THESIS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

Understanding the Roles of Stakeholders in the Water and Sanitation Sector

Implementation and Operation of Water Supply and Sanitation Systems in the Kanata metropolitan region, Bolivia

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Department of Architecture and Civil Engineering

CHALMERS UNIVERSITY OF TECHNOLOGY

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Cover: There are three main ways to access water and sanitation services in the Kanata metropolitan region: municipal providers, community-managed systems and individual solutions. The arrows indicate that households change water and sanitation providers over time (Section 1.2, p. 4) (Drawing by Cristofer Vidaurre).

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To my sister, my hero!

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Abstract

This thesis aims to understand how distinct population segments access water and sanitation services in low and middle income countries, including the role of community-based organizations (CBOs) and individual households. A qualitative case study approach of the water and sanitation sector of the Kanata metropolitan region, Bolivia was selected. At first, the holistic case of the whole water and sanitation sector was studied through a deductive approach that implied application of transition theory. Secondly, embedded cases of unique interest were included to develop new theories, i.e. inductive reasoning.

Identification and evaluation of the existing water and sanitation regimes in the Kanata metropolitan region highlighted weaknesses that implied opportunities for change. The community actors played a crucial role for service provision and the following internal prerequisites for community-managed water and wastewater systems were identified: agreed vision, collective action, leadership and management. These were then connected to three distinct planning and management phases. Community-managed wastewater systems were, however, less common than community-managed water systems. One explanation was found to be that communal wastewater management included many weaknesses that limited its spread. A number of facilitating factors were identified as crucial for the promotion of community-managed wastewater systems. At the household level, an adoption framework for sanitation facilities, including triggers and veto-barriers, was developed. It was found that most residents can be pushed or pulled into action, i.e. the adoption time can be shortened. For example, timing with other housing improvements and insecurity of daughters while practicing open defecation (OD) triggered many families to implement pour-flush toilets. Some residents did, however, need targeted interventions to overcome veto-barriers.

The findings of this research project may be used by local stakeholders in the Kanata metropolitan region, as well as bring learnings to similar contexts. The identified weaknesses of the water and sanitation regimes open up for changes and transition to safe water and sanitation services for all. The results regarding community management enable customization of external support to CBOs that have or will implement communal water and wastewater systems. In addition, the adoption framework for household sanitation facilitates development programs that aim to speed-up sanitation coverage. Apart from its practical value, this thesis also increases the theoretical understanding regarding water and sanitation regimes in low and middle income countries, as well as lays the groundwork for theories regarding community management and adoption of household sanitation. It contributes to unravelling the roles of CBOs and individual households, and their importance for speeding-up the access to safe water and sanitation services.

Keywords: Wastewater, Urban areas, SDG 6, Socio-technical regimes, Service providers, Transition, Universal access, Community management, Adoption, Households

Resumen

Esta tesis intenta entender cómo la población tiene acceso a servicios de agua potable y saneamiento en países de ingresos medianos y bajos, incluso el papel de los sistemas comunitarios y los hogares individuales. Un cualitativo enfoque era elegido, en cual la Región Metropolitana de Kanata, Bolivia era seleccionado como un estudio de caso. Primero, el caso de todo el sector de agua y saneamiento era estudiado a través de teoría de transición. Además, casos incrustados ("embedded cases") había incluidos para desarrollar teorías nuevas.

La identificación y evaluación de los regímenes existentes de agua y saneamiento en la Región Metropolitana de Kanata destacaron debilidades que implicaban oportunidades a cambio. Los sistemas comunitarios eran clave para la provisión de servicios básicos y los siguientes requisitos internos eran identificados: visión fijado, acción colectiva, liderazgo y gestión. Los cuales eran conectados a tres fases distintas de planificación y gestión. En la región, los sistemas comunitarios de saneamiento eran, sin embargo, menos comunes que los sistemas comunitarios de agua potable. Una explicación era que los sistemas comunitarios de alcantarillado y plantas de tratamiento incluyeron muchas debilidades que limitaban su expansión. Se identificaron varios factores facilitadores que eran importantes para la expansión de los sistemas comunitarios de alcantarillado y plantas de tratamiento. A nivel de los hogares, se desarrolló un marco de adopción para baños, que incluye disparadores ("triggers") y barreras de veto. La mayoría de los residentes podían ser empujados o llevados a la acción, es decir, se podía hacer el tiempo de adopción más corto. Por ejemplo, momento con otros mejoramientos de la vivienda e inseguridad de las hijas mientras defecaban al aire libre provocaron que muchas familias implementaron baños. Sin embargo, algunos residentes necesitaban intervenciones específicas para superar las barreras de veto.

Los resultados de esta tesis pueden ser utilizados por actores locales en la Región Metropolitana de Kanata, así como llevar aprendizajes a contextos similares. Las debilidades de los regímenes existentes de agua y saneamiento que eran identificados implican oportunidades de mejoramiento y transición a servicios de agua y saneamiento seguros para todos. Los resultados sobre sistemas comunitarios permiten la personalización del apoyo externo a las organizaciones comunitarias que tienen o implementarán sistemas comunitarios de agua y saneamiento. Además, el marco de adopción para baños facilita los programas de desarrollo que intentan acelerar la cobertura de saneamiento. Encima de este valor práctico, esta tesis también contribuye a la compresión teórica sobre los regímenes de agua y saneamiento, además de desarrollar la base para teorías de la implementación y operación de los sistemas comunitarios y la adopción de baños al nivel del hogar.

Sammanfattning

Denna avhandling vill visa hur och varför man får tillgång till vatten och toaletter i låg- och medelinkomstländer samt vilka roller som byalag och enskilda hushåll har. Studien hade ett kvalitativt förhållningssätt med vatten- och sanitetssektorn i Kanatas storstadsregion i Bolivia som fallstudie. Först studerdes hela vatten- och sanitetssektorn genom tillämpning av transitionsteori. Därefter användes unika fall (“embedded cases”) som ledde till nya teoretiska insikter.

Identifiering och utvärdering av befintliga vatten- och sanitetsregimer i Kantatas storstadsregion pekade på svagheter som visade på möjligheter till förändring. Byalag spelade en stor roll för vattenförsörjningen och fyra olika grundförutsättningarna för koorperativa vatten- och avloppssystem identifierades: gemensam vision, kollektivt handlande, ledarskap och underhåll. Dessa kopplades sedan till tre olika planerings- och underhållsfaser. Kooperativa avloppssystem är dock mindre vanliga än motsvarande vattensystem. En förklaring är att kooperativ avloppshantering präglas av många svagheter som hindrar dess utbredning och ett antal möjliggörande faktorer för utbredningen av kooperativa avloppssystem identifierades. På hushållsnivån utvecklades en teoretisk modell som förklarade implementering av toaletter (”adoption framework”). Tiden det tar för en familj att implementera toaletter kan förkortas med rätt motivation. Exempelvis triggar timing med andra renoveringsprojekt och osäkerhet för döttrar som måste uträtta sina behov i det fria många familjer att implementera toaletter. Några familjer behövde dock riktade åtgärder för att ta sig över ”veto-barriers”.

Resultaten från denna avhandling kan användas av lokala aktörer i Kanatas storstadsregion, men också ge lärdomar i liknande sammanhang. De olika vatten- och sanitetsregimerna med dess identifierade svagheter visar på möjligheter till förändring som kan leda till att alla kan få säkert vatten och fullgod sanitet. Resultaten gällande kooperativa vatten- och avloppssystem gör det möjligt att skräddarsy stödprogram och bistånd som syftar till att stötta byalag som har eller vill implementera vatten- och/eller avloppssystem. Den framtagna teoretiska modellen för implementering av toaletter kan stötta utvecklingsprogram för att snabba på implementeringen av toaletter. Förutom att ha ett praktiskt värde, bidrar avhandlingen till att öka den teoretiska förståelsen kring vatten- och sanitetsregimer i låg- och medelinkomstländer. Den lägger också grunden för teorier om implementering och drift av kooperativa vatten- och avloppssystem samt implementering av toaletter.

List of publications

This thesis is based on the work contained in papers I-IV, referred to by Roman numerals in the text. The contribution by the author, Ida Helgegren, to the respective papers and this thesis is outlined in italics and Table 1 below.

I I. Helgegren, J. McConville, G. Landaeta, S. Rauch. A multi-level regime analysis of the water and sanitation sector of the Kanata metropolitan region, Bolivia. Submitted for publication.

II I. Helgegren, J. McConville, G. Landaeta, S. Rauch, 2019. Importance of internal factors for community-managed water and wastewater systems in Cochabamba, Bolivia. International Journal of Water Resources Development. DOI: 10.1080/07900627.2019.1616536

III I. Helgegren, F. Minelli, J. McConville, G. Landaeta, S. Rauch. Facilitating factors for community-managed wastewater systems in the Kanata metropolitan region, Bolivia. Manuscript.

IV I. Helgegren, S. Rauch, C. Cossio, G. Landaeta, J. McConville, 2018. Importance of triggers and veto-barriers for the implementation of pour-flush toilets in informal peri-urban settlements - the case of Cochabamba, Bolivia. PLoS One, e0193613. DOI: 10.1371/journal.pone.0193613.

The author independently performed the study design, data collection and analysis for papers I, II and IV (Table 1). She also had the lead role in the writing process of these papers, but the co-authors reviewed and edited all papers. The fellow PhD student Claudia Cossio at Chalmers University of Technology, Sweden also provided comments on the original draft of paper IV. For paper III, the author and Francesca Minelli, a graduated PhD student from the University of Glasgow, Great Britain, separately collected data that later was analysed together under the lead of the author. The paper was, however, independently compiled and written by the author, but it was reviewed and edited by the co-authors.

Table 1 The author contributions for the respective papers.

Paper	**Study design**	**Data collection**	**Data analysis**	**Writing**		
				Original draft	**Reviewing and editing**	**Submission**
I	I. Helgegren	I. Helgegren	I. Helgegren	I. Helgegren	S. Rauch, J. McConville, G. Landaeta	I. Helgegren
II	I. Helgegren	I. Helgegren	I. Helgegren	I. Helgegren	S. Rauch, J. McConville, G. Landaeta	I. Helgegren
III	I. Helgegren, F. Minelli	I. Helgegren, F. Minelli	I. Helgegren, F. Minelli	I. Helgegren	F. Minelli, S. Rauch, J. McConville, G. Landaeta	I. Helgegren
IV	I. Helgegren	I. Helgegren	I. Helgegren	I. Helgegren	S. Rauch, J. McConville, C. Cossio, G. Landaeta	I. Helgegren

The research study presented in this thesis was almost entirely performed by the author. She independently performed the research design, data collection, analysis of the collected data and presentation of the findings under supervision from Sebastien Rauch, Jennifer McConville and Graciela Landaeta. Sebastien Rauch and Jennifer McConville are researchers based in Sweden where they work with water and sanitation related research projects. Together they provided continuous input and guidance throughout the whole research process, such as giving feed-back on research design, discussing emerging analytical concepts and acting as sounding boards for ideas. Graciela Landaeta is the director of a local NGO in Cochabamba, Bolivia and she mainly contributed with contextual knowledge.

In addition to the listed papers above, the author also wrote papers V and VI during her time as a PhD student, but these are not included in this thesis.

V I. Helgegren, H. Siltberg, S. Rauch, M. Mangold, G. Landaeta, C. Ledo, 2013. Contextualizing Sustainable Development for Small Scale Water and Sanitation Systems in Cochabamba, Bolivia. In: Rauch S., Morrison G., Norra S., Schleicher N. (eds.), Urban Environment (pp. 217-225). The Netherlands, Dordrecht: Springer.

