data use was found. This analysis by Boulenouar and Adank (2022) of data use cases related to investment planning in Colombia, area-based planning in districts in Ghana, Sierra Leone and Uganda, operations of water stations in Ghana, and water quality management in Uganda, did not consider political economy or the strength of data-use systems as factors. However, it identified organisational financial capacity and incentives as potential leverage points, in line with the findings of this thesis. With the identification of national culture, political economy, and strength of data-use systems, this thesis provides evidence for advocating that monitoring initiatives should go beyond producing more and better data. They should also strengthen the political economy and data-use systems in the sector, or at least take these into account. This would prevent the situation observed in this thesis: major investments in the production of huge data sets, without resulting in systematic use of the produced data.

11.3 Recommendations

11.3.1 Recommendations for development partners and practitioners

For monitoring data to be used for informed decision-making and accountability, they must be of adequate quality and accuracy, and be presented in accessible and understandable formats for intended users. To achieve this, development partners should fund and support not only the development of systems and capacity for producing data, but also for processing them and making them available in accessible formats.

However, as demonstrated by this thesis, having data available in accessible formats does not ensure data use. Motivations, capacities, good relationships between data producers and users, and organisational, sectoral, and contextual opportunities for data use need to be in place. Political economy, strong data-use systems and incentives, and a national culture for data use have potential leveraging power on demand and motivation for data use, and on other factors that can enable data use, including the production of relevant, credible, timely and accessible data.

Having strong data-use systems in place is key for processing, analysing, and using data for informing policy, planning, operational and regulatory decision-making, learning and accountability. Therefore, development partners involved in developing or strengthening monitoring systems should do so within the context of wider systems strengthening interventions.

Development partners should gain insight into how political economy features can enable or hamper the use of monitoring data, and where possible, address these accordingly.

As Hofstede et al. (2010) note, it is (nearly) impossible to influence national culture. However, development partners involved in monitoring interventions should be aware of and understand the cultural context and how this influences data use.

Development partners can play a role in developing, introducing or strengthening decision support tools. However, this must go hand-in-hand with ensuring individual and organisational capacity to operationalise and use such tools, and with ensuring, stimulating, and enabling data-use systems and a political economy in which data-based decision-making is expected and required, as mentioned above.

11.3.2 Recommendations for governments

Governments should have evidence-based accountability relationships in place at the national level, with ministries being accountable for reporting to parliament. This should not only involve reporting on coverage, but also on utility performance.

Governments should ensure the presence of strong data-use systems with clear incentives for data use in policy-making, planning, regulation, and operations and asset management. Enabling systems and political economy features that facilitate both the production and the use of monitoring data would enable and encourage utilities to invest in systems, tools, processes and capacities to produce, process, analyse, and use data to improve operational efficiency and sustainable asset management.

In the Ethiopian context, the government should strengthen systems, mechanisms, processes, and guidelines for developing utility business plans. This can be done in various ways. Business planning should be included in professional curricula. Regional Water Bureaus could provide technical support to utilities for developing business plans. The national government could draw up clear national or regional guidelines. Furthermore, having a robust evidence-based business plan in place should be a condition for the establishment of a utility, or for receiving financial support or loans for asset development. This should not only be mandated on paper, but also actively monitored and enforced. This requires investing in systems and manpower for doing so.

The Ethiopian government should also finalise and operationalise its regulatory framework for the water supply sector. This should involve establishment of clear institutional rules, roles, responsibilities, and capacities for regulation of water utilities, with clearly set, monitored, and enforced norms and standards.

11.3.3 Recommendations for utilities

Utilities should invest in tools and processes for collecting, processing, and using monitoring data, based on clear data use cases. In low-income countries with capacity and resource constraints, utilities should focus on implementing relatively simple processes and mechanisms for processing and analysing data on a regular basis. In high-income countries, utilities could invest in more advanced tools and processes involving data integration tools, machine learning, and AI. However, in all contexts, investments in data collection and processing tools should be guided by clear data use cases and the utility's available (or potential) human resource and financial capacity.

11.4 Limitations and recommendations for future research

This section presents the main limitations of this thesis research and, based on these, proposes directions for future research.

This thesis focused on a single case: Use of monitoring data in town water supply in Ethiopia. This proved to be a case with generally weak utilities, lacking capacity, finance, and agency.

To gain deeper understanding of the actual use of monitoring data and the factors that enable and hamper this, similar analyses could be conducted for different cases, for example, in middle- and high-income contexts with more (digitally) mature utilities, or for different sub-sectors, e.g. community-managed rural water supply. Comparing findings across different cases would deepen insight into the influence of organisational, sectoral and contextual factors and their influence on each other.

While this research focused on the use of monitoring data by actors involved in the provision of town water supply at different institutional levels, further research into the use of monitoring data could examine the use of project monitoring data or organisational monitoring data. The methodology used in this thesis could be applied. This could provide insights for improving use of data within organisations, companies or projects.

A second limitation was the exclusion of data use cases related to reporting for accountability in the assessment of factors that enable or hamper data use in Chapter 8 (relationship perspective) and Chapter 9 (behaviour systems perspective). In Chapter 5, a total of 52 data use cases were identified. These included 39 data use cases related to decision-making and 13 related to reporting for accountability. Reporting for accountability was considered a two-step process, each involving different data users: 1) a duty bearer user uses data for reporting, 2) a rights holder uses the reported data to hold the duty bearer accountable. This would have complicated and potentially doubled the analysis of the quality of relationships between data producers and users (Chapter 8), and the assessment of the capacities, motivations and opportunities for data use by both the duty bearer and the rights holder (Chapter 9).

A third limitation was the subjective rating of the degree of data use, the strength of enabling or hampering factors, and factor interdependence. This was mitigated as much as possible by developing clear rating tables. Nevertheless, the rating was done by a single sector professional, with over 20 years of experience in the sector, bringing the potential risk of symbolic use of research findings to confirm pre-defined ideas.

Further validation of the findings by sector professionals is therefore recommended. In future research, this challenge could be mitigated by directly involving sector professionals in the assessment and validation of actual data use, factor strength and influence. This implies that future research should adopt a more constructivist epistemological approach.

Fourth, the exploration of the influence of factors on each other, as presented in this thesis, was an oversimplification of a more complex reality. Factors not only directly and indirectly influence each other, but can also have a mediating effect on the relationship between different other factors.

Future research could employ different methods and models to gain deeper understanding of the interdependence of factors, such as structural equation modelling or Bayesian networks. This could provide deeper insight into factors with the greatest leveraging power.

Finally, the water supply sector in Ethiopia is continuously evolving. This thesis has not considered some recent developments in the sector, such as the development of a central utility asset data system and a central utility performance system, supported by UNICEF, and further development and application of utility performance benchmarking indicators by the Federation. Future research on data use in the water supply sector in Ethiopia could include action research on the uptake of the recommendations of this thesis, examining whether and how these contribute to better data use over time.

EPILOGUE

As mentioned in the prologue, my personal interest in doing this thesis was driven by a desire to understand how and to what extent monitoring data are actually used, why these data are often not used to their full potential, and what could be done to enhance their use and impact.

Over the course of this thesis, it has become clear that, as expected, actual data use is generally lower than intended and potential data use, both in the case of town water supply in Ethiopia and beyond. I explored the reasons why this was the case from different perspectives, exploring the influence of a wide variety of factors, but concluded that in essence the main reason for lack of data use was lack of demand for and interest in use of these data, caused by weak data-use systems, lack of clear accountability mechanisms and political economy features.

In Ethiopia, and in other developing countries, there is a high demand for harmonised data from development partners, who therefore support the development of monitoring systems and the production of data. However, this rarely goes hand-in-hand with the development of the systems, incentives and capacities for enabling and stimulating actual data use to inform better decision and enhance accountability, resulting in improved services for all. As a result, the demand for data from development partners is often not (fully) in line with the demand for and interest in data use from other stakeholders at different institutional levels.

As a sector professional, this insight has made me an even bigger advocate for ensuring that development of monitoring systems and production of data should not be a standalone activity, but should be integrated with wider systems strengthening (and where needed, systems change), to ensure strong data-use systems, with clear roles and responsibilities, capacities and incentives for data use.

Working on this thesis, it also has become abundantly clear to me that the rather naïve notion of rational data-informed decision-making is often overshadowed by the reality of decision-making informed by various other factors, including personal or political motivations. Nevertheless, I still believe data could and should play a key role in decision-making processes at different institutional levels. This requires understanding and addressing the political economy and cultural factors influencing data use.

As we seem to stand at the dawn of the artificial intelligence (AI) revolution and the 'end of aid', I feel I cannot end this thesis without a short reflection on how these could influence the use of monitoring data in the (town) water sector. Although the use of AI might seem beyond the reality of monitoring town water supply in Ethiopia at this moment in time, it is likely to play a key role in the (near) future. AI can especially play a role in processing, analysing and visualising data that is currently often unused. It can be integrated into, or replace, decision support tools.

The 'end of aid' also seems to be increasingly visible on the horizon, with socio-economic developments of countries in the Global South, the decolonisation movement, and a move away from funding of development aid by (populist and less-populist) governments in the Global North. How this will affect the production and use of monitoring data remains to be seen. A decrease in

funding from development partners may decrease the demand for monitoring data. However, it could also lead to governments in the Global South becoming more accountable to their own constituents, resulting in higher demand for such data from decision makers at different institutional levels. Whether this will lead to a genuine increase in demand, production and use of relevant, credible, timely and accessible data, through the development and strengthening of data-use systems and enabling political economy, remains to be seen.

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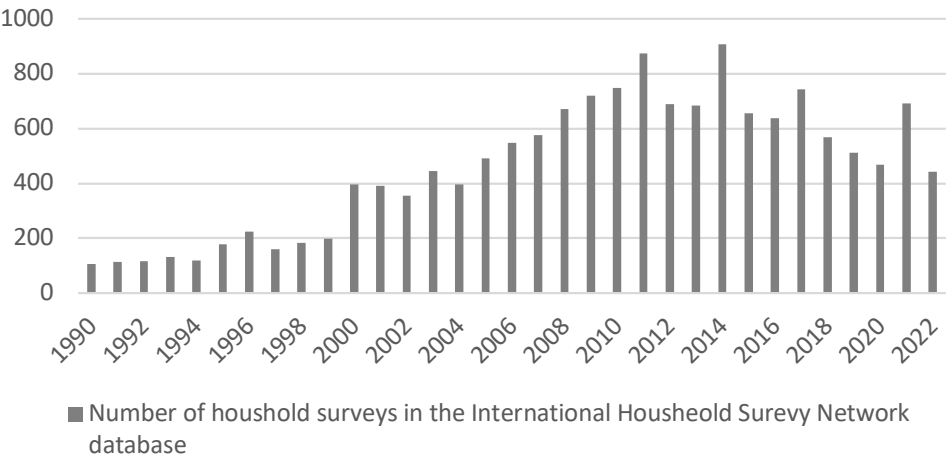
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ANNEX 1: TRENDS IN NUMBER OF HOUSEHOLD SURVEYS CONDUCTED ANNUALLY, 1990-2022



Source: Compiled by author, based on data from International Household Survey Network (IHSN) (<https://catalog.ihsn.org/catalog>, accessed 26/5/2025)

ANNEX 2: LIST OF INTERVIEWEES

Name	Position, organisation	Data of interview
Muluken Wondirad	Utility manager Debre Tabor	7/3/2017
Anonymous	National consultant	1/3/2018
Eyob Defere	IRC Associate / sector specialist	20/3/2018
Samuel Godfrey	WASH chief, UNICEF Ethiopia	
Michele Paba	Urban WAHS lead, UNICEF Ethiopia	21/3/2018
Bahiru Woldemariam Bashira	Urban Coordinator MoWIE	22/3/2018
Tamene Hailu	MoWIE	23/3/2018
Getachew Abdi	WaSH M&E Team leader at Coffey/ Consultant and WaSH Advisor	23/3/2018
Tamene Gossa	Urban WAHS specialist. UNICEF Ethiopia	30/3/2018
Muktar Ahmed	Director General, Ethiopian Urban Water Federation	30/3/2018
Azeb Tadessa	MoWIE/ IBNET focal person	13/4/2018
Gullilat Berhane	World Bank/Consultant	13/4/2018
John Butterworth	IRC Ethiopia	20/4/2018
Lieke Nijk	Vitens Kenya	4/5/2018
Teklay Behalu	Utility manager, Wukro utility	2/4/2018
Getnet Hailu Baralo	Head finance department, Wukro utility	3/4/2018
Kelem Redda	Deputy head and head of planning department, Wukro utility	3/4/2018
Anonymous	Wukro board member	3/4/2018
Gebreyesus Zeruu Haile	Team leader Monitoring and Support, Tigray Regional Water Bureau	4/4/2018
Melaku Estifanos Abraha	Director Directorate Water Resources Management and Regulation, Tigray Regional Water Bureau	4/4/2018
Samuel Teko Zebo	Utility Manager, Jinka Water Utility	29/3/2018
Tsigereda Haylemariam	Head finance department, Jinka Water Utility	8/6/2018
Tariku Haylu	Co-chair Jinka board (representing Zonal Water Department)	8/6/2018
Haile Dinku	WaterAid Ethiopia	3/3/2020
Haimanot Belete	Director, water supply and sanitation Infrastructure Management Directorate	20/6/2022
Tameru Gedefa Wami	Director, Water Supply SD & CM Directorate at Federal Water Development Commission / Water and Sanitation program coordinator / PMU OWN	23/6/2022
Agash Asmamaw Molla	National consultant, on WASH programme planning and management, at MoWE	30/6/2022
Abera Tesfaye	National consultant	1/07/2022
Gebreyesus Zeruu Haile	Tigray Regional Water Bureau Head Monitoring and Support	28/8/2024
Muktar Ahme	Director General, Ethiopian Urban Water Federation	5/9/2024

ANNEX 3: INTERVIEW GUIDE

SEMI-STRUCTURED INTERVIEWS

Monitoring system development

1. What was the process like of the development of the monitoring system?
 - 1.1. Which actors and stakeholder groups were involved?
 - 1.2. What role did these actors and stakeholder groups play in these processes? What has been the role of civil society groups, researchers and media, if any?
 - 1.3. What were your main expectations about how the monitoring system would be used (at different levels)?
 - 1.4. What do you think were the expectations of other actors (see actors mentioned under 1.1)? What was the main interested of these actors in the monitoring system?
 - 1.5. How were decisions on the design of the monitoring system made, related to a)
Indicators, b) Tools for data collection, processing and analysis c) Institutional framework, d) financing framework
 - 1.5.1. Which actors were involved in these decisions? Which actors were driving these decisions?
 - 1.5.2. What do you think were the main reasons behind these decisions? How have their expectations about the use of data shaped these?
 - 1.5.3. What other factors influenced these decisions?
2. Has the monitoring framework changed over the last 5 years? If so, what influenced this change? (repeat question 1 for the changes in the monitoring system).

Monitoring data and information characteristics and motivation and capacities related to monitoring data creation

3. How is data collected and compiled?
 - 3.1. Who are the main actors for data collection, processing and analysis? What is their roles?
 - 3.2. Does data flow from one level to another? If so, how?
4. How is data made available (in the form of information)? In what format? When? How are decisions made on which data to make available? Which actors play a role in this and which actors drive the decisions?
5. To what extent are different actors involved in small town water service provision aware of the monitoring findings? How is monitoring data and information internalised by different actors involved in small town water services?
6. How would you rate the motivation of the actors involved in data collection, processing and analysis? What are their main incentives? What are their interests in the data?
7. How would you rate the capacity of the actors involved in data collection, processing and analysis?

8. How would you rate the organisational capacity (in terms of financial and logistical resources) related to data collection, processing and analysis?
9. Is monitoring data or information shared at coordination or learning platforms (at different levels)? If so, which platforms? Who are involved?

Use of monitoring data

10. How has monitoring data actually been used as far as you know by utilities, Water Board, Regions, Ministry, development partners and other stakeholders?
 - 10.1. Reporting to other entities
 - 10.2. Instrumental use -> corrective actions by utilities; used in planning, regulatory use.
 - 10.3. Conceptual use -> influencing policies; influencing learning
 - 10.4. Symbolic use -> used to justify decisions
 - 10.5. What is the degree of influence of the data and information on the decisions?
(decision would not have been made without the monitoring data / decision would have been made even without the monitoring data)
 - 10.6. Have these resulted in new plans, policies, normative frameworks and practices?
11. Which actors are involved? How do these actors relate to each other? Who drives the decisions? How do they relate to the actors involved in data collection, processing and analysis?
12. How would you rate the motivation for using monitoring data of the key actors involved in decision-making? How have motivations of the actors involved in the use of monitoring data (including indirect involvement through advocacy and research) shaped their use of the data?
 - 12.1. What ideologies did actors have related to small town water service provision and how did these influence the decision-making and implementation processes?
 - 12.2. What was their level of interests in evidence-based decision-making?
 - 12.3. What were the incentives related to the use of evidence-based decision-making?
13. How have capacities of actors and stakeholder groups involved in use of monitoring data shaped their use of the data?
14. How has availability of financial resources available to organisations involved in use of monitoring data influence the use of data?
15. What formal platforms are in place for stakeholder coordination and communication related to small town water services provision at the different levels? What role does monitoring information play in these platforms?
16. What other factors shape the decision-making processes?