VI. J. McConville, S. Rauch, I. Helgegren, J. Kain, 2016. Using role-playing games to broaden engineering education. International Journal of Sustainability in Higher Education, 18(4), pp.594-607. DOI: 10.1108/IJSHE-08-2015-0146

Paper V is a conference paper based on a pre-study performed with fellow student Helena Siltberg, i.e. they did the study design, data collection and analysis together. The author then compiled and wrote the conference paper with continuous input from co-authors. For paper VI, the author participated in supervising gaming sessions with master students. She also came with input during the development of the game and writing of the paper.

Preface

I have always been interested in development issues and how to deal with challenges, such as poverty and lack of opportunities in low and middle income countries, as well as how these challenges are connected to environmental issues. I did my MSc thesis in the Kanata metropolitan region, Bolivia where I studied two housing cooperatives and their water and sanitation systems. This later led to this PhD project that, initially, aimed to continue the study of water and sanitation systems in relation to the housing projects of the local foundation Procasha, but the purpose changed over time. It was continuously adapted to the context thanks to the explorative character of this study.

From the beginning, the focus was more technical, but over time that changed to mainly studying social and organizational issues connected to the implementation and operation of technical systems. The focus on housing cooperatives was also broadened to different types of CBOs, since the housing cooperatives preferred not to manage their own water and sanitation systems, instead they wanted to connect to other neighbouring CBOs. In addition to community management, household sanitation was studied, due to interesting examples of neighbourhoods where the coverage levels recently had increased rapidly. The embedded cases that concerned community management and household sanitation took advantage of study opportunities that came along in the field. Both CBOs and individual households were found to be very important for water and sanitation provision in low-income neighbourhoods. The included CBOs and their members were happy to talk to me, i.e. many informants openly shared their life-experiences. Especially over time, since I spent several months there over a few years period. The water and sanitation sector of the whole metropolitan region was the holistic case of this study, but it was, first, described and evaluated through regime analysis towards the end of this thesis. Note, however, that much of the data collection for this regime analysis was performed in the beginning, but the increased knowledge and understanding that I gained over time made it suitable to carry out the regime analysis of the holistic case towards the end.

My PhD studies have been an exciting, but also demanding process that have taken various turns. I have learnt a lot, especially to stay open towards the knowledge of the informants. For me, the every-day experiences of the people have been the key to understand the implementation and operation of water supply and sanitation systems in-depth. With time I have got more and more convinced that the challenge to assure universal access to safe water and sanitation services is not a lack of technical systems, rather how to make sure that neighbourhoods and households implement and use the technical systems that are already available. It is therefore crucial to understand how and why the water and sanitation sector looks like it does and learn from real-world cases.

This thesis contributes to increased knowledge regarding co-existing service regimes, as well as in-depth understanding of community-managed systems and adoption of household sanitation. Together with other recent studies, this thesis lay the groundwork for increased understanding on why and how some community actors and households implement and operate water and sanitation systems. If we understand this, we might also be able to affect the current development, i.e. support communities and individual households so that they adopt technical systems and thereby contribute to speeding-up access to safe water and sanitation services.

Acknowledgements

This thesis is a result of many collaborations and contacts throughout the last eight years in both Bolivia and Sweden. It has been an adventure and I am deeply grateful to all the people that have supported this research. I would like to extend a big thanks to everyone!

At first, I would like to acknowledge my supervisors Sebastien Rauch, Jennifer McConville and Graciela Landaeta for their excellent support. In addition to guidance, they have given me the freedom to influence the content and direction of this thesis. It has been a great opportunity to learn and develop my skills as a researcher. Many thanks to all of you!

I also owe a big thanks to the foundation Procasha in Cochabamba, Bolivia for their magnificent support. They have provided guidance and support both regarding water and sanitation issues and contextual information. They also helped me getting settled in Cochabamba during my field studies.

In addition, I would like to send a special thanks to the included informants for their time and sharing their knowledge and every-day life experiences with me. I am very grateful for the trust and relationships that were built throughout the data collection. I would, especially, like to thank the included CBOs and their members that opened up their organizations and homes to me, i.e. made this research possible. In addition, many local researchers at the University of San Simon and NGO professionals have provided invaluable information and knowledge throughout the collection process.

I am of course also very grateful to the Swedish International Development Agency (SIDA) that funded this research. Without funding this research would not have been possible. In addition, the Adlerbertska forskningsstiftelsen, Göran Wallbergs minnesfond and Anérs stiftelse financed my follow-up trip to Bolivia towards the end of the thesis.

Finally, I owe a big thanks to my family and friends that have supported me throughout this process. This thesis was possible, due to your support, both with practical things, such as babysitting, as well as emotional support and encouragement. You mean everything to me!

Abbreviations and Acronyms

BS	Bolivianos (local currency in Bolivia)
CBO	Community-based Organization
EMAPAS	Municipal water utility of Sacaba municipality
GNI	Gross National Income
INE	National Institute of Statistics (Instituto Nacional de Estadística in Bolivia)
MDG	Millennium Development Goal
NGO	Non-governmental Organization
OD	Open Defecation
OTB	Base Territorial Organization (Organización Territorial de Base)
SDG	Sustainable Development Goal
SEMAPA	Municipal water utility of the Cochabamba municipality
UN	United Nations
UN-Habitat	United Nations Human Settlements Programme
UNICEF	The United Nations Children's Fund
USD	US Dollars
WHO	World Health Organization
WWAP	World Water Assessment Programme

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1 Introduction

Millions of people lack access to safe water and sanitation services worldwide. This has disastrous effects on human health and the environment. Many water resources have become increasingly contaminated and cannot be used for drinking water purposes, not even for recreational purposes. It is estimated that over 80% of the wastewater produced globally is discharged without adequate treatment (WWAP, 2017), and many urban dwellers, especially in informal settlements, are directly exposed to untreated wastewater. In 2016, an estimated 870 000 deaths were connected to inadequate water, sanitation and hygiene (WHO, 2018). Young children are especially exposed and, in 2017, more than 530 000 children below five died of diarrhoea, due to lack of safe water, sanitation and hygiene services (Troeger et al., 2020). In addition, lack of access to safe water and sanitation affects education, economic productivity, and personal safety and dignity, in particular for girls and women (Mara et al., 2010). Rapidly increasing access to safe water and sanitation services has, however, proven to be a major challenge. It is often emphasized that there is a lack of political interest in extending public services to low-income areas, since they constitute of social groups that traditionally have been discriminated (Bakker, 2008). Many low and middle income countries claim, however, that they have implemented water and sanitation programmes that target low-income groups (Romano and Akhmouch, 2019), but critics argue that it is the relatively well-off neighbourhoods that enjoy the benefits of these measures (Ledo, 2013; Mehta et al., 2014). Poor households are often not able to pay the connection fees to municipal services, although they are subsidized (Wolf, 2009; Carrard et al., 2019). The subsidies to implement water and sanitation infrastructures are often relatively low, i.e. the connection cost is, despite subsidies, high for low-income groups and therefore often captured by middle-income neighbourhoods (Mara et al., 2010; McGranahan, 2015). Low-income neighbourhoods have also less political influence and therefore less ability and opportunity to affect municipal provision of public services.

It is, however, important to note that access to safe water and sanitation is increasing and significant improvements have been achieved. For example, the mortality of diarrhoea per 100 000 children below five decreased by almost 70% between the years of 1990 and 2017 (Troeger et al., 2020). Although, there is still a lot to be done and there is a need for effective approaches that rapidly extend water and sanitation services to low-income areas. Connection rates to safe water and sanitation services barely keep up with population growth (Figure 1). To incentivize stakeholders to act, national governments and intergovernmental organizations, such as the United Nations (UN), have decided on various goals and targets that aim to increase access to safe water and sanitation. The Millennium Development Goals (MDGs), signed in 2000, included the target to halve the proportion of the population that did not have access to safe drinking water and basic sanitation by 2015. The drinking water target was met, whereas the target for sanitation was missed by almost 700 million people with 2.4 billion still lacking access to improved sanitation facilities in 2015 (UNICEF/WHO, 2015). The Sustainable Development Goals (SDGs) that were adopted by 193 countries, in 2015, is the continuation and development of the MDGs and aim to build on prior work regarding sustainable development with emphasis on inclusion of all people, i.e. leaving no one behind. Provision of safely managed water and sanitation services[1] to all by 2030 is one of its goals, but to reach this goal, investment of significant resources and time by many actors is needed, as well as targeting of the most vulnerable groups (Figure 1). Hutton and Varughese (2016) estimate that the global investments in water supply, sanitation, and hygiene need to triple. In addition, the current governing institutions need to be strengthened to enable effective and inclusive

[1] Safely managed water services meet the following standards: accessible on the premises, available when needed and free of contamination, and safely managed sanitation services include an improved sanitation facility and adequate treatment of the excreta or wastewater (UNICEF/WHO, 2019).

service delivery over time (Wolf, 2009), including well-functioning policies that facilitate and regulate service provision (Mara et al., 2010).

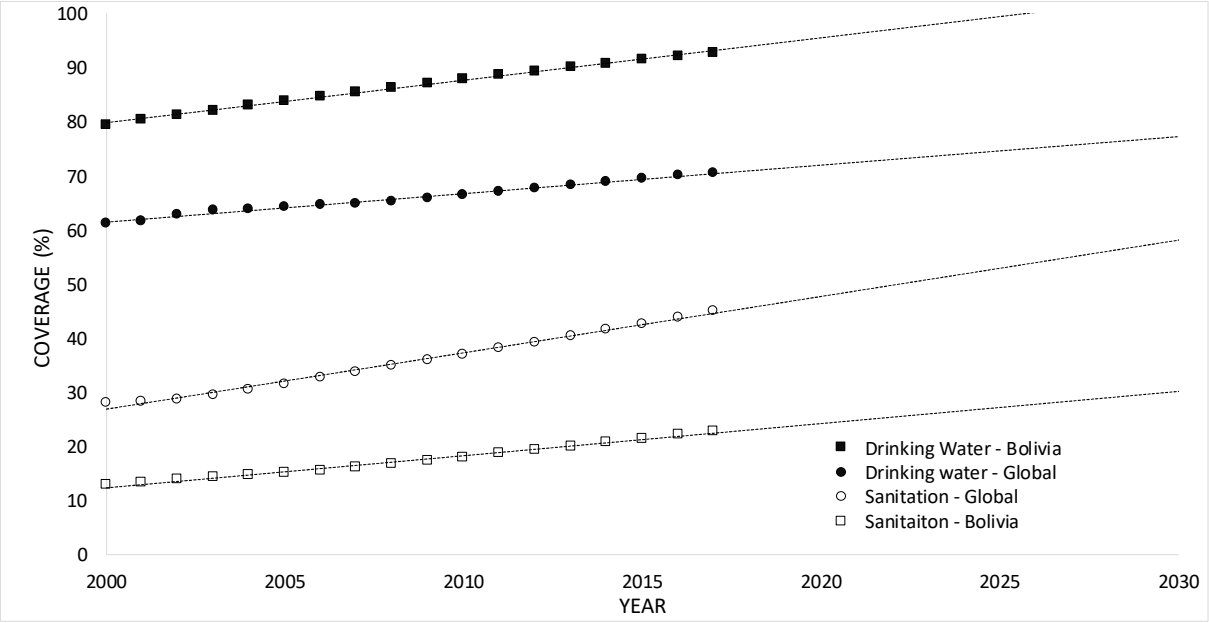

Figure 1 Coverage levels for safely managed water supply and sanitation, according to UNICEF/WHO (2019), including projections for the coming years through extrapolation that is illustrated by the dashed trend lines. Note that the coverage levels for water supply in Bolivia represent basic water supply, since no data for safely managed water supply is available. Basic water supply implies an improved water source from which collection takes 30 minutes or less.