ANNEX 4: LIST OF SECTOR GUIDELINES

2013 national guidelines:

- Operation and maintenance manual for Urban water utilities
- National Guideline for Technical Service Provision to Customers by Urban Water Supply Utilities
- National guideline for Organisational set-up for urban water supply and sewerage services
- National Guideline for Urban Water Utilities tariff Setting

2023 national guidelines:

- Electro-mechanical equipment guideline for urban water supply & sewerage service enterprises
- Customer service guideline for Urban water supply & sewerage service enterprises
- Organisational set up guideline for urban water supply & sewerage service enterprises
- Tariff setting guideline for water and wastewater services utilities
- Financial Management Manual for Urban Water Supply& Sewerage Service Enterprise
- Asset management guideline for urban water supply & sewerage service enterprises
- Capacity Building Strategies for Ethiopian Urban Water Supply and Sanitation Enterprises
- Human resources management manual for urban water supply & sewerage service enterprises
- Board guideline for Ethiopian towns water supply and sewerage services
- Performance based contract agreement for urban water supply & sewerage service enterprises
- Guideline for drinking water quality monitoring and control for urban water supply & sewerage service utilities

ANNEX 5: OVERVIEW OF MONITORING SYSTEM COMPONENTS AND DRIVERS

Drivers and components	JMP	National M&E MIS Phase 1a	National M&E MIS Phase 1b	National M&E MIS Phase 2	National M&E MIS, Compiled coverage data	PI&BM	TUMS	Utility-level MIS
Year								
Main funders	2000-ongoing UNICEF and WHO	2006-2010 World Bank	2010-2015 World Bank, DFID, AfDB, UNICEF	2015-ongoing DFID, AfDB	2000-ongoing Ministry	2012-2022 WB	2015-2020	ongoing Utility (occasionally supported by development partner-funded programme)
Main implementor	UNICEF and WHO	Ministry + WSP	Ministry + UNICEF	Ministry + Coffey	Ministry	Ministry + WSP/WB	Regional Water Bureau	Utility (occasionally supported by development partners)
Drivers	SDGs, UN, UNICEF and WHO	MSP and JSR	MSP and JSR	OWNP	Ministry	Ministry and WSP-WB	Tigray Water Bureau	Utility
Driving factors	Progress tracking against SDGs		Insight in coverage data	Inform Ministry plan	Inform annual planning and reporting	Benchmarking for performance improvement	Rewarding of well-performing utilities	Reporting
Main stated objective(s)	Inform policy and decision-making by national governments, development partners and civil society	Track progress towards UAP; Guide planning and resource allocation at national and sub-national level	See phase 1 + Harmonisation of coverage figures	Track progress towards OWNPs; Inform evidence-based decision-making at all levels	Track coverage on national standards; Inform macro-level infrastructural investment plans	Inform performance improvement; regulation and evidence-based decision-making at all levels	Inform regulatory decision-making by the Regional Water Bureau.	Inform operational decision-making; annual and strategic planning by utility and regulatory decisions by the Water Board.

Drivers and components	JMP	National M&E MIS Phase 1a	National M&E MIS Phase 1b	National M&E MIS Phase 2	National M&E MIS, Compiled coverage data	PI&BM	TUMS	Utility-level MIS
Indicator framework (urban water indicators)	Coverage based on JMP service ladder	4 KPIs on coverage and utility performance	8 KPIs on coverage and utility performance	7 KPIs on coverage, utility performance, service authority performance	Coverage based on national standards	22 utility performance indicators	8 utility performance indicators (2016/17)	Various. Some utilities without indicators
Urban water data collection tools and procedures	No primary data collection, but linear regression of nationally representative secondary data	Annual urban utility form for ongoing data collection. 42 variables, with 62% contributing to KPIs. Focused on ongoing data collection	4 urban utility forms for occasional data collection. Total of 49 urban water supply variables, with 65% contributing to KPIs.	Urban inventory form suitable for one-off (or occasional) data collection. Total of 94 urban water supply variables, with 24% contributing to KPIs	Regional Water Bureaus submit data on number and types of schemes and number and proportion of people served.	An excel-based form, focused on ongoing (annual or bi-annual) data submission. 60 urban water supply variables, all (100%) contributing to indicators	Checklist / reporting format	Various
Data production process	More or less bi-annual national service level data	Data to be collected and compiled by Utility and regional staff. No actual data collection done.	Paper-based data collected by about 70,000 trained enumerators in October 2010 to October 2011. Data cleaning and processing by Ministry and national consultants	Data collection by 3,379 trained enumerators using tablets with COSMOS in late December 2018 to early March 2019. Data cleaning and processing by Ministry focal person, national consultant and IBNET focal point at World Bank HQ		Data submission by 75 utilities in round 1, 90 utilities in round 2, and selected utilities in 2017-2018. Data cleaning and processing by Ministry focal person, national consultant and IBNET focal point at World Bank HQ	By Regional Water Bureau based on data submitted by 69 utilities	By utility
ICT	JMP	PUT MIS development. No data collected	Adjusted PUT MIS, accessible	Synergy MIS, accessible only at	None	Data on indicators available in global online data base	Excel	Various different computerised and

Drivers and components	JMP	National M&E MIS Phase 1a	National M&E MIS Phase 1b	National M&E MIS Phase 2	National M&E MIS, Compiled coverage data	PI&BM	TUMS	Utility-level MIS
			only at national level with login. Data available on all variables and all KPIs. Discontinued in 2019	national level with login. Data available on all variables and all KPIs. Discontinued in September 2021				paper-based systems
Information products	Biannual reports with national data on service levels	None	Ppt presented at Ethiopia's National WASH Inventory seminar on 8 April 2013, focused on coverage data	2021 draft report (published unofficially online) focused on coverage and few rural KPIs (no data or information on urban KPIs)	Presented in Ministry annual reports and sector presentations by Ministry.	Data from round 1 presented at national level in ppt. No report.	None	Monthly, quarterly, annual hard copy reports
Estimated costs (approx.) ²⁷	0.011 million USD (per country)	Unknown	About 5.3 million USD (NWI1)	3 million GBP (framework development, NWI2, impact evaluation) + 1 million GBP (MIS development) + unknown partner contributions	Unknown. No separate budget	Unknown	Unknown	Unknown

27. It should be noted that this also including monitoring system development and data collection for rural water, sanitation and institutional WASH

ANNEX 6: INDICATORS

Utility-level monitoring and reporting indicators

Indicators proposed for monthly and annual utility performance report in the 2013 guidelines

Indicator group	Indicators
Level of Service	Reliability or Piped water supply continuity: Average number of hours of supply per day divided by 24
	Water Quality: No. of customers complained on water quality/Total number of customers
	Demand Response: Number of new connection /Number of requests for connection
NRW	Unaccounted-for water %
System efficiency	Total O&M Cost per volume of Sold Water
	Energy cost per Volume Sold Water
Financial	Revenue collection Efficiency: Total revenue collected / Total billed
	Billing efficiency: Total billed /total number of connections required to pay
	Operating cost-recovery ratio
	Contribution of following cost components to total O&M expenditure:
	Power/fuel Labor cost Chemicals
Human resource management	Attendance: Total hours of operation personnel on duty /Total hours of operation personnel Assigned)
	Overtime: Total number of hours worked on overtime / Total number of hours worked
	Training: Number of days spent on training of all staffs/ Total number of days on duty of all the staffs
Equipment and parts	Efficiency of equipment: Equipment operating capacity / Equipment design capacity
	Efficiency of units: Units or component production capacity/ Units or components design capacity

Source: Adapted from (Ministry of Water and Energy, 2013a) (*indicator groups by author)

Indicators proposed by the Water Board utility performance evaluation format in the 2013 guidelines