Cities in low and middle income countries are typically characterized by diverse water and sanitation sectors, including many different actors of varying scale and at different levels, that manage a wide range of technical systems (Alba et al., 2019). It is increasingly emphasized that these diverse water and sanitation sectors need to be acknowledged for transformative change to more sustainable urban water management (Meene et al., 2011; Marlow et al., 2013; Rijke et al., 2013). Distinct actors and their respective governance structures are all crucial for speeding-up access to safe water and sanitation services (Mara et al., 2010; Ahlers et al., 2014; Bédécarrats et al., 2019; Misra and Kingdom, 2019; Blomkvist et al., 2020). In addition, a mix of technical systems, including centralized and decentralized water and wastewater services, complement each other and are important for considering local characteristics and meeting the needs of all citizens (Gutterer et al., 2009; Britto et al., 2019). WHO (2014) estimates that formal service providers currently deliver drinking water to 71% of the urban population, and sanitation services to only 50%. The rest resort to informal service providers, such as community-managed systems and private operators. There is, however, a limited understanding regarding alternative service provision and its role for assuring universal access to safe water and sanitation servicers. Alternative actors, such as CBOs and individual households therefore need to be understood in-depth (Hofmann, 2017; van Welie et al., 2019).

The multidisciplinary concept of water and sanitation regimes, defined as the interaction between institutions, actors and technical infrastructures, are increasingly used to understand the development of water and sanitation sectors. It is part of the field of transition studies that are used to understand the underlying causes to shifts in socio-technical (ST) regimes (Quezada et al., 2016). Although a number of recent transition studies have investigated water and sanitation regimes, there is still a need to better understand regimes and their development (Holtz et al., 2008; Fuenfschilling and Truffer, 2014; Fuenfschilling and Binz, 2018; Geels, 2018; Köhler et al., 2019). Especially in the context of low and

middle income countries that typically are characterized by multiple water and sanitation regime that include a wide range of both formal and informal actors (Hansen et al., 2018).

1.1 Research problem

There is a lack of knowledge regarding the development of the water and sanitation sectors in low and middle income cities (Hofmann, 2017; Srivastava et al., 2019). The processes that have led to the current coverage levels in urban areas are not understood in-depth (Allen et al., 2010; Carrard et al., 2019). One way forward would be additional regime studies that try to understand the development of the co-existing, multiple water and sanitation regimes in low and middle income cities. Hansen et al. (2018) highlight the need for contextualising theoretical frameworks to low- and middle-income countries, e.g. considering multiple regimes and less efficient governance. In addition, the lack of knowledge is connected to few theory-generating studies regarding alternative actors, such as CBOs and individual households, that are crucial for assuring universal access to safe water and sanitation services (Allen et al., 2010; Satterthwaite et al., 2015; Calzada et al., 2017; Dickin et al., 2017). Community management is often emphasized as important for rural water supply, but it also plays an increasingly significant role for service delivery in urban areas (Kyessi, 2005; WHO, 2014; Adjei and Charles, 2015; Cain, 2018). It is therefore crucial to understand the causes behind community management of water and sanitation services (le Grand and Zoomers, 2017; Kumar, 2018). There is also limited knowledge regarding the role of individual households for assuring universal access to safe water and sanitation services. Diffusion of sanitation services is often highlighted as an important focus for further studies (Jenkins and Scott, 2007; Whittington et al., 2012; Banana et al., 2015; Das, 2015). The drivers and activators behind sanitation improvements in low-income areas are still poorly understood (Jenkins and Scott, 2007; Isunju et al., 2011; Whittington et al., 2012).

1.2 Aim and objectives

This thesis aims to increase the understanding regarding the development of multiple, co-existing water and sanitation regimes in low and middle income countries through studying the water and sanitation sector of the Kanata metropolitan region [2], Bolivia. At first, the water and sanitation sector of the whole Kanata metropolitan region was examined at the city level through multi-level regime analysis. Secondly, CBOs and individual households were studied in-depth through an inductive approach at the neighbourhood and household level, due to their importance for service provision in low-income areas (Figure 2). The aim was to identify general patterns in these local experiences in order to develop theories regarding community management and adoption of household sanitation.

In the Kanata metropolitan region, there are currently three main ways to access water and sanitation services: municipal providers, community-managed systems and individual solutions (Figure 2), but their respective coverage levels have changed over time. The objectives of this thesis are to describe this current situation and then try to understand how and why the water and sanitation sector looks like it does, i.e. the processes that have led to occurring coverage levels. In addition, the aim is to identify ways forward that could improve the water and sanitation sector and lead to universal access to safe water and sanitation services.

[2] Note that the Kanata metropolitan region was until recently called the metropolitan area of Cochabamba.

The main research questions that guided this study and the focus of the respective manuscripts are provided below:

1. In what way do different population segments access water and sanitation services in the Kanata metropolitan region, Bolivia?
2. How and why are small-scale water and sanitation systems implemented, operated and improved over time?

The water and sanitation sector of the Kanata metropolitan region was selected as a case study, due to its diverse waterscape. It includes hundreds of formal and informal actors responsible for technical systems of varying size, both large-scale centralized infrastructures, as well as small and medium-sized systems. Due to many similarities with the water and sanitation sectors of other cities in low and middle income countries it may be seen as a typical case (Yin, 2009), but it also includes unique examples of water and sanitation provision. Successful mobilization that have led to implementation and operation of community-managed water and sanitation systems and low-income neighbourhoods where many households have adopted sanitation facilities were included as extreme embedded cases (Flyvbjerg, 2006; Yin, 2009).

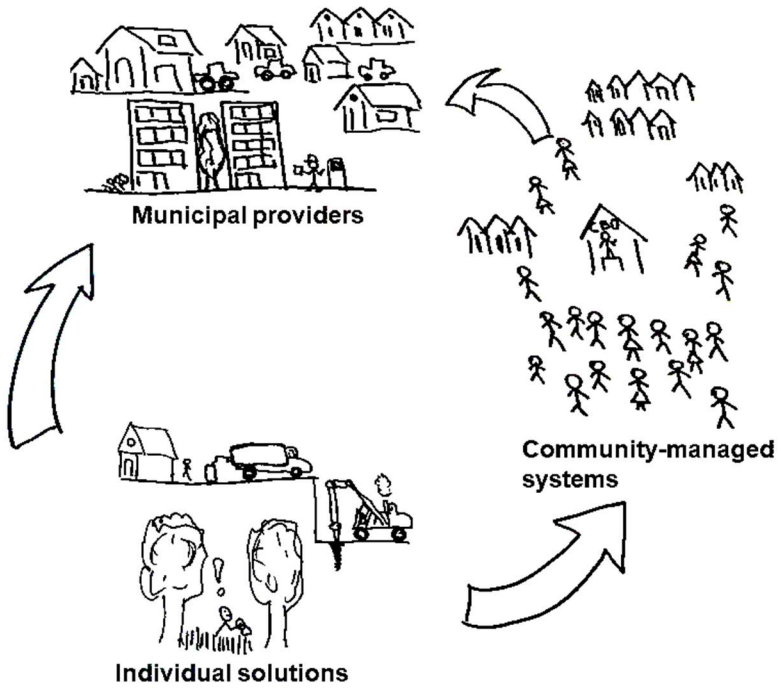

Figure 2 There are three main ways to access water and sanitation services in the Kanata metropolitan region, i.e. municipal providers, community-managed systems and individual solutions. The arrows indicate that households change water and sanitation provision over time. Note, however, that some households that enjoy piped water from municipal or community providers might revert to individual solutions, due to mal-functioning technical systems or lack of water within the network, but this is not included in this figure (Drawing: Cristofer Vidaurre).

1.3 Research approach

This thesis had a qualitative case study design of explorative character that enabled accommodations to the context and emergent findings, i.e. inclusion of extreme embedded cases that were found important for assuring universal access to safe water and sanitation services (Yin, 2009). The research was divided into the following three sub-themes that were all of major importance for the research questions: regime analysis, community management and adoption of household sanitation. Each of these sub-themes were investigated through multiple methods and the findings are presented in the respective papers (Table 2). The included papers represent different level of analysis in order to obtain a holistic understanding of the water and sanitation sector of the Kanata metropolitan region. Note, however, that the scope of the second research question was limited to community management and adoption of household sanitation, since these sub-themes were found to be crucial for assuring universal access to safe water and sanitation services.

Table 2 The included papers investigated the different sub-themes that underpin the main research questions. The sub-themes then influenced the scope and outcomes of the respective papers.

Main research questions	**Sub-themes**	**Paper**	**Paper-specific**		**Overall outcome**
			Research questions	**Findings**	
In what way do different population segments access water and sanitation services in the Kanata metropolitan region, Bolivia?	Regime analysis	I	What water and sanitation regimes exist in the Kanata metropolitan region? How strong are the respective regimes and what opportunities for transition do they imply?	Analytical framework for assessing regime strength	Holistic understanding of the underlying causes to the occurring coverage levels of water and sanitation services, including theory-building regarding community management and adoption of household sanitation
How and why are small-scale water and sanitation systems implemented, operated and improved over time?	Community management	II	Why and how some urban and peri-urban neighbourhoods self-organize and succeed in implementing and operating communal water and wastewater systems internally, whereas others do not?	Internal prerequisites and distinct planning and management phases for community-managed systems	
		III	How are community-managed wastewater affected by external factors?	External facilitating factors for community-managed wastewater systems	
	Adoption of household sanitation	IV	Why are improved sanitation facilities adopted at the household level?	Adoption framework for household sanitation	

2 Theoretical background

This chapter aims to position this thesis in relation to today's literature, as well as give the reader a brief introduction to water and sanitation provision in low and middle income countries. At first, the challenge of urban areas is outlined. This is then followed by the recent trends in water and sanitation provision. Finally, the knowledge fields of demand-led approaches and transition studies are outlined, including the knowledge gaps that the included paper aim to fill. Note that most sections of this chapter are general for both water and sanitation. Some sections do, however, deal exclusively with sanitation, due to important differences in delivery approach and theoretical underpinnings of water and sanitation provision (Mehta et al., 2016). The sections that deal exclusively with sanitation are clearly indicated below.

2.1 The challenge of urban service delivery

Urban areas in low and middle income countries are increasingly highlighted as challenging for assuring universal access to safe water and sanitation services, due to rapid urbanization and population growth. In 2017, 15% of the urban populations worldwide lacked access to safely managed water services and 53% of the urban households lived without access to safely managed sanitation services (UNICEF/WHO, 2019). In addition, it is estimated that the urban population of low and middle income countries will double by 2030 (UN-Habitat, 2016). Changing consumption patterns and climate change have also altered the conditions and requirements for the water and sanitation sector. The expansion of peri-urban areas, where municipal provision typically is lacking, is of special concern (Angoua et al., 2018). Lack of space and high population density make implementation and operation of water and sanitation services technically complex in these areas (McGranahan, 2015). In addition, their diverse urban populations of constitute a challenge when it comes to collective action and common solutions. The residents of peri-urban areas originate from different social groups and cultures, and uniting the residents is challenging (Mara et al., 2010; Srivastava et al., 2019). Many cities worldwide also suffer from increasing water scarcity and sufficient water supply is of increasing concern (UN-Habitat, 2016).