Indicator group*	Indicators
Service coverage	1.1 The percentage of people with connections or within 500 meters of a standpipe.
	1.2 The number of new water supply connections made during the period.
Connections	1.3 The number of disconnections and reconnections
	1.4 The total number of water supply connections
Customer service	1.5 Responses to customer requests
Water Consumption	2.1 The total amount of water extracted, treated, supplied and sold; (in m ³)
	2.2 The average amount of water sold per connection per month (in m ³)
	2.3 Per capita consumption
Quality of Service [continuity]	6.1 The Average Hours of water supply per day for the period. (Hour/7/30)
Unaccounted for Water	3.1 The difference between water supplied and water sold expressed as a percentage of net water supplied;(UFW)
	3.2 Volume of water lost per kilometre of water distribution network. (water loss)
Metering and meter reading	4.1 The proportion of connections that have water meter and number of meters red (computed as the total number of connections with a meter/total number of connections red as a percentage).
Cost of Operations	5.1 Unit Operational Cost (Average operation cost Birr per m ³)
	5.2 Total Costs divided by total volume of water produced (in m ³) for the period.
	5.3 Staff per 1000 connections computed as: Total Number of staffs multiplied by 1000divided by number of connections
Investments	7.1 The capital works carried out and the investment involved for the period.
Financial Performance	8.1 Revenue collection efficiency (%)
	8.2 Cost recovery (Revenue cost ratio)
	8.3 A summary income statement
	8.4 A summary balance sheet
Human resources development	9.1 The approved structure are occupied by relevant professional staff
	9.2 Staffs capacity building (Staffs got trainings)

Source: Adapted by author from (Ministry of Water and Energy, 2013c) (*indicator groups by author)

Wukro indicators in the strategic plan

Indicator group	Indicator
Citizens	Coverage (%)
	User satisfaction (%)
Finance	Revenues
	Budget utilisation (%)
Internal process	Community ownership index
	Number of discussions
	Water production (m3)
	NRW (%)
	User satisfaction (%)
	data system (?)
Learning and development	Qualified leadership in number
	Employee satisfaction (%)
	Number of qualified staff
	Support and monitoring provided in numbers
	Number of computer-using staff
	New technologies introduced

Source: Wukro five-year strategic plan (2015-2020)
(Wukro Water Services Office, 2014)

Ethiopia Utility Federation indicators

Indicator		Unit	Indicator description
Service quality	Coverage of water supply connections	%	Population with access to water services, either as a domestic water connection (individual or shared) or through public water points
	Water Demand Coverage (Actual)	%	percentage of the per capita water consumed by residential customers to that of the estimated per capita water demand or country targets
	Average total per capita water consumption	lpcd	total volume water sold to all customer type per person per day
	Average Per capita residential consumption	lpcd	total volume of water sold to residential customers per day divided by the number of populations served
	Continuity of piped water supply	hours	hours in a day a consumer can draw drinking water from the tap at his household connection or the public stand post.
	Water quality compliance	%	percentage of the total number of water samples tested and passed the tests for drinking water quality standards
	Increase in domestic connections over the year	%	percentage increase in the connection of water supply to the consumers over the year
	Treatment capacity utilized	%	percentage of average daily volume of water treated to the total design capacity of the entire treatment plan
Economic efficiency	Bill-Revenue collection efficiency	%	total billed tariff revenue collected in a year divided by the total billed revenue (printed bills) in a year
	Working ratio (Tariff Cost Recovery)	%	ratio of total billed tariff revenue collected in a year to total operation & maintenance plus expansion and improvement (capital) cost in a year
	Operating Cost Coverage (OCC)		total annual operating revenues and the total annual operation and maintenance costs
	Personnel expenditure as percentage of revenue collection		ratio of personnel expenditure to the total collection of current water and sewerage bills (including collections from other operational water and sewerage related services)
	Water production cost per cubic meter		total running expenses to produce water per cubic meter of water sold (consumption) over the year (e.g., personal cost, electric cost, chemical cost etc.)
	Average Tariff (in to supply)		total water revenue collected divided by the total volume of water consumption/sold
	Total energy cost against total O&M Cost	%	energy cost expense in percentage of the total O&M cost
Operational sustainability	Non-Revenue Water or NRW	%	difference between total water supplied and total water sold expressed as a percentage of total water supplied
	Staffing level/1000 water connections		Staff per 1,000 Water and Sewer Connections,
	Maintenance costs as a percent of total operating costs	%	relative level of maintenance costs in comparison with total operating costs
	Number of burst pipes	#/km/year	total number of bursts per year and per km of water mains
	Share of Women in Management position	%	proportion of females in the total number of persons employed in managerial positions
	Share of Women from total staff	%	percentage of the number of women to that of the total number of full-time employees

National urban water service indicators

		Phase 1	Phase 2	Phase 3
Indicator group*		Urban water KPIs in WASH M&E framework and manual (NWCO, 2008)	Urban water KPIs in WASH M&E MIS for NW11 (PUT MIS, 2011)	KPIs and SIs for NW12 (MoWIE and Coffey, July 2018)
Coverage and service levels	Access / Use	2. % of urban population <u>using</u> improved water sources	KPI 112021 - Urban Water <u>Access</u> with Dom. <u>Consumption</u> KPI 112022 - Urban Water <u>Access</u> with Domestic <u>Production</u> Approximation KPI 112031 - Urban Water <u>Usage</u> with Served Population KPI 112032 - Urban Water <u>Usage</u> with Domestic Connection Mode	Urban KPI 1: Percentage of population with <u>access</u> to 40-100 lpcd within 0.5 km radius from yard connections, public taps or on spot water supply schemes Urban KPI 2: Percentage of population who <u>used</u> 40-100 lpcd within 0.5 km radius from yard connections, public taps or on spot water supply schemes
	Continuity	8. No & % of Towns with supply more than 6 hours for more than 5 days per week		Urban SI 1: % of utilities with 12 hours of service
Service provider presence, capacity and performance	NRW	7. No & % of Towns with NRW 20% or greater	KPI 112061 - Urban Water Supply Non-Revenue Water	Urban KPI 3: % of non-revenue water
	Cost recovery	9. No & % of Towns that cover full cost recovery and No & % of Towns that cover operating costs	KPI 112071 - Urban Water Supply in Full Cost Recovery	Urban KPI 4: %of O&M cost recovery Urban KPI 10: %of full cost recovery Regional SIS: Percentage of utilities with full cost recovery
	Water balance		KPI 112091 - Urban Water Supply with Adequate Water Source	Urban KPI 5: Water balance
	Water safety plan			Urban KPI 9: %of water supply schemes with water safety plan
	Staffing		KPI 112081 - Urban Water Supply fulfill Key Utility Staffs	Urban SI 5: % of utility trained staff
	Other	4. Number of unserved urban population to which improved services have been extended in past 12 months		Urban SI3: %of utilized budget Urban SI 2: %of water supply schemes with sustainability check Regional SI 1: %of utilities which have ICT based Management Information System (MIS) Regional SI 1: %of utilities which have an Asset Management System
Service authority presence, capacity and performance	Consumer forum			Urban SI 4: %of legalized Consumer Forums
	Water Board			Regional SI 3: %of water utilities which have WASH teams or Water Boards
	% women in Water Boards			

PI&BM indicators

Indicator group*	Indicator (KPIs in bold)
Technical indicators	1.1 - Water Coverage (%)
	1.2 - Water Coverage – Household Connections (%)
	1.3 - Water Coverage – Public Water Points (%)
	3.1 - Water Production (liters/person/day)
	3.2 - Water Production (m3/conn /month)
	4.1 - Total Water Consumption (liters/person/day)
	4.2 - Total Water Consumption (m3/conn/month)
	4.7 - Residential Consumption (liters/person/day)
	4.8 - Residential Consumption – connections to mains supply (liters/person/day)
	4.9 - Residential consumption - public water points (liters/person/day)
	4.3 - Water consumption split by Residential Consumption (%)
	4.4 - Water consumption split by Industrial / commercial Consumption (%)
	4.5 - Water consumption split by Consumption by Institutions & others (%)
	4.6 - Water consumption split by Bulk treated supply (%)
	6.1 - Non Revenue Water (%)
	6.2 - Non Revenue Water (m3/km/day)
	6.3 - Non Revenue Water (m3/conn/day)
	15.1 - Continuity of Service (Hrs/day)
	15.2 - Customers with discontinuous supply (%)
	15.3 - Quality of water supplied: nr of tests for residual chlorine (% of # required)
	15.4 - Quality of water supplied: samples passing on residual chlorine (%)
Personnel indicators	12.1 - Staff Water /000 Water connections (#/000 W conn)
	12.3 - Staff Water/000 Water pop served (#/000 W pop served)
	13.1 - Labor Costs vs Operational Costs (%)
	14.1 - Contracted-out service costs as percentage of operational costs (%)
Operational indicators	9.1 - Pipe Breaks (breaks/km/yr) [in KPI list as 2 separate indicators: Length of distribution network and number of pipe breaks]
	Maintenance cost against total operating cost [not in IBNET list of indicators]
Financial indicators Metering	11.1 - Unit Operational Cost Water (US\$/m3 sold)
	11.2 - Unit Operational Cost Water (US\$/m3 produced)
	13.2 - Electrical Energy Costs as percentage of Operational Costs (%)
	18.1 - Average Revenue W&WW (US\$/m3 water sold)
	18.2 - Average Revenue W&WW (US\$/W conn/yr)
	18.3 - Average Revenue – water only (US\$/m3 water sold)
	18.6 - Water revenue – residential (% of total water revenue)
	18.7 - Water revenue – industrial/commercial (% of total water revenue)
	18.8 - Water revenue – institutions & others (% of total water revenue)
	18.9 - Water revenue – bulk treated supply (% of total water revenue)
	19.1 - Total revenues per service pop/GNI (% GNI per capita)
	19.2 - Annual water bill for a household consuming 6m3 of water per month through a household or shared yard tap (but excluding the use of standposts)? (US\$/year)
	21.1 - Ratio of industrial to residential tariff (ratio)
	21.2 - Ratio of industrial to residential tariff - water (ratio)
	22.1 - Connection Charge - water (US\$/conn)
	22.2 - Connection Charge - water (% GNI per capita)
	23.1 - Collection Period (days)
	23.2 - Collection ratio (%)
	Account receivable (%) [not in IBNET list of indicators]
	24.1 - Operating Cost Coverage (ratio)
	25.1 - Debt Service Ratio (%)
	27.2 - Gross Fixed Assets - water (US\$/W pop served)
Customer services	7.1 - Metering level (%)
	8.1 - Water sold that is metered % (%)
	16.1 - Complaints (% of W and WW conn) [for KPI indicated as No.]
	Response time to complaints (No.) [not in IBNET list of indicators]