By local governments, urban areas have traditionally been prioritized over rural areas in water and sanitation delivery. It is technically easier and due to politicians wanting political support from urban populations (Wolf, 2009). Donor organizations have instead often focused on rural areas, since these are judged not to be prioritized by local governments. This has, however, started to change, since municipal actors do not keep up with population growth and urbanization, but the financial investments that target urban areas need to increase further in order to assure water and sanitation services for all (Hutton and Varughese, 2016). Water and sanitation infrastructures are capital-intensive technologies, but the challenging physical characteristics of peri-urban areas require even further investments (McGranahan, 2015).

Today the majority of peri-urban areas depend on small private service providers and community initiatives, but these services are often of dubious quality (Wolf, 2009; Walnycki, 2013; Linsalata, 2014). To improve urban service delivery, it is crucial to both extend municipal services and support alternative operators to improve their current service delivery (Misra and Kingdom, 2019). For example, community management and individual households are increasingly seen as part of the solution to safe water and sanitation provision also in urban areas (Kyessi, 2005; Whittington et al., 2009; Moriarty et al., 2013; Adjei and Charles, 2015).

2.2 Trends in delivery approach

During the 1980s, the importance of well-functioning political structures was increasingly recognized as important for delivery of water and sanitation services in low and middle income countries. This led to increased funding to capacity development of the existing public institutions that typically promoted a supply-oriented sector. In addition, decentralization reforms of the public institutions started in the 1980s. These aimed to move the responsibility for service provision from the central government to sub-national authorities (Kitonsa and Schwartz, 2012; Herrera and Post, 2014). It was assumed that decentralization would lead to increased consideration of the context, i.e. accommodation of water and wastewater management to the diverse geographical settings and social groups. The possibility for increased public involvement, i.e. consideration of customer demands, was also used as a reason for the decentralization reforms. Despite of these reforms, public service provision was in the end of this decade still argued to be ineffective and not able to recover the full cost of the service they provided (Allen et al., 2010).

The focus during the 1990s was instead structural changes of the governing institutions through corporatization and privatization reforms (Mehta et al., 2016). It was argued that autonomous water utilities, ultimately privatization, would increase the efficiency (Allen et al., 2010; Herrera and Post, 2014). There was a trend to treat water as an economic good and neoliberal policies led to privatization of many municipal enterprises throughout low and middle income countries (Moyo, 2009). In addition, insulation of public water utilities and privatization was used as a means to decrease the direct influence of politicians. The effect of the (continued) decentralization and privatization policies was, however, contradictory. The privatization of water and sanitation services led to decreased state control, whereas the decentralization reforms intended to increase public participation (Herrera and Post, 2014). Privatization received a lot of critique, especially for not considering social and environmental factors (Ahlers et al., 2013). There were many examples where large-scale private corporations were unsuccessful to extend water and sanitation services to the urban poor. In addition, privately managed wastewater management was highlighted as particularly challenging, since it is difficult to recover costs for wastewater management, due to a reluctance to pay high charges for sanitation provision (Allen et al., 2010; McGranahan, 2015).

When the privatization wave ended in the 2000s, several distinct actors and delivery approaches were promoted. There was no clear consensus on what approach or way forward that was the most appropriate. Due to the failure of privatization to assure efficient and inclusive service provision, many national and sub-national governments chose to re-municipalize urban water and sanitation services. It was argued that increased public involvement opened up for progressive change that enabled service extension to low-income neighbourhoods, improved service quality and more democratic governance (Lobina, 2017). As in the 1980s there were, however, also critics of municipal service provision, due to its claimed inefficiency. Partnerships and collaboration between actors of varying scale, as well as capacitation of the public organisations were highlighted as important (Bakker, 2008; Coppel and Schwartz, 2011). Others argued that small-scale private actors were one way forward to obtain efficient and inclusive water governance. They were seen as an alternative to large-scale corporations that were the focus of the privatization wave in the 1990s (Bakker, 2008). The same arguments were used as in the 1990s, but large-scale corporations were changed for small-scale private actors (Ahlers et al., 2014). In addition, participatory approaches gained increased attention in the 2000s. Inclusion of citizens in decision-making processes and increased participation in the implementation and management processes through involvement of communities and individual households were seen as important (Romano and Akhmouch, 2019).

Today an increasing amount of literature argue that all these different approaches are crucial. No actor or delivery approach is seen as superior. Instead a mix of actors and approaches are argued to be critical for assuring universal access to safe water and sanitation services (Misra and Kingdom, 2019). The local conditions of each context influence best practice. Cooperation and coordination among distinct actors and approaches are, however, highlighted as crucial (Pahl-Wostl and Knieper, 2014). Rijke et al. (2013) argue that the water sector should include both centralized and decentralized approaches, as well as formal and informal providers in order to be able to face the challenges of today's transforming cities. Actors from the heterogenous private, public and civil society spheres are all important for increasing water and sanitation coverage levels (Allen et al., 2010; Ahlers et al., 2013; Misra and Kingdom, 2019). It is also important for addressing challenges connected to population growth, urbanization, economic expansion and climate change (Romano and Akhmouch, 2019). It is agreed that provision of universal water and sanitation services require a multi-disciplinary approach, including social, technical and ecological dimensions across multiple scales, as well as connection to everyday life of urban citizens (Mehta and Movik, 2014).

2.3 Demand-led approaches

Demand-led approaches are seen as crucial for assuring universal access to safe water and sanitation services. They are typically applied at the community level through community management, i.e. implementation and operation of communal water and sanitation services, and at the household level where they aim to speed-up the adoption of sanitation facilities (Whittington et al., 2009; Prabhakaran et al., 2016; Satterthwaite, 2016). This thesis aims to shed light on both of these alternative models of service delivery. If they are better understood, they also have the possibility to speed up the access to safe water and sanitation services.

2.3.1 Community management

Community management that, here, is defined as neighbours that join together to implement and operate communal systems together, is increasingly seen as part of the solution if all citizens are to gain access to safe drinking water and sanitation services (Kyessi, 2005; Whittington et al., 2009; Moriarty et al., 2013; Adjei and Charles, 2015; McGranahan, 2015; Cain, 2018). It is argued to lead to efficient services, due to in-depth contextual knowledge and high cost-recovery (Ahlers et al., 2013; Linsalata, 2014). In contrast to top-down approaches by large-scale and centralized service providers, community management include bottom-up approaches and collective action, i.e. grassroot initiatives. There is, however, no consensus regarding the impact of community-managed water and sanitation systems. Many studies still criticize community management and question the ability of communities to implement and manage communal water systems (Adjei and Charles, 2015; Bisung et al., 2014; Blaikie, 2006; Chowns, 2015; Mandara et al., 2013). Informal service providers are generally not regulated or supervised by the state (Gerlach and Franceys, 2010; WHO, 2014). This has led to that they have typically not been acknowledged as formal service providers by national and international actors (Allen et al., 2010). Although formalization of CBOs is crucial to obtain external support and influence the external landscape in which they are located (Marston, 2014). CBOs have instead often been considered as substandard service provision (Allen et al., 2017). This has, however, started to change. There are many well-functioning community-managed systems of varying complexity that lately have gained increased attention (Barde, 2017; González Rivas et al., 2014; Kyessi, 2005; Smits et al., 2013), but there are far fewer examples of communal sanitation systems than community-managed water systems. It is, however, important to note that community management does not take away the state responsibility for delivery of basic services (Bakker, 2008). Currently, private actors and CBOs are often the only water and sanitation providers in peri-urban areas,

but they do not have access to the same level of state support and subsidies as municipal water and sanitation utilities (Bakker, 2008; Allen et al., 2010).

One explanation to the mixed views regarding community-managed systems is the lack of knowledge (Mandara et al., 2013; Moriarty et al., 2013), especially from a multidisciplinary point of view (Kumar, 2018). Some studies, such as Das (2015) and Allen et al. (2017), argue that theory-building studies that contributes to increased understanding about the existence and functionality of communal systems are needed (Allen et al., 2010; Das, 2015; Allen et al., 2017). **Paper II** aims to contribute to filling this knowledge gap through building theory regarding the implementation and operation of community-managed water and sanitation systems. It also tries to contribute to increased knowledge regarding self-initiated communal services that have received less attention (Mandara et al., 2013; Moriarty et al., 2013; Calzada et al., 2017; Dickin et al., 2017; Kumar, 2018). Many studies focus on community-managed systems which have been initiated by external development programmes (Alexander et al., 2015; Chowns, 2015; Hoko and Hertle, 2006; Tigabu et al., 2013), although there are various self-organized communal systems (Calzada et al., 2017; Ostrom, 2011; Pahl-Wostl et al., 2012). **Paper II** focuses on internal factors, but community-managed services are also affected by external factors (Achi and Kirchheimer, 2006; Calzada et al., 2017; Foster, 2013; Harvey and Reed, 2006). It is often highlighted that community-managed systems need external support to function in the long run (Calzada et al., 2017; Foster, 2013; Harvey and Reed, 2006; Hutchings et al., 2015). There is, however, a lack of in-depth understanding regarding how the societal and political context actually affect community-managed wastewater systems (Miller et al., 2019). **Paper III** tries to add knowledge regarding this through studying external factors that promote communal wastewater management. Note that the focus of **paper III** is specifically on wastewater services, due to the need for more studies regarding communal sanitation systems. Much less attention and investments have been directed towards sanitation compared to water supply (Mara et al., 2010; Isunju et al., 2011; Banana et al., 2015). Together **paper II** and **III** aim to increase the understanding regarding the underlying causes behind community management. They also aim to expand existing knowledge regarding community management to urban areas, since few studies focus on this, despite its significance (Adjei and Charles, 2015; Cain, 2018; Kyessi, 2005; WHO, 2014), especially for the rapidly growing peri-urban areas (Butterworth and Warner, 2007).

2.3.2 Adoption of household sanitation

At the household level, demand-led approaches within the development sector aim to motivate and enable households to improve their own life situation, e.g. implement sanitation facilities themselves (Kar and Chambers, 2008; Lüthi et al., 2011). The mechanisms for creating demand for improved household sanitation remain, however, poorly understood (Jenkins and Scott, 2007; Isunju et al., 2011; Whittington et al., 2012). **Paper IV** tries to fill this knowledge gap through a qualitative theory-building study regarding why individual households adopt household sanitation.

Many studies list drivers and barriers that affect adoption of sanitation facilities (Jenkins and Curtis, 2005; O'Loughlin et al., 2006; Rodgers et al., 2007; Devine, 2009; Keraita et al., 2013; Sara and Graham, 2014; Gross et al., 2014; Obeng et al., 2015), but fewer go beyond this. Convenience, cleanliness, privacy, prestige, safety and health benefits are often reported as drivers for adoption, while high cost is frequently stated as the main barrier. Many scholars have also tried to identify household characteristics (Jenkins and Curtis, 2005; O'Loughlin et al., 2006; Rodgers et al., 2007; Ross et al., 2011; Sara and Graham, 2014) and socio-geographical contexts (Jenkins and Curtis, 2005; Jenkins and Cairncross, 2010), which are linked to improved sanitation ownership and use, in order to customize sanitation programs. Sanitation adoption typically correlates with more education (Jenkins and Curtis, 2005; O'Loughlin et al., 2006; Rodgers et al., 2007; Sara and Graham, 2014) and larger household size (O'Loughlin et al., 2006;

Rodgers et al., 2007; Ross et al., 2011). Finding consistent results which link adoption behaviours to household characteristics and socio-geographical contexts has, however, proven difficult. For instance, some studies link occupation to sanitation adoption (Jenkins and Curtis, 2005; Ross et al., 2011), whereas other studies do not find such a correlation (O'Loughlin et al., 2006; Rodgers et al., 2007). Some studies also find that gender affects sanitation adoption (Jenkins and Curtis, 2005; Ross et al., 2011), whereas others do not support this finding (O'Loughlin et al., 2006; Rodgers et al., 2007; Sara and Graham, 2014). This highlights the difficulty to establish general relationships like these. Instead, in-depth studies, such as **paper IV**, are highlighted as important for theory-building regarding complex phenomena that is connected to a variety of disciplines. Qualitative studies have, however, often been criticized for developing too context-specific results (Isunju et al., 2011). According to others, the dependence on the context is necessary when building new theories regarding real-life events, but as a next step in knowledge creation a mix of qualitative and quantitative approaches is of course crucial (Eisenhardt, 1989; Flick, 2009).

There have been attempts to create diffusion models for sanitation at the household level in order to understand adoption mechanisms. Devine (2009) developed the conceptual SaniFOAM framework for analysis of sanitation behaviours. It claims that opportunity, ability and motivation are all needed if individuals are to adopt a specific sanitation behaviour. Jenkins and Scott (2007) developed a behavioural model specifically for sanitation facilities, similar to the well-known framework diffusion of innovation by Rogers (2003). This latter diffusion framework explains diffusion as a process over time, including 5 stages: knowledge, persuasion, decision, implementation and confirmation. Knowledge constitutes awareness of the innovation. Persuasion is defined as attitude formation (negative or positive). Decision implies a choice to adopt or reject the innovation. Implementation is the start of usage and confirmation is reinforcement of the already taken adoption decision (Rogers, 2003). **Paper IV** uses the framework by Roger (2003) as a starting point to build an adoption framework specifically for household sanitation.

2.4 Transition studies and regime analysis

Transition studies are used to understand technological innovation processes, i.e. the development of a specific sector, such as water and sanitation provision. One of its key frameworks is the multi-level perspective (MLP) that aims to understand the development of socio-technical (ST) systems through interaction between three different levels: the external landscape, ST regimes and niches. The landscape refers to the society in which the ST regime exists, i.e. external factors outside the regime, such as economic and population growth. Niches are smaller protected spaces where innovations are under development (Geels, 2004). The ST regimes are the dominant ST systems, including the interaction between institutions, actors and technical infrastructures. They are formed by the presence of formal and informal rules that create ‘practices’ and ‘routines’ (Fuenfschilling and, Binz 2018). Due to these rules, a regime is assumed to be stable. Changes take time and are often incremental. The regime can, however, be considered dynamic because it constantly experiences incremental change, due to internal disagreements and power struggles, adaption to changing landscape conditions and the availability of new innovations from niches (Geels and Schot, 2007; Geels, 2018; Fuenfschilling and Binz, 2018; Schot and Kanger, 2018). Weaker regimes will be more open to change than strong ones, although there is no single cause to regime changes. Instead, processes at different levels and scales reinforce each other (Geels, 2012).

Understanding existing regimes is a prerequisite for facilitating the transformation of ST regimes, i.e. the weaknesses and potential tipping points of regimes need to be identified. While many transition studies analyse diffusion of new technologies (e.g. Fuenfschilling and Truffer, 2014; McConville et al., 2017), or

alternative governance models (e.g. Yasmin et al., 2018), there are fewer studies that examine the regime itself (Geels, 2018). Transition studies that focus on the regime itself can enable the identification of alternative and more sustainable trajectories for development (Berkhout et al., 2009; Novalia et al., 2018). While a number of recent transition studies have investigated ST regimes, there is still a need to better understand regimes and their development (Holtz et al., 2008; Fuenfschilling and Truffer, 2014; Fuenfschilling and Binz, 2018; Geels, 2018; Köhler et al., 2019), especially for low and middle income countries (Hansen et al., 2018). Together with recent studies, such as van Welie et al. (2018), **paper I** aims to contribute to filling this knowledge gap. Hansen et al. (2018) highlight the need for contextualising theoretical frameworks when studying transition in low and middle income countries, e.g. considering multiple regimes and less efficient governance. van Welie et al. (2018) argue that theoretical models of regime transition should allow for co-existing regimes, if they are to be applicable in low and middle income countries. They further differentiate between sectoral and service regimes through emphasizing that a sectoral regime may constitute of one or more distinct service regimes that operate in parallel, either co-existing or competing. For example, for a typical low and middle income city, the whole water and sanitation sector would be characterized as the sectoral regime, whereas the respective delivery approaches for water and sanitation, such as community management, would be considered as service regimes. In addition, **paper I** adapts and applies existing theories presented in Fuenfschilling and Truffer (2014) and McConville et al. 2017 to add further knowledge regarding the development of water and sanitation regimes.

3 The case of the Kanata metropolitan region

Bolivia is a landlocked country of great diversity. The geography and altitude vary significantly within the country, from the Altiplano in the Andes to the Eastern lowlands in the Amazon basin. It has a population of 11.5 million people and two thirds of the population are of indigenous origin (INE, 2019). The official language is Spanish, but there are also many indigenous languages of official status, e.g. Aymara, Quechua and Guarani. The economy has been growing during the last decades, mainly due to mining and natural gas exports. Bolivia is, however, one of the poorest countries in Latin America and it faces many challenges connected to delivery of health care and education, as well as provision of basic services. The study presented in this thesis is performed in the Kanata metropolitan region that is located in a valley in the Andes, in the central parts of Bolivia. In this chapter the case of the Kanata metropolitan region is outlined through inclusion of the following themes: socio-economic characteristics, environment and climate, mobilization and collective action, as well as water and sanitation provision.

3.1 Socio-economic characteristics

The Kanata metropolitan region is the third largest metropolitan city in Bolivia and consists of the following municipalities: Sacaba, Cochabamba, Tiquipaya, Colcapirhua, Quillacollo, Vinto and Sipe Sipe (Figure 3). It was until recently called the metropolitan area of Cochabamba, but this was changed, partly to avoid confusion with the municipality of Cochabamba. The different municipalities differ in both population size and other socio-economic characteristics (Table 3). Their management is separated, but there are initiatives and policies that aim to facilitate collaboration among the different municipalities. In total, the metropolitan region had a population of 1.2 million people in 2012, but the population growth is high and the population is projected to almost double until year 2036 (INE, 2019). The region has experienced economic growth due to a diversified economy consisting of a service, manufacturing and agriculture sector during the last decades (Alarcón et al., 2013). It also had a low unemployment rate of 1.5%, in 2012 (Nogales and Rejas, 2016). The average household income was 4905 Bolivianos (BS) that is equivalent to 712 US Dollars (USD), in 2012, but the salary varies significantly between the residents. Many households also have one or more family member that works abroad and sends home allowances to their respective families.

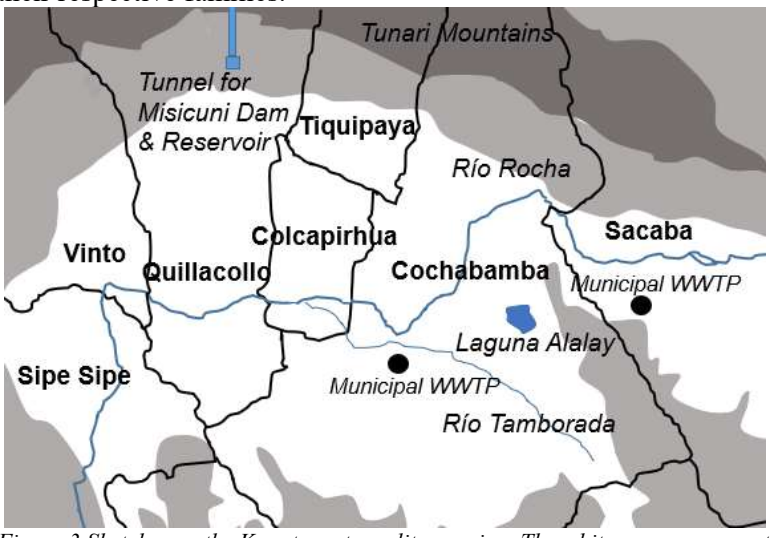

Figure 3 Sketch over the Kanata metropolitan region. The white areas represent the valleys below the mountain ranges (Adapted from Hines 2018).

There are various indigenous groups that traditionally have been discriminated and many argue that different social groups are treated differently, i.e. the elite are benefited by current regulations and policies, whereas low-income groups are often excluded (Waisman, 2006). Some argue, however, that these power structures are slowly starting to change through increased political and economic influence on behalf of indigenous groups (Feinberg et al., 2006). It is, however, clearly visible that the Kanata metropolitan region is still very segregated, both within each municipality and across the respective municipalities. Different social and economic groups typically live in clusters, i.e. there are many relatively old and well-established neighbourhoods often characterized by a mestizo population, as well as newer peri-urban areas where many of indigenous origin live. Informal peri-urban areas typically suffer from poor living conditions, e.g. the under-five mortality rate is, here, 40 per 1000 children (Alarcón et al., 2013). In addition, the access to public services varies greatly within the metropolitan region.

Table 3 Characteristics for the respective municipalities in the Kanata metropolitan region, in 2012 (INE, 2019).

Municipality	**Population**	**Average household income**		**Quechua or Aymara as their first language (%)**
		BS	**USD**	
Sacaba	177 041	4871	707	35
Cochabamba	736 171	5182	752	21
Tiquipaya	68 913	4622	671	29
Colcapirhua	70 413	4323	628	18
Quillacollo	128 841	4361	633	29
Vinto	29 915	4492	652	39
Sipe Sipe	20 755	4200	610	53
Total	*1 232 049*	*4905*	*712*	*26*

3.2 Environment and climate

The Kanata metropolitan region is situated in a valley in the Andean mountains within the watershed of Río Rocha at an altitude of 2500 meter. It has a fairly stable semi-desert climate, i.e. the seasons are not very distinguished. The soil is fertile and agriculture is widespread in the outskirts of the metropolitan area, as well as in the neighbouring municipalities. It is one of the driest cities in Bolivia and precipitation is mainly concentrated to between November and March. The average annual precipitation in the region is 651 mm (Menendez, 2015), but it varies a lot, i.e. it rains much more in the mountain range than in the valley where the Kanata metropolitan region is located. Climate change is an increasing challenge and changes in precipitation patterns affect water availability. The frequency and duration of the droughts has been altered and increased the water scarcity even more (Alarcón et al., 2013). Increasing pollution levels are also of increasing concern and a big threat to the environment and its freshwater resources. Many groundwater and surface water sources are already severely contaminated and cannot be used as water supply sources, e.g. no surface water sources at lower elevations can be used as drinking water sources (Menendez 2015). During the dry season the low flow and strong odour of the river río Rocha, which passes through the metropolitan region, reveal that it is almost entirely constituted of wastewater. Ledo (2013) claim that industrial effluents, inadequate solid waste management and lack of wastewater treatment are the main sources of pollution. Increased wastewater management would therefore improve the current situation significantly.

3.3 Mobilization and collective action

In Bolivia, different types of community initiatives and various types of CBOs are widespread (Albro, 2006; Cielo, 2010; Boelens, 2011; Calzada et al., 2017). Social organization and collective action are considered as part of the Andean culture and the local organizations have mobilized to defend their rights to local environmental resources for centuries. They have been fighting both against colonial and post-colonial state organizations and corporations (Hidalgo et al., 2017).