Source: compiled from IBNET database and Tadesse (2020)

TUMS indicators

Tigray benchmarking indicators

	2008EC*	2009EC**	2010EC***
Coverage	✓		✓
Water production	✓	✓	✓
Water sales	✓	✓	✓
NRW	✓	✓	✓
Revenues	✓	✓	✓
Water quality	✓		
Submission of annual plans		✓	
Submission of reports		✓	
Auditing practices		✓	
User satisfaction		✓	✓

*source: (Monitoring, Support and Maintenance Subprocesses, Drinking water supply process, Tigray Bureau of Water Resources, 2015); **source: (Monitoring, Support and Maintenance Subprocesses, Drinking water supply process, Tigray Bureau of Water Resources, 2016); ***source: (Monitoring, Support and Maintenance Subprocesses, Drinking water supply process, Tigray Bureau of Water Resources, 2017)

Tigray region utility scoring and WaterAid 20 town scoring matrix

Tigray region town utility scoring:

Series category 1 Water Services Performance 2009 FY (2016/17)										
Town	Submission of plans From 5%	Submission of reports From 5%	Revenues From 25%	Water production From 15%	Water sales From 15%	NRW From 15%	User satisfaction From 10%	Audit From 10%	Score From 100%	Rank
AKSUM	5	5	18.0	13.2	12.9	11.8	8.4	10	84	1
Adwa	5	3	16.8	14.0	11.0	9.4	9.7	0	69	2
MEKELLE	5	5	23.0	6.9	6.5	11.2	8.1	0	66	3

Source: Tigray Regional, 2017 (translated with google translate, and edited by author)

WaterAid scoring matrix of the 20 town programme

S.N.	Project Town	Region	Ranking Criteria and Weight (2016/17)					2016/17 Total Score (100%)	/2015/16 Score (100%)	2015/16 Traffic Light
			WASH Governance & Accountability (20%)	Implementation of Systems (60%)	Key Performance Measurement (15%)	Utilization of Transferred Budget (3%)	Reporting (2%)			
1	Adigrat	Tigray	16.5	54	14	3	2	89.5	59	G
2	Adola	Oromiya	10	32.5	11.5	1.5	1	56.5	50	Y
3	Ambo	Oromiya	9	56	13	3	2	83	71	G
4	Axum	Tigray	19	57	13	2	1	92	84	G
5	Bati	Amhara	13	37.5	11.5	1	1	64	31	R

Source: (WaterAid, 2017)

ANNEX 7: NWI2 KPIS, VARIABLES AND CHALLENGES FOR CALCULATING THE KPIS

KPI	Variables related to KPI	KPI calculation challenges
Urban KPI 1: Percentage of population who have <u>access</u> to 40-100 lpcd within 0.5 km radius from yard connections, public taps or on spot water supply schemes [GTP2 goal 1.2)	- How many people are able to access 100 l/p/c/d for category 1 towns, 80 l/p/c/d for category 2 towns, 60 l/p/c/d for category 3 towns, 50 l/p/c/d for category 4 towns and 40 l/p/c/d for category 5 towns within a 250m radius of public tap 1? Asked for - Household connection - Yard tap - Public tap	Difficult to assess: Very difficult to impossible for data collectors to determine.
Urban KPI 2: Percentage of population who <u>used</u> 40-100 lpcd within 0.5 km radius from yard connections, public taps or on spot water supply schemes		No variables for assessing this indicator
Urban KPI 3: % of non-revenue water [GTP2 goal 3.1)	- What is the non-revenue water (NRW) rate (%)? - What is the average amount pumped or abstracted from source 2 in cubic metres (m3) per day (this will be the same or less than the capacity which is 720 m3) - What is the total amount of water supplied to this town in cubic metres (m3) per day? (this should not be greater than the total water production capacity from all water supply schemes)	Difficult to assess: Difficult to verify data provided for variable 4.2.1.6.9. Amount of water produced from different sources would need to be added. Also, assessing per day requires calculation by data collector (dividing total annual amount by 365), which potentially leads to data collection errors.
Urban SI 1: % of utilities with 12 hours of service [GTP2 goal 3.2)	What is the utility's average number of continuous supply hours per day?	
Urban KPI 4: % of O&M cost recovery [GTP2 goal 3.3]	- What is the status of cost recovery? - What is the average annual Operations and Maintenance (O&M) cost over the past three years (in Birr)? - What is the average annual revenue over the past three years (in Birr)?	Not possible to calculate from collected variables. The first variable is a categorical variable, not suitable for assessing this KPI. The other two variables ask for amounts over past 3 years. This requires calculation by data collectors. Also, this does not give an indication of the indicator in a certain year.
Urban KPI 10: % of full cost recovery [GTP2 goal 3.3]		No variables for assessing this indicator
Regional SI5: Percentage of utilities with full cost recovery		No variables for assessing this indicator
Urban KPI 5: Water balance	What is the total amount of water supplied to this town in cubic metres (m3) per day? (this should not	Difficult to assess: Basis of the required calculations by data

KPI	Variables related to KPI	KPI calculation challenges
	- be greater than the total water production capacity from all water supply schemes) - What is the total water demand in cubic metres (m3) per day for this town?	collectors are not given / unclear.
Urban KPI 9: % of water supply schemes with water safety plan	Is there a formal Water Safety Plan or Strategy for this water supply scheme?	
Urban SI 5: % of utility trained staff	- What is the total number of utility staff? - What is the percentage (%) of staff trained to diploma level? - What is the percentage (%) of staff trained to high degree level? - What is the percentage (%) of staff trained to Artisan level?	Not possible to calculate from collected variables. The three questions about "training" as not about training, but about educational level of staff.
Urban SI3: % of utilized budget	- What is the average annual allocated budget over the past three years (in Birr)? - What is the average annual allocated budget utilisation over the past three years (%)?	Not possible to calculate from collected variables. This requires calculation by data collectors. Also, this does not give an indication of the indicator in a certain year.
Urban SI 2: % of water supply schemes with sustainability check	Has the utility carried out a sustainability check of the water supply scheme? (a sustainability check can be undertaken by a utility to assess whether the conditions for sustainable WaSH service provision are in place)	
Regional SI 1: % of utilities which have ICT based Management Information System (MIS)	Does the utility have an ICT system?	
Regional SI 1: % of utilities which have an Asset Management System	Does the utility have an asset management system?	
Urban SI 4: % of legalized Consumer Forums	Does the utility have a Water Consumer Forum?	
Regional SI 3: % of water utilities which have WASH teams or Water Boards	Does the utility have a Water Board?	