In the outskirts of the Kanata metropolitan region communal irrigation systems have existed for centuries (Hines, 2015; Minelli, 2018), but in urban and peri-urban areas it is a newer phenomenon. In urban areas, the first community-managed drinking water systems were implemented in the late 1950s, due to the absence of state-driven service provision. With time, as the population of the Kanata metropolitan area grew, more community-managed systems were implemented and operated. They rapidly increased in numbers during the 1980s and 1990s, especially in the southern parts of the municipality of Cochabamba, due to mass migration as a result of the economic crises (Walnycki, 2017). It is argued that the population influx from the countryside and mining areas particularly contributed to widespread communal systems, due to prior experiences from rural water organizations and mining syndicates (Walnycki, 2013). Furthermore, decentralization reforms and increased funding to CBOs that fulfilled specific administrative criteria in the 1990s enabled implementation and operation of community-managed systems (Nijenhuis, 2002). Many CBOs in the southern parts of the municipality of Cochabamba also received donor support in the 1990s and 2000s. Partly as a consequence of the movements prior and during the water war in 1999/2000, when grassroot movements successfully expelled the international consortium responsible for water and sanitation provision (Walnycki, 2017). The communal wastewater systems have, however, not increased to the same extent as community-managed water systems. Many CBOs do not implement wastewater management. It is mostly the older, well-established CBOs that manage both water and wastewater systems.

The political power of CBOs that manage water systems in Bolivia have increased over time, due to increased mobilization and coordination between different CBOs, including both urban and rural organizations. Note, however, that there typically are tensions between urban water systems and rural irrigation syndicates, due to competition for water sources. The well-known water war in 1999/2000 is often taken as an example of the political power that united grassroot organizations may have when they are well organized. During the water war public protests and mass mobilization against the privatization of the water supply in Cochabamba prompted abolishment and rejection of the international consortium. Some does, however, claim that the mobilization among the CBOs has decreased since the water war (Minelli, 2018). On the other hand, public protests against undemocratic procedures during the latest elections in October 2019, showed that the mobilization within and between grass roots organizations are still strong and that many local organizations are very well organized.

3.4 Water and sanitation provision

The Kanata metropolitan region is characterized by a diverse water and sanitation sector that consists of hundreds of formal and informal actors that manage water and sanitation systems of varying size. The distinguished governance structures that include municipal enterprises, community actors and self-supply were used to identify the following co-existing water and sanitation regimes in **paper I**: municipal, community and individual regimes (Table 4). The municipal regime consists of formal municipal actors that typically govern centralized water and sanitation infrastructures, whereas the community regime is characterized by hundreds of CBOs that manage their own decentralized water and sanitation systems.

The remaining households constitute the individual regime and they typically buy water from water tankers and discharge their produced wastewater in constructed leach pits or in the open. Note, however, that all of the households in the individual sanitation regime do not have a bathroom, i.e. they practice open defecation and/or use public bathrooms (INE, 2019).

*Table 4 The population of the Kanata metropolitan region can be divided into three different water and sanitation regimes based on their primary service provider, in 2012 (TYPSA et al., 2014) (**Paper I**).*

Municipality	**Population**	**Municipal regime (% of population)**		**Community regime (% of population)**		**Individual regime (% of population)**	
		Water	Sanitation	Water	Sanitation	Water	Sanitation
Sacaba	177 041	12	23	78	55	10	22
Cochabamba	736 171	46	53	40	NA	14	NA
Tiquipaya	68 913	0	75	93	4	7	21
Colcapirhua	70 413	0	75	97	1	3	24
Quillacollo	128 841	31	74	64	9	5	17
Vinto	29 915	26	70	69	NA	5	NA
Sipe Sipe	20 755	0	29	97	NA	3	NA
Total	*1 232 049*	*33*	*53*	*56*	*9*	*11*	*38*

NA stands for non-applicable. The data source TYPSA et al. (2014) did not include the coverage figures where NA is stated.

3.4.1 Water and sanitation regimes

The municipal actors are either part of the municipal authorities or organized as a municipal enterprise. The three municipalities with the largest populations (i.e. Sacaba, Cochabamba and Quillacollo) have municipal enterprises responsible for water and sanitation coverage. The other municipalities have entities within the municipal organization that are responsible for water and sanitation services (TYPSA et al. 2014). Four of the municipalities provide both water supply and sewers, and the remaining three municipalities have only implemented and operate sewer infrastructures. The municipal actors that provide water services utilize surface water and/or groundwater sources (Table 5). Surface water is mainly exploited from dammed reservoirs and catchments just below the mountain range. Groundwater is withdrawn from a number of drilled wells. All municipal operators collect wastewater from the connected households, but there are only two municipalities in the Kanata metropolitan region that operate wastewater treatment plants and these two plants only treat part of the collected wastewater. Both the collected treated and untreated wastewater is discharged into the closest surface water bodies, which implies that most of it ends up in the river Río Rocha that passes through the metropolitan region. SEMAPA in Cochabamba has the largest wastewater treatment plant and it is estimated that around 50% of the produced wastewater in Cochabamba reaches the plant (Menendez, 2015), but it is, currently, under renovation and amplification (Tapia Callao, 2019). The utility of Sacaba (EMAPAS) operates the second plant that started operation in 2017, with around 30% of the population connected to this plant. The other five municipalities of the metropolitan area have plans to implement wastewater treatment plants, but nothing is yet implemented (TYPSA et al., 2014).

There are no complete and exact records over the number of community-managed water and sanitation systems in the Kanata metropolitan region. TYPSA et al. (2014) estimates that there are more than 600 CBOs that manage water and wastewater systems and each CBO has between 50 and 1500 households. They typically use groundwater (Table 5), but a few CBOs close to the mountain range or near springs utilize surface water. These are, however, relatively few and therefore not included in the formal statistics in Table 5. If the groundwater table is low, or of bad quality, community-managed water systems buy water from water tankers, which they store in a common storage tank connected to a network. In contrast to communal water services, there are relatively few CBOs that provide sewer systems, and there are even

fewer CBOs that operate wastewater treatment. There are, however, some examples of small functioning wastewater plants. The majority of the CBOs are self-organized (Faysse et al., 2007; Cabrera et al., 2014), but some are induced by an external party (Marston, 2015). The internal management structure differs between community-managed water and sanitation systems (VSB/PAS, 2007; Cabrera et al., 2014; Marston, 2015). Some comply with formal administrative requirements, whereas others do not. The leaders are generally appointed by the members who are viewed as co-owners of the organization. The most common organizational forms are: OTBs, service cooperatives and water committees. OTBs stands for Base Territorial Organizations and they are part of the political and administrative system. Each OTB represent a specific geographic area and should aim to manage community-led projects, i.e. OTBs do not only focus on water and sanitation systems, but also other neighbourhood improvements. Service cooperatives are a legal entity registered through an umbrella organization and they also need to comply with specific administrative requirements. Water committees is an informal way of organizing and there are no legal requirements on governance structure that all of them fulfil. In addition to CBOs, there are various umbrella organizations for water actors both locally in the Kanata metropolitan region and on a national level.

*Table 5 Water sources of municipal water providers and CBOs (TYPSA et al., 2014) (**Paper I**).*

	Groundwater				**Surface water**
	Municipal providers		*Community-managed systems*		*Municipal providers*
	# of wells	**Withdrawal (l/s)**	**# of wells**	**Withdrawal (l/s)**	**Withdrawal (l/s)**
Sacaba	48	74	105	75	31
Cochabamba	31	414	192	185	471
Tiquipaya	-	-	49	66	35
Colcapirhua	-	-	86	82	-
Quillacollo	14	62	115	48	-
Vinto	-	-	29	52	-
Sipe Sipe	-	-	20	22	10
Total	*93*	*550*	*596*	*530*	*547*

There are various private actors, e.g. tanker trucks and sludge emptying companies. Tanker trucks sell water to households that are not connected to municipal or community-managed systems in barrels or small tanks. The water provided by tankers is of unknown quality and depends on the source from which it was bought. In addition, the water quality is easily degraded due to contamination of household storage vessels or during transfer from one vessel to another. The possibility to purchase water from tankers depends on the season and the location of the neighbourhood. Tankers supply water on a daily basis and at a fixed priced in many unconnected neighbourhoods, but supply and demand varies with the season. In the dry season there are fewer water tankers selling water, due to water scarcity, and in the rainy season many households collect rainwater, thereby reducing water demand. The households that do not benefit from sewers and instead manage their wastewater with on-site systems (e.g. various types of pits or septic tanks), hire sludge emptying companies for emptying their on-site systems. The frequency of the emptying depends on the respective systems, some have deliberately facilitated leaking in order to avoid emptying. Sludge emptying companies that are formally registered discharge the sludge at the municipal wastewater treatment plants, at least according to their own records. Informal businesses do, however, discharge the sludge untreated into water bodies or pass it on untreated as a fertilizer for agriculture. Note, however, that 15% of the households have, in 2012 census, stated that they do not have a bathroom. They practice open defecation and/or use public bathrooms. There are public bathrooms managed by both the municipality and private actors, primarily in low-income neighbourhoods and commercial districts. For

example, in 2019, in the municipality of Cochabamba, more than 100 public bathrooms were registered with the authorities, out of which 26 were managed by the municipality (Claros 2019).

3.4.2 Distribution of the respective regimes

The distinct regimes tend to be distributed in clusters (Figure 4). Municipal actors mainly serve richer neighbourhoods and are typically concentrated to the city centres and neighbouring areas (Alarcón et al., 2013; Ledo, 2013). Bakker et al. (2008) argue that the location of water mains limits the possibilities for poor neighbourhoods to be connected to the municipal supply. The geographic position of the municipal water sources seems to be of less significance for what neighbourhoods that are connected to the municipal regime. Many municipal suppliers exploit water sources outside of their jurisdiction, i.e. far from the households that are serviced by the municipal water regime. Neither does the location of wastewater treatment plants necessarily affect what neighbourhoods that are connected to the municipal sanitation regime. Although, the community regime also tends to be distributed in clusters, it is not as dependent on its location relative to existing water and sanitation distribution networks as the municipal regime. The community regime constitutes of hundreds of disconnected systems and independent actors. Instead, it is mainly internal neighbourhood dynamics and facilitating factors that determine the spread of the community regime (**paper II**; **paper III**). The location of water sources does, however, affect the community water regime. They generally make use of groundwater within their jurisdiction (close to their homes), but if local water sources are not available, they buy bulk volumes of water through water tankers. Note, however, that as mentioned earlier, the implementation and operation of community - managed systems are not dependent on the positioning of other community-managed distribution networks.