ANNEX 8: JMP DATA SOURCES

Survey	Years (since 2010)	Sample size latest survey	Survey objectives
Afrobarometer	2020	2,400 households	
Performance Monitoring & Accountability (PMA)	2014, 2015, 2016, 2017, 2018, 2019	7,616 households (2016)	Generate data on a variety of reproductive, maternal, and new-born health (RMNH) indicators that can inform national and regional governments.
Ethiopia Socio-Economic Survey (ESS)	2012, 2014, 2016, 2019	4,954 households (2016)	Collect multi-topic, household-level panel data with a special focus on improving agriculture statistics and generating a clearer understanding of the link between agriculture and other sectors of the economy.
Demographic Health Survey (DHS)	2000, 2011, 2014 (mini), 2016, 2019 (mini)	16,650 households (2016)	To collect and share key information about people, their health and their health systems
Census	2017	Census	
LSMS-ISA project Socioeconomic Survey 2013 - 2014	2014	5,262 households	
National WASH inventory	2011	12 million households	
Welfare Monitoring Survey 2011: Report	2011	28,032 households	
Welfare Monitoring Survey	2000	26,072 households	

ANNEX 9: UTILITY PERFORMANCE INDICATOR OVERVIEW

Indicator	Utility MIS		2013 guidelines Performance report	2013 guidelines Performance evaluation format	2023 performance- based contract agreement	Utility performance report		Tigray monitoring system	PI&BM	National system (mix of coverage and benchmarking)			Total count
						Jinka	Wukro			Phase 1	Phase 2	Phase 3	
NRW	1	2	1	1	1	1	1	1	3	1	1	1	11
Coverage		1	2		2		1	1	3	1	4	2	8
Cost recovery	1	2			2				2	1	1	3	7
Water quality	1			1	2	1		1	1			1	7
Continuity	1	1			1				2	1		1	6
Expenditure	3	3			4	1			6				6
Revenues		1				1	1	1	9				6
HR		2				1	1						
Consumer services	1	1					1	1	1		1	1	5
Water consumption		2			2	1		1	9			1	6
Water production		1				1	1	1	2				5
Staff efficiency	3	1			1				2				5
Billing and revenue collection	2	1			1				2				4
Women representation					2								1
Connections		2			1								3
Presence of Water Board												1	1
Metering		1				1			2				3
tariff					1				6				2
Efficiency of equipment	2												2
Pipe breaks					1				1				2
Water resource adequacy											1	1	2
Other indicators						6	10	3	1			4	6
Total	15	21		21	21	14	16	7	51	4	8	12	11

ANNEX 10: NWI2 DATA ON KPIS AND SIS

KPIs and Sis for NWI2	Value	Remark
Urban KPI 3: % of non-revenue water [GTP2 goal 3.1]	NA	Not configured, due to inadequate data* / Difficult to assess based on available data
Urban KPI 4: % of O&M cost recovery [GTP2 goal 3.3]	NA	Not configured, due to inadequate data *
Urban KPI 5: Water balance	NA	Difficult to assess based on available data
Urban KPI 9: % of water supply schemes with water safety plan	Report: 22%** Tigray: 27% as per data, 8% as per report**	
Urban KPI 10: % of full cost recovery [GTP2 goal 3.3]	NA	Not configured, due to inadequate data *
Urban SI 1: % of utilities with 12 hours of service [GTP2 goal 3.2]	Tigray data (n=45): 40%***	Not configured, due to inadequate data *
Urban SI 2: % of water supply schemes with sustainability check	Tigray data: 60%***	
Urban SI3: % of utilized budget	NA	Not possible to assess from data
Urban SI 4: % of legalized Consumer Forums	Tigray data: 84%***	
Urban SI 5: % of utility trained staff	NA	Not possible to assess from data
Regional SI 1: % of utilities which have ICT based Management Information System (MIS)	Tigray data: 38%***	
Regional SI 1: % of utilities which have an Asset Management System	Tigray data: 67%***	
Regional SI 3: % of water utilities which have WASH teams or Water Boards	Tigray data: 93%***	
Regional SI5: Percentage of utilities with full cost recovery	NA	Not configured, due to inadequate data *

Source: *Asmamaw (2021); **Water Development Commission (2021);

***Assessment by author based on raw NWI2 data

ANNEX 11: DATA CHARACTERISTICS

Utility asset and operational data

Data attributes	Data characteristics	Description of utility data characteristics	
		Asset data	Operational data
Relevance	Frequency	Irregular, instead of regular / real-time	Regular / real-time
	Scale, unit of observation	Most, but not all assets of a utility	Single utility
	Scale, unit of analysis	Utility	Utility
	Content	Type, age, status of assets	Operational data
Credibility	Data quality and accuracy	Often inaccurate, due to being based on limited available records and (institutional) memory, rather than complete records	Accurate financial data, inaccurate water production and sales data.
Timeliness	Data processing time	Irregular, instead of real-time	Within a month
Comprehensiveness	Number of variables and indicators	Less than the 7 required variables	<i>Not applicable</i>
	Number of units of observation	No data on all assets	<i>Not applicable</i>
	Data availability	Lack of asset data	
Physical accessibility	Physical accessibility	Hard and soft copies	Hard and soft copies
Accessible format	Data processing	Raw data	Raw data
	Information product development	Some maps and tables	Data tables and reports

Utility performance data

Data attributes	Data characteristics	Description of utility performance data characteristics			
		Utility MIS	TUMS	PI&BM	NWI
Relevance	Frequency	Quarterly	Half yearly	Irregular, instead of annual	Irregular, instead of annual
	Scale, unit of observation	Single utility	Census of utilities in Tigray region	Sample instead of census of utilities	Census of utilities
	Scale, unit of analysis	Utility	National and utility	National and utility	National and utility
	Content	Data against set targets	Data on Tigray indicators	Data on IBNET indicators	Data on urban KPIs
Credibility	Data quality and accuracy	Variable, with accuracy challenges	Moderate to low accuracy of source data. Data quality insurance process in place	Moderate to low accuracy of source data. Data quality insurance process in place	Evidence of inaccurate data
Timeliness	Data processing time	Within a quarter	Within 6 months	Considerably more than a year	Considerably more than a year
Comprehensiveness	Number of variables and indicators	Jinka: 13 indicators Wukro: 16 indicators	32 variables and 8 KPIs and one composite, ranked indicator	56 indicators, 17 KPIs	NWI1: 83 variables, 8 indicators NW12: 52 variables, 15 indicators
	Number of units of observation	Single utility	69	Some 90 utilities	NWI1: 332
	Data availability	Not fully in line with indicators	68%	80%	NWI1: 84% NWI: low
Physical accessibility	Physical accessibility	Hard and soft copies	Excell file	Open access online	Accessible through password protected MIS at national level only
Accessible format	Data processing	Not fully done on indicators	On indicators	On indicators	NWI1: On all indicators NW12: On very few indicators
	Information product development	Narrative reports with tables	Table	Dashboard and report	Dashboard and information products

Coverage data

Data attributes	Data characteristics	Description of coverage data characteristics	
		Ministry	JMP
Relevance	Frequency	Annual	Every 2 years
	Scale, unit of observation	Census of assets and population	Representative households sample
	Scale, unit of analysis	Regional and national level	National
	Content	Coverage, national standards	Coverage, global standards
Credibility	Data quality and accuracy	Low data accuracy	
Timeliness	Data processing time	Within a year	1 to 2 years
Comprehensiveness	Number of variables and indicators	1	MDG era: 1
	Number of units of observation	<i>Not applicable</i>	SDG era: 2
	Data availability	<i>Not applicable</i>	
Physical accessibility	Physical accessibility	Hard and soft copies	Open access online
Accessible format	Data processing	On indicators	On all indicators
	Information product development	Sector presentations	Dashboard and reports

ANNEX 12: CAPACITY, MOTIVATION AND OPPORTUNITIES RATING TABLE

Data user	Data use case	Individual capacity	Individual motivation	Organisational human resource capacity	Organisational financial capacity	Data and information systems	Systems strength	National culture	Political economy	Actual data use
Federation	Use of Pi&BM data by Federation for Regulatory decision making	0	1	1	0	0	0	2	0	3
	Use of JMP data by Ministry for Planning	1	0	1	1	2	1	1	1	2
	Use of national coverage data by Ministry for Planning	1	2	1	1	0	1	1	1	5
	Use of NW11 by Ministry for Planning	0	0	1	1	0	0	0	0	1
	Use of Pi&BM data by Ministry for Planning	0	0	1	1	2	0	0	0	1
	Use of NW11 by Ministry for Regulatory decision making	0	0	0	0	0	0	2	0	1
	Use of JMP data by Ministry for Reporting for downwards accountability	1	2	1	0	2	0.0	0	0	2.5
	Use of national coverage data by Ministry for Reporting for downwards accountability	1	2	1	1	0	0	0	0	2
	Use of NW11 by Ministry for Reporting for downwards accountability	0	0	1	1	0	0.0	0	0	1
	Use of Pi&BM data by Ministry for Reporting for downwards accountability	0	0	1	1	2	0.0	0	0	1
Ministry	Use of JMP data by Ministry for Reporting for upwards accountability	1	2	1	1	2	1	2	2	2.5
	Use of national coverage data by Ministry for Reporting for upwards accountability	1	2	1	1	0	1	2	2	4
	Use of NW11 by Ministry for Reporting for upwards accountability	0	0	1	1	0	0	2	2	1
	Use of Pi&BM data by Ministry for Reporting for upwards accountability	0	0	1	1	2	0	2	2	1
	Use of JMP data by Ministry for Policy making	1	0	1	1	2	1	1	1	3
	Use of national coverage data by Ministry for Policy making	1	2	1	1	0	1	1	1	4
	Use of NW11 by Ministry for Policy making	0	1	1	1	0	1	0	0	3
	Use of Pi&BM data by Ministry for Policy making	0	1	1	1	2	1	0	0	3