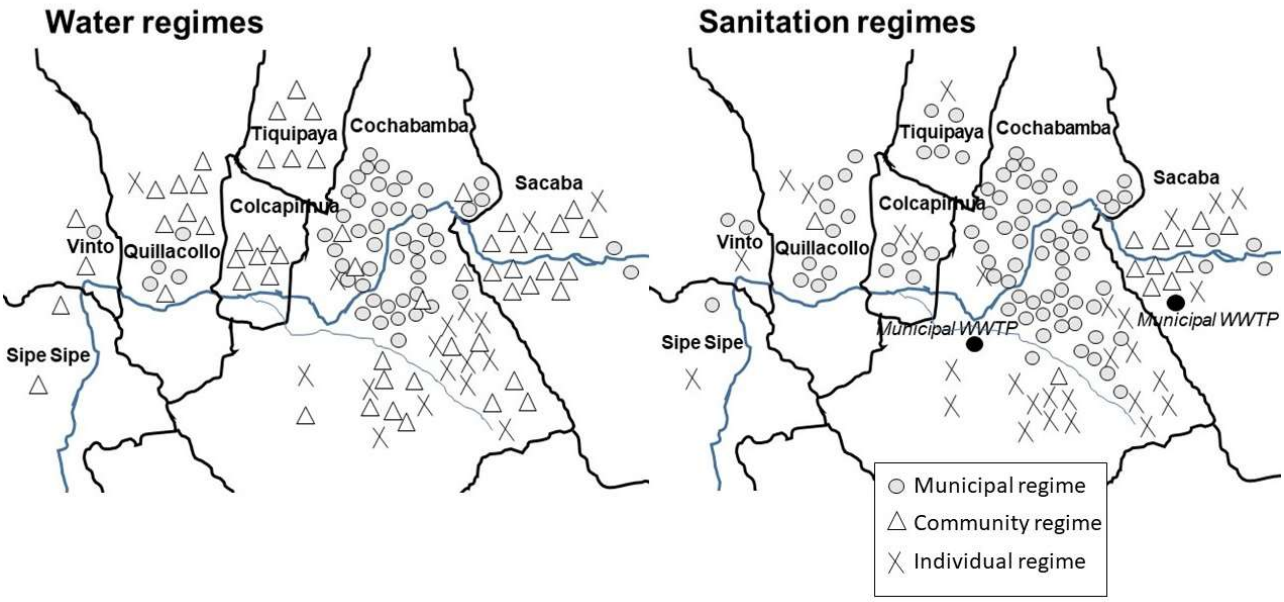

*Figure 4 Conceptual maps of the water and sanitation regimes. Each regime symbol represents 10 000 users, i.e. smaller systems are not included. The estimations are based on literature and interviews performed during this study (**Paper I**).*

In addition to regime actors, there are various centralized state organizations that are involved in the water and sanitation management of Bolivia. The ministry of water and environment and its subdivisions promote sustainable water management through both policymaking and execution of water and sanitation programs. There is also a control agency of water providers, as well as a state organization that provide technical and administrative support to water operators and guidance for public investments regarding water and sanitation management. The county board at the regional level is also involved in water and sanitation projects and implementation of water and sanitation policies. Furthermore, there are additional actors at the local level that play a crucial role for the waterscape, such as the NGOs and independent consultant companies that plan and implement water and sanitation projects, e.g. the Misicuni company.

4 Methods

For this thesis a qualitative case study approach of explorative character was selected in order to stay open to emergent findings. This chapter describes the research approach, including the scope of this thesis, i.e. study boundaries, as well as the selected data collection and analysis procedures for the respective papers. Finally, the ethical considerations during this research process is outlined.

4.1 Qualitative case study design

Since water and sanitation provision implies a complex interplay between social, organizational and technical factors a qualitative research design was selected for this thesis (Suddaby, 2006; Flick, 2009; Yin, 2009). In line with Maxwell (2005), the design was dynamic and reflexive, i.e. the different research steps were carried out more or less simultaneously and the research process and its components were continuously re-evaluated (Figure 5). In addition, this research followed the two pillars of grounded theory: theoretical sampling and constant comparison. Theoretical sampling implied that the informants were selected through a set of criteria (Eisenhardt, 1989; Yin, 2009), i.e. the cases or informants were included due to specific reasons, such as inclusion of informants of varying socio-economic characteristics. Constant comparison, which is typical for theory-building case studies, emphasized the importance to go back and forth between data collection and analysis (Eisenhardt, 1989; Suddaby, 2006; Yin, 2009). In addition, existing literature connected to the research questions was used and incorporated at all stages in the research process (Eisenhardt, 1989; Suddaby, 2006; Flick, 2009).

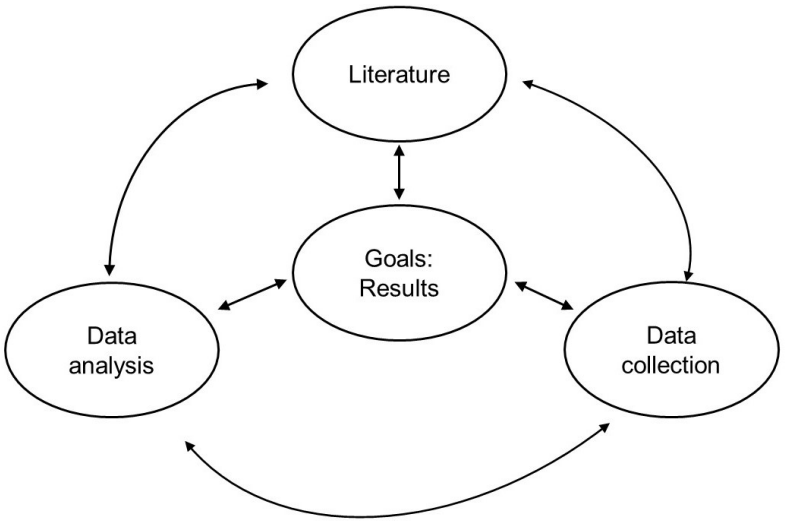

Figure 5 This thesis had a qualitative research approach that implied iteration between literature, data collection and analysis (Adapted from Maxwell 2005).

Apart from a qualitative research design of explorative character, a case study approach was judged to be suitable for this thesis, since a real-world phenomenon within its context was studied. Yin (2009) claim that case studies are especially useful when the research questions start with “how” and/or “why”, i.e. when the intention is to build theory and find satisfactory explanations to a contemporary behaviour or phenomenon. In addition, case study methodology is often used when the study cannot control the events that are under investigation. There are, however, some scepticism towards case studies, since it does not enable statistical generalizations. Historically, the most common use of case studies has been to develop

research questions and/or hypothesis (Yin, 2009). Much literature does, however, argue that case study design is suitable for theory-building when no hypotheses can easily be developed (Eisenhardt, 1989; Flyvbjerg, 2006). There is, however, a danger to develop theories that are too complex and narrow, since they are built upon very rich and contextualized empirical evidence for one or several cases (Eisenhardt, 1989). In this study, it was therefore crucial to select a typical case, i.e. a water and sanitation sector that was representative for urban water management in low and middle income cities (Flyvbjerg, 2006; Yin, 2009). Embedded extreme cases, i.e. sub-cases, were then studied within the boundaries of the selected holistic case study (Yin, 2009). These extreme cases were important for building theory regarding alternative actors, i.e. CBOs and individual households that were found to be important to assure universal access to safe water and sanitation services. More actors and mechanisms are activated in extreme cases than in typical cases, i.e. the phenomenon under study is more visible, which in turn enables theory-building (Flyvbjerg, 2006).

4.2 Research scope

The water and sanitation sector of the Kanata metropolitan region was selected as a case study, since it was seen as characteristic for waterscapes of low and middle income cities, due to its wide range of actors and technical systems. It was viewed as a typical case, but it still included unique characteristics. At first, a deductive approach was used to describe and evaluate the water and sanitation sector of the Kanata metropolitan region, through the application of regime analysis that is part of the field of transition studies (**paper I**). CBOs and individual households were found to be especially important for assuring universal access to safe water and sanitation services. Community management and high adoption rates by individual households in peri-urban areas were therefore selected for in-depth studies and represented extreme embedded cases (**papers II-IV**) (Figure 6). The aim with the embedded cases were to contribute to theory-building, i.e. inductive reasoning, that laid the groundwork for theories that were relevant in similar contexts elsewhere. In addition, the selected research design aimed to include distinct stakeholders at different levels, i.e. the city, neighbourhood and household level in order to obtain a holistic understanding, as well as an in-depth knowledge regarding critical components for universal service provision.

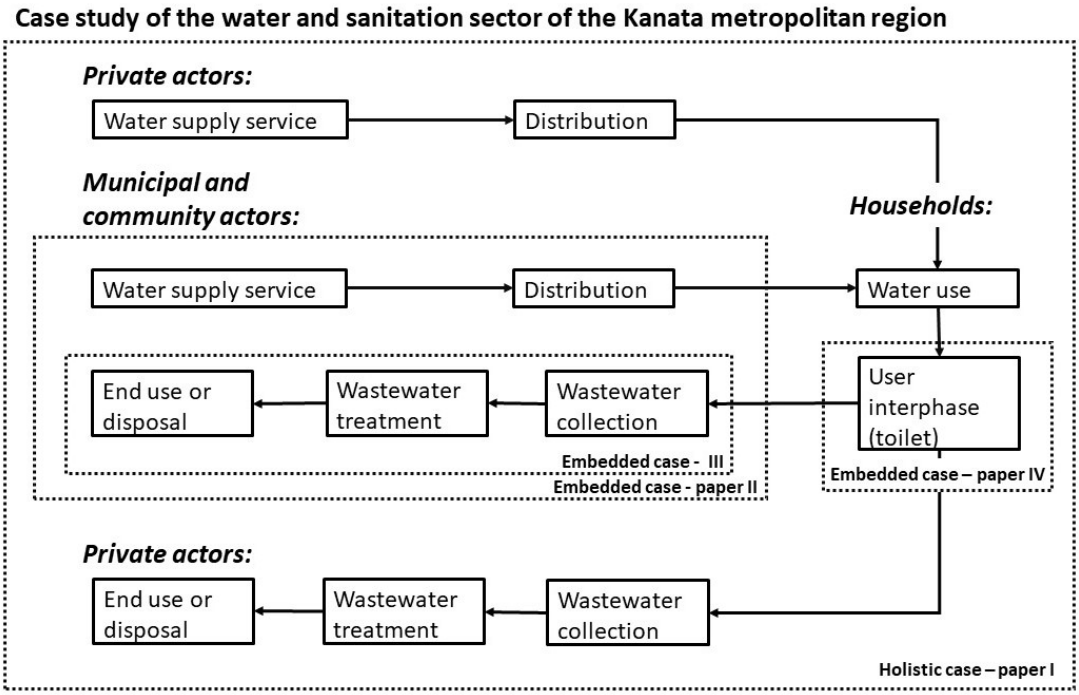

Figure 6 Research scope of this case study. The dashed boxes represent the holistic and embedded cases that were investigated in the respective papers.

4.2.1 Study boundaries

The key concepts that limit and define this study are described below. Note, however, that the theoretical concepts that are relevant for the respective articles are defined in Chapter 2.

Water and sanitation systems

The definitions of water and sanitation systems differ slightly in literature, but conventional water supply systems are typically described through the following steps: water source, water purification, storage, distribution and water use. The three first steps of water management are, here, summarized by the use of water supply service. A sanitation system is generally defined through the stages of user interface (toilet), wastewater collection, wastewater treatment and end use or disposal. In this thesis, sanitation refers to all these steps, whereas wastewater management only refers to wastewater collection, treatment and end use or disposal, not the user interphase. Note, however, that technical details were not included in-depth in none of the papers, although the adaption of technical solutions is important to assure universal access to safe water and sanitation services (McGranahan, 2015; McGranahan and Mitlin, 2016).

The Kanata metropolitan region

This thesis was geographically limited to the Kanata metropolitan region in Bolivia, i.e. the findings are based on this specific area. Due to similarities with water and sanitation sectors in other low and middle income cities, it is considered as a typical case (Yin, 2009). The Kanata metropolitan region is a diverse metropolitan area that experience rapid population growth and urbanization. The urban population consists of different social and economic groups that typically live in clusters, i.e. the city is segregated. For example, there are large differences in household income and the public services are lacking or of inadequate quality in many low-income neighbourhoods (for more details see Chapter 3).

Urban areas

There is no common definition for urban areas (Breckenkramp et al., 2017). Instead it varies between different countries. For example, Bolivia through the National Statistics Institute (INE) defines urban areas as jurisdictions with more than 2,000 inhabitants. In this thesis urban areas are defined as continuous urban agglomerations. It refers to the whole urban context, including peri-urban areas, i.e. not limited by administrative jurisdictions. Peri-urban areas are, here, as elsewhere used for the rapidly growing settlements in the outskirts of cities. Growing urban areas have implied increased demand for water, due to population growth, urbanization and changes in consumption patterns. Changing water demand and water scarcity is, however, not directly included in this thesis.