Data user	Data use case	Individual capacity	Individual motivation	Organisational human resource capacity	Organisational financial capacity	Data and information systems	Systems strength	National culture	Political economy	Actual data use
RWB	Use of NWI1 by RWB for Operational decision making	2	0	0	0	0	0	2	0	1
	Use of PI&BM data by RWB for Operational decision making	2	0	0	0	0	0	2	0	1
	Use of TUMS data by RWB for Operational decision making	2	2	0	0	2	0	2	2	4
	Use of Utility performance data by RWB for Operational decision making	2	0	0	0	0	0	2	2	2
	Use of NWI1 by RWB for Regulatory decision making	2	0	1	1	0	0	2	0	1
	Use of PI&BM data by RWB for Regulatory decision making	2	0	1	1	0	0	2	0	1
	Use of TUMS data by RWB for Regulatory decision making	2	0	1	1	2	0	2	0	2
	Use of Utility performance data by RWB for Regulatory decision making	2	0	1	1	0	0	2	0	2
	Use of NWI1 by RWB for Regulatory decision making	2	0	1	1	0	0	2	0	1
	Use of PI&BM data by RWB for Regulatory decision making	2	0	1	1	0	0	2	0	1
	Use of TUMS data by RWB for Regulatory decision making	2	2	1	1	2	0	2	2	6
	Use of national coverage data by RWB for Planning	1	2	1	1	0	1	1	1	6
	Use of NWI1 by RWB for Planning	1	0	1	1	0	0	1	0	1
	Use of PI&BM data by RWB for Planning	1	0	1	1	0	0	1	0	1
	Use of TUMS data by RWB for Planning	1	2	1	1	2	0	1	1	5
	Use of TUMS data by RWB for Reporting for downwards accountability	0	0	0	0	2	0	0	0	2
	Use of TUMS data by RWB for Reporting for upwards accountability	2	2	1	1	2	0	2	2	3

Data user	Data use case	Individual capacity	Individual motivation	Organisational human resource capacity	Organisational financial capacity	Data and information systems	Systems strength	National culture	Political economy	Actual data use
Utility	Use of Utility asset data by Utility for Operational decision making	1	2	1	1	0	0	1	1	1
	Use of Utility operational data by Utility for Operational decision making	1	2	1	1	0	0	1	1	5
	Use of Utility operational data by Utility for Reporting for downwards accountability	1	0	0	0	0	0	0	0	2
	Use of Utility operational data by Utility for Reporting for upwards accountability	1	2	1	1	0	1	2	2	3
	Use of Utility performance data by Utility for Reporting for upwards accountability	1	2	1	1	0	1	2	2	3
	Use of NWI1 by Utility for Planning	0.5	0	0	0.5	0	0	0	0	1
	Use of PI&BM data by Utility for Planning	0.5	0	0	0.5	0	0	0	0	1
	Use of TUMS data by Utility for Planning	0.5	0	0	0.5	0	0	0	0	3
	Use of Utility asset data by Utility for Planning	0.5	2	0	0.5	0	0	0	0	4.5
	Use of Utility operational data by Utility for Planning	0.5	2	0	0.5	0	0	0	0	4.5
	Use of Utility performance data by Utility for Planning	0.5	2	0	0.5	0	0	0	0	4.5
	Use of Utility asset data by Utility for Tariff setting	0.5	1	0	0.5	0	0	1	0	4
	Use of Utility operational data by Utility for Tariff setting	0.5	1	0	0.5	0	0	1	0	4
	Use of Utility performance data by Utility for Tariff setting	0.5	1	0	0.5	0	0	1	0	4
Water Board	Use of Utility operational data by Water Board for Operational decision making	1	1	1	0	0	0	1	1	4
	Use of Utility performance data by Water Board for Operational decision making	0	1	1	0	0	0	1	1	2
	Use of Utility performance data by Water Board for Regulatory decision making	0	0	1	0	0	0	1	1	3

Levels: Local; Sub-national; National; Factor rating: 0= low; 1= moderate; 2= high; Rating of actual data use: 0= Data are not available to potential users; 1= Data are available to the decision maker(s) / duty bearer; 2 = Decision makers / duty bearers have engaged with and understand the data; 3 = Decision makers refer to, but does not use data /Duty bearers reports data, but rights holder does not hold duty bearer accountable/process use; 4 = Low use: Decision makers have made use of data for informing decisions, but these decisions are mainly informed by other factors than the data /Rights holders have hardly used data for holding the duty bearer accountable; 5 = Moderate use: Decision makers have made use of data for informing decisions, but these decisions have to some degree been informed by other factors than the data /Rights holders have used data for holding the duty bearer accountable to a moderate degree; 6 = High use: Decision makers have made use of data for informing decisions, mainly depending on the data for informing their decision / Rights holders have used data for holding the duty bearer accountable to a high degree (P) = process use

ANNEX 13: METHODOLOGY AND RESULTS OF FACTOR RANKING BASED FACTOR CENTRALITY AND CAUSAL LOOPS

Methodology

Closeness and betweenness centrality analysis of factors

As introduced in Chapter 2, the concepts of closeness centrality and betweenness centrality can provide insight into the role of actors in social networks. Applying these concepts to factors in a factor network obtained through the structural analysis, rather than to actors in a social network, can provide insight into the leveraging power of factors.

In social networks, actors with higher closeness centrality need relatively fewer steps to reach all other individuals in the network and thus can potentially move information faster (Freeman, 1978). Betweenness centrality measures the frequency at which a node lies on the shortest path connecting other nodes in the network. Factors with high closeness centrality are the ones with the potential of influencing other factors in the most direct way.

Actors high in betweenness centrality are more likely to serve as a bridge in the network, connecting groups of nodes which would otherwise not be connected. Actors with high betweenness centrality can thus act as gatekeepers. If they oppose the dissemination of data or an idea, this piece of information may not be able to flow to other areas of the network (Freeman, 1978). Factors with high betweenness centrality are the ones that have a big influence on the systems as they have more pathways to propagate through the system than a factor with a low betweenness score. If factors with high betweenness centrality are weak or not in place, they can have a big influence on the rest of the system.

The open-source software program Gephi (gephi.org, 2023) has been applied for the Centrality Analysis presented in Chapter 9 of this thesis.

Causal loop analysis

As mentioned in Chapter 2, feedback loops are a crucial element of systems. In this thesis, feedback loops in the data-use system are explored through causal loop analysis. This involved the development of causal loop diagrams, based on the cross-impact matrix.

The average loop strength for each loop can be determined by assessing the average factor influence scores of the factors involved in the loop. For example, a loop involving factor A, B, and C ($A \rightarrow B \rightarrow C \rightarrow A$), with factor influence score $A \rightarrow B = 2$, $B \rightarrow C = 1$ and $C \rightarrow A = 1$ has an average loop strength of $2 + 1 + 1/3 = 1.33$. The frequency with which a factor is included in feedback loops, especially in feedback loops with high average loop strength, can give an indication of the possible leverage power of the factor.

This thesis has used the VENSIM PLE software (Ventana Systems INC, 2024) for constructing the causal loop diagram and analysing the resulting causal loops.

Results

Factor centrality

The table below presents an overview of the assessed closeness and betweenness centrality for each of the factors. It shows factors with highest level of closeness centrality are 1) Political economy and National culture, 2) Individual motivation, and 3) Strength of systems building blocks. These factors have the potential of influencing other factors in the most direct way. The table below shows factors with the highest betweenness centrality are: 1) Individual motivation, 2), Quality of relationships 3) Political economy. If these factors are weak or not in place, they can have a big influence on the rest of the system.

Factors, ordered by closeness centrality	Closeness centrality	Factors, ordered by betweenness centrality	Betweenness centrality
Political economy	0,9375	Individual motivation	55,85
National culture	0,9375	Quality of relationships	31,4
Individual motivation	0,83333	Political economy	16,36666
Strength of systems building blocks	0,7894	Individual capacity	2,53333
Organisational financial capacity	0,714286	Data credibility	1,65
Individual capacity	0,6818	Strength of systems building blocks	1,53333
Quality of relationships	0,652	Organisational human resources	1,3333
Organisational decision support tools	0,6	Data format accessibility	1,2
Data credibility	0,57	Organisational decision support tools	0,5
Data format accessibility	0,5556	Data timeliness	0,45
Organisational human resources	0,555556	Data comprehensiveness	0,45
Data comprehensiveness	0,533	Data relevance	0
Data physical accessibility	0,533	Data physical accessibility	0
Data timeliness	0,5	Organisational financial capacity	0
Data relevance	0,48	National culture	0

Causal loops

The cross-influence matrix presented in 10.23 has been used to construct the causal loop diagram presented in figure 10-3, showing the influence of factors on other factors in the data-use system. To highlight linkages and feedback loops between the factors from the different perspectives, the data attributes have been combined into a single factor, as have the organisational, sectoral and contextual opportunities for data use.

Analysis of this factor network (using VENSIM software) showed it includes a total of 894 feedback loops with the outcome factor 'data use' as start and end point. As shown in the figure, these include direct feedback loops with data attributes, relationships, individual capacity and motivation for data use, and sectoral opportunities for data use. In addition, there are various feedback loops involving multiple factors, with most involving six (31% of feedback loops) or seven factors (30% of feedback loops).

The strength of each loop was assessed, using the method introduced in Chapter 3. A total of 19 feedback loops has a loop strength of 2, indicating strong loops. These involved four direct

loops (with relationships, capacity, motivation and service opportunities for use), seven loops involving 2 factors, six involving three factors and two involving four factors. A complete list of the factors loops with loop strength 2 can be found below.

Direct loops

1. Data use → Sectoral opportunities for data use → Data use
2. Data use → Capacity for data use → Data use
3. Data use → Motivation for data use → Data use
4. Data use → Relationship between data producers and users → Data use

Loops with 2 factors:

1. Data use → Capacity for data use → Relationship between data producers and users → Data use
2. Data use → Capacity for data use → Motivation for data use → Data use
3. Data use → Sectoral opportunities for data use → Motivation for data use → Data use
4. Data use → Motivation for data use → Relationship between data producers and users → Data use
5. Data use → Sectoral opportunities for data use → Organisational opportunities for data use → Data use
6. Data use → Sectoral opportunities for data use → Relationship between data producers and users → Data use
7. Data use → Relationship between data producers and users → Motivation for data use → Data use

Loops with 3 factors

1. Data use → Sectoral opportunities for data use → Motivation for data use → Relationship between data producers and users → Data use
2. Data use → Sectoral opportunities for data use → Relationship between data producers and users → Motivation for data use → Data use
3. Data use → Sectoral opportunities for data use → Organisational opportunities for data use → Motivation for data use → Data use
4. Data use → Capacity for data use → Relationship between data producers and users → Motivation for data use → Data use
5. Data use → Sectoral opportunities for data use → Data attributes → Motivation for data use → Data use
6. Data use → Capacity for data use → Motivation for data use → Relationship between data producers and users → Data use

Loops with 4 factors

1. Data use → Sectoral opportunities for data use → Data attributes → Motivation for data use → Relationship between data producers and users → Data use
2. Data use → Sectoral opportunities for data use → Organisational opportunities for data use → Motivation for data use → Relationship between data producers and users → Data use

Factor	Frequency of factor in loops	% of loops
Data attributes	2	11%
Relationship between data producers and users	11	58%
Capacity for data use	5	26%
Motivation for data use	13	68%
Organisational opportunities for data use	3	16%
Sectoral opportunities for data use	10	53%
Contextual opportunities for data use	0	0%
Total	19	

A bit more than half (52%) of loops were found to have a loop strength of at least 1.5 and therefore considered as at least moderately strong loops. The table below indicates the number of times each of the (consolidated) factors was included in a feedback loop.

Factor (group)	Frequency with which the factor is included in strong data use feedback loops (loop strength at least 1.5)		Frequency with which the factor is included in weak data use feedback loops (loop strength < 1.5)	
Data attributes	275	60%	357	83%
Relationship between data producers and users	407	88%	416	96%
Individual capacity for data use	292	63%	357	83%
Individual motivation for data use	407	88%	359	83%
Organisational opportunities for data use	304	66%	371	86%
Sectoral opportunities for data use	347	75%	291	67%
Contextual opportunities for data use	210	45%	159	37%

The table shows that the quality of relationships between data producers and users, and individual motivation of data use are factors that are included in many feedback loops. It also shows that the frequency of **data attributes**, **individual capacity**, and **organisational opportunities for data use** in feedback loops is higher for weaker feedback loops than for stronger ones. The frequency with which sector and contextual opportunities were included in feedback loops, was higher for the stronger feedback loops than for the weaker ones.

The **Quality of relationships between data producers and users**, **Individual motivation** and **sectoral opportunities for data use** were found to be the factors that featured most frequently in strong feedback loops (with a loop strength of at least 1.5). Based on the causal loop analysis, these factors are thus assumed to be the factors with the highest leveraging power in the data-use system.

ANNEX 14: INDIRECT INFLUENCE MATRIX

	D_REL	D_TIME	D_CRE	D_COMP	D_PA	D_FA	QR	IC	IM	OC_HR	OC_FR	OC_DST	C_BB	C_POLEC	C_CUL	DU
D_REL	1212302	1705760	963648	979308	1118442	1359566	1428074	616228	2283724	372252	318452	426240	577964	125282	21192	2140944
D_TIME	1333646	1875840	1059840	1078084	1231736	1496731	1570752	679288	2509654	409328	350068	468320	637164	137752	23348	2353056
D_CRE	1601912	2251302	1272140	1297340	1483876	1801364	1885893	820286	3006522	491134	419582	560710	769578	165224	28204	2819510
D_COMP	1388380	1951718	1102848	1123688	1284802	1560113	1634698	709652	2608066	425828	363896	486504	665692	143274	24368	2445674
D_PA	1536618	2161093	1221006	1242528	1419886	1725110	1809671	783298	2890534	471576	403212	539346	734772	158664	26966	2710180
D_FA	1422926	2001674	1130864	1150028	1313806	1596652	1675971	724306	2678598	436814	373582	499874	679406	146990	24940	2511266
QR	2474091	3477634	1965404	2002526	2289613	2780140	2913028	1264642	4646890	758930	648670	867008	1186430	255393	43416	4358058
IC	2631006	3697087	2089368	2131032	2437542	2958803	3097200	1347672	4936610	806590	689134	920720	1264426	271304	46350	4630002
IM	3705977	5205735	2942832	3003104	3436021	4169182	4361710	1900922	6947062	1135732	970264	1295722	1783548	382195	65174	6516996
OC_HR	2081340	2927170	1653960	1682812	1922972	2336312	2450948	1060644	3915256	638736	546168	730608	994976	215048	36452	3671008
OC_FR	3434876	4825010	2726968	2784096	3185716	3865616	4042974	1763144	6437824	1052440	898976	1200432	1654348	353988	60604	6038768
OC_DST	2200296	3092502	1747800	1781088	2036556	2472704	2590367	1125118	4131442	674738	576730	770754	1055570	227100	38620	3874810
C_BB	4395056	6175220	3490428	3560232	4072896	4942940	5173328	2252268	8243936	1347156	1150892	1537540	2112996	453392	77280	7725240
C_POLEC	6197344	8709316	4922396	5018328	5739536	6967068	7296016	3172076	11632048	1900452	1623804	2169972	2975844	639504	108960	10909532
C_CUL	6197344	8709316	4922396	5018328	5739536	6967068	7296016	3172076	11632048	1900452	1623804	2169972	2975844	639504	108960	10909532
DU	3422274	4808302	2717412	2772568	3171814	3849258	4028276	1754136	6418592	1049020	896036	1197144	1645732	353034	60108	6019960

D_REL= Data relevance; D_TIME= Data timeliness; D_CRE= Data credibility; D_COMP= Data comprehensiveness; D_PA= Data physical accessibility; D_FA= data in accessible formats; QR= quality of relationships between data producers and users; IC= Individual capacity for data use; IM= Individual motivation for data use; OC_HR= Organisational human resource capacity; OC_FR= Organisational financial capacity; OC_DST= Presence of decision support tools; C_BB= Strength of data-use systems; C_POLEC= Political economy for data use; C_CUL= National culture for data use; DU = Data use.