Low and middle income countries

The focus of this thesis is low and middle income countries. According to the World Bank, low income countries are defined as economies that have a gross national income (GNI) lower than 1025 USD per capita, whereas middle income countries are defined to have a GNI per capita between 1026 USD and 12 375 USD (A: The World Bank, 2020). In addition, middle income countries are sometimes separated in low middle and upper middle income countries. Bolivia belongs to the group of lower middle income countries and it had a GNI of 7 670 USD per capita, in 2018. This can be compared to the high income country of Sweden that had a GNI per capita of 54 030 USD for the same year (B: The World Bank, 2020). Despite the study focus of this thesis, context-specific poverty-related factors within the urban context were to some extent excluded. For example, the effect of formal property rights on provision of safe water and sanitation services were not included, despite its importance for access to water and sanitation services (Mara et al., 2010; McGranahan, 2015).

Stakeholders

Stakeholders are, here, defined as organizations, businesses and individuals that are connected to provision of water and sanitation services, such as municipal actors and CBOs. Some provide water and sanitation services, whereas others have a supportive or regulatory function. In addition, the water and sanitation users, i.e. individuals, are an important stakeholder. Stakeholders and actors have the same meaning in this thesis, and they are used interchangeable. Alternative actors are used for informal and quasi-formal stakeholders, such as CBOs and individual households. This thesis studies both individual actors separately, as well as the interaction between different actors. Interaction regarding water supply issues is, however, not included, although it is an important factor in the study context. Tension and conflicts regarding rights to water sources and their claimed use have characterized the waterscape of the Kanata metropolitan region for centuries (Hines, 2015).

4.3 Data collection and analysis

In this thesis a number of different procedures for data collection and analysis were carried out, i.e. methods triangulation was applied (Yin, 2009). The data collection was accommodated to the context and respective informants, since it was important to take advantage of the informants' specific knowledge and experiences (Eisenhardt, 1989). The aim was to include as comprehensive data as possible, i.e. both corroborating and contrasting evidence (Yin, 2009). In addition, both descriptive and explanatory data was collected for all the included papers. Descriptive data included facts and descriptions of contexts etc., whereas explanatory data tried to provide reasons or explanations to a specific fact.

The main data collection was carried out by the author during four periods: one month in 2012, five months in 2013, two months in 2014 and six months in 2019-2020. During these periods different types

of interviews with a wide range of actors were performed. The stakeholder groups and selected informants varied between the respective papers, as well as the number of interviews (Table 6). The number of informants and interviews were determined through theoretical saturation, i.e. when no new information was revealed the collection was stopped, as well as through practical limitations (Eisenhardt, 1989; Flick, 2009). Narrative interviews were, initially, performed with many distinct stakeholder groups to understand the context. This interview form was chosen to enable the informants to talk freely about the development of the water and sanitation sector of the Kanata metropolitan region. The role of the author was to keep the informants on track, i.e. stick to water and sanitation issues (Flick, 2009). Formally arranged ethnographic interviews were then conducted with CBO leaders and members to collect in-depth data. They also implied a flexible type of interview technique, but instead of letting the informants steer the interview, they were guided by on a beforehand decided topic list (Hammersley and Atkinson, 2007). In addition, semi-structured interviews that included pre-determined questions were performed with household members, since, in these cases, some specific details needed to be covered. The aim was to make the interview situation as similar as possible between the distinct informants, but the order of the pre-determined questions was accommodated to the interview situation (Flick, 2009; Yin, 2009). All these types of interviews were recorded and the relevant parts were transcribed.

Table 6 The type of interviews, stakeholder groups, number of informants and interviews, as well as analysis procedures varied for the respective papers. Some of the informants were interviewed more than once, thus the difference in the number of informants and interviews. Note that all the listed interviews were performed by the author.

Type of interview	**Stakeholder groups**	**# of infor-mants**	**# of inter-views**	**Analysis procedure for the respective interviews and associated papers**	**Paper**
Narrative interviews	Public officials (including staff at municipal enterprises), local researchers, NGO professionals, CBO leaders and representatives of associated networks	48	57	Qualitative content analysis	I
				Thematic coding and analysis	III
Formally arranged interviews	CBO leaders and members	46*	69	Analytic induction and then time-series analysis	II
				Thematic coding and analysis	III
Semi-structured interviews	Household members	27	55	Time series analysis and explanation building	IV

* In **paper II** it is mistakenly stated that 47 CBO leaders and members were included as informants for performance of formally arranged interviews.

Spontaneous ethnographic interviews were also performed, but these were difficult to quantify and therefore not included in Table 6. They constituted of everyday conversations during the collection periods. This interview technique was one of the main data collection methods and data collected in this way was used for all papers in order to take advantage of spontaneous meetings and chats. To get to know the embedded field study sites in-depth, the author shared daily life with the residents several times per week during the collection periods, in 2013 and 2014. She participated in coffee breaks, meals and participated in the activities of the respective CBOs, such as meetings and community work. The author also rented a room and stayed temporarily in the house of one of the key informants. In addition, she interviewed water and sanitation actors connected to the study sites, such as construction workers of water and sanitation infrastructure and drivers of water tankers and vacuum trucks that empty sludge. Notes were taken during or after these spontaneous ethnographic interviews. The author also performed short complementing phone interviews and email requests when performing analysis and writing throughout the research process. In addition, in 2019, she performed spontaneous ethnographic interviews at several

additional neighbourhoods that had formed CBOs to manage communal systems. These additional interviews were included to double-check and complement the data for **paper III**, as well as understand the developments of the water and sanitation sector of the Kanata metropolitan region since the prior data collection periods. Finally, in the beginning of 2020, the data collection was also complemented conducting a questionnaire with key informants in the Kanata metropolitan region to review the results.

As part of the data analysis, memo writing that implied writing down thoughts and ideas regarding the research questions was performed continuously throughout the research process. It allowed for constant review of the empirical evidence through reflection around the order of events and facts, as well as their meaning (Suddaby, 2006; Yin, 2009; Eisenhardt, 1989). Writing open answers and reflections regarding the research objectives, as well as paying attention to the differences among the informants helped to steer the data collection (Eisenhardt, 1989; Yin, 2009). In addition to memo writing, various other types of data analysis techniques were conducted, but these differed between the included papers (Table 6). For **paper I** the procedures of qualitative and structuring content analysis were used (Flick, 2009). This implied analysis of the field data through pre-defined theory-based categories, followed by scaling of the identified categories. For **papers II-IV** coding and categorization were used to, initially, select and organize the relevant data that was used for further analysis. Analytic induction, outlined by Hammersley and Atkinson (2007), was then applied to develop a theoretical proposition that was supported by all case study sites in **paper II**. In addition, time-series analysis in the form of chronologies, according to Yin (2009), was used to identify distinct operation and management phases that were connected to the identified categories. For **paper III** thematic coding and analysis, by Flick (2009), was used. This implied that five main illustrative cases of CBOs and their respective services were used to identify common categories and themes that then were developed through inclusion of additional cases and interviews with other stakeholders. For **paper IV**, in addition to coding and categorization, through which common categories were identified, chronologies and explanation building, according to Yin (2009), were performed. Chronologies enabled ordering of identified categories in relation to when adoption of household sanitation took place, i.e. determining the relative importance of the respective categories. Explanation building aimed to find casual links between the distinct categories through iterations between existing theory and case study data, in order to refine a theoretical proposition that was supported both by the existing theory and all case study data. Descriptive information plays a crucial role for case studies (Yin, 2009), but, in this thesis, it was mainly the explanatory data that were analysed. The descriptive data were used as a way of corroborating the results of the data analysis of all the included papers.

4.4 Ethical considerations

Since the stories of the informants are the main unit of analysis in qualitative research, it is absolutely crucial to respect ethical and moral standards (Suddaby, 2006; Yin, 2009). This study was approved by the University of San Simón of Cochabamba, Bolivia in line with concerned ethical guidelines. All participation was voluntary, and the informants could choose to cancel his or her participation at any time. Before participation the included informants gave their informed oral consent. All the informants were anonymous, i.e. neither names nor information through which identification can be done is presented. Apart from the consent on behalf of the informants, the study was also approved by the CBOs of the embedded case study sites before initiation of the data collection. The collected data was, solely, administered by Ida Helgegren and not accessible by anyone else.

5 Results

This thesis is built upon four papers that are presented in numerical order below. Note, however, that **paper II** and **III** that focus on community management are presented under the same heading, i.e. Section 5.2.The theories that the included papers are built upon, including the knowledge gaps they intend to fill are outlined in Sections 2.3 and 2.4, and the knowledge gained are discussed in Sections 6.2 and 6.3.

5.1 Regime analysis

The study presented in **paper I** was performed as a multi-level regime study of the water and sanitation sector of the Kanata metropolitan region. The aim was to identify the multiple water and sanitation regimes, as well as evaluate their respective strength. In addition to increased contextual knowledge, the intention was to add knowledge regarding water and sanitation regimes in low and middle income countries, through application of transition theory.

Initially, the type of governance organizations guided the identification of the following water and sanitation regimes: municipal, community and individual regimes, which are described further in Section 3.4. The distinct service regimes were then evaluated, and their strength determined through an analytical framework that was adapted from Fuenfschilling and Truffer (2014) and McConville et al. (2017) (Figure 7). This implied analysis of the field data through the following pre-defined theory-based categories (Flick, 2009), here, called regime characteristics: 1) water and sanitation infrastructure, 2) actors & organisation mode, 3) social coordination, 4) rational values, 5) financing and 6) legislation. The choice of regime characteristics was based on literature, with many studies looking at technical infrastructure (Fuenfschilling and Truffer, 2014; Nastar, 2014; Xu et al., 2016; van Welie et al., 2018; McConville et al., 2017), actors & organisation mode (Fuenfschilling and Truffer, 2014; Nastar, 2014; Xu et al., 2016; Nti Acheampong et al., 2016; van Welie et al., 2018; McConville et al., 2017), and legislation (Nastar, 2014; Nti Acheampong et al., 2016; McConville et al., 2017). It was chosen to specify sociocultural or social aspects (Nastar, 2014; Xu et al., 2016; Nti Acheampong et al., 2016; van Welie et al., 2018) as social coordination and rational values, since both these characteristics were mentioned as crucial and of major importance by the informants. In addition, values were included in regime studies by Fuenfschilling and Truffer (2014) and McConville et al. (2017). Financing was included, since it is especially important to consider in a low- and middle-income country context (Xu et al., 2016; Nti Acheampong et al., 2016), as well as for transitions studies to more sustainable modes (Fuenfschilling and Truffer, 2014).

The strength of the different water and sanitation regimes was then analysed qualitatively through structuring content analysis, according to Flick (2009). This implied scaling of the institutionalization of the respective regime characteristics, i.e. measurement of how embedded the different characteristics were. Three different degrees, i.e. weak, medium and strong, of institutionalization were defined for each respective regime characteristic. For example, the regime characteristic of water and sanitation infrastructure was ranked weak if there were no standardized technical solutions within a specific regime, medium if the technical solutions were partly standardized and high if the technical solutions were standardized. The bulls-eye rings were a way to illustrate this institutionalization, the closer to the core a characteristic was placed, the more institutionalized, and the more institutionalized regime characteristics, the stronger the regime and harder to change (Figure 7).

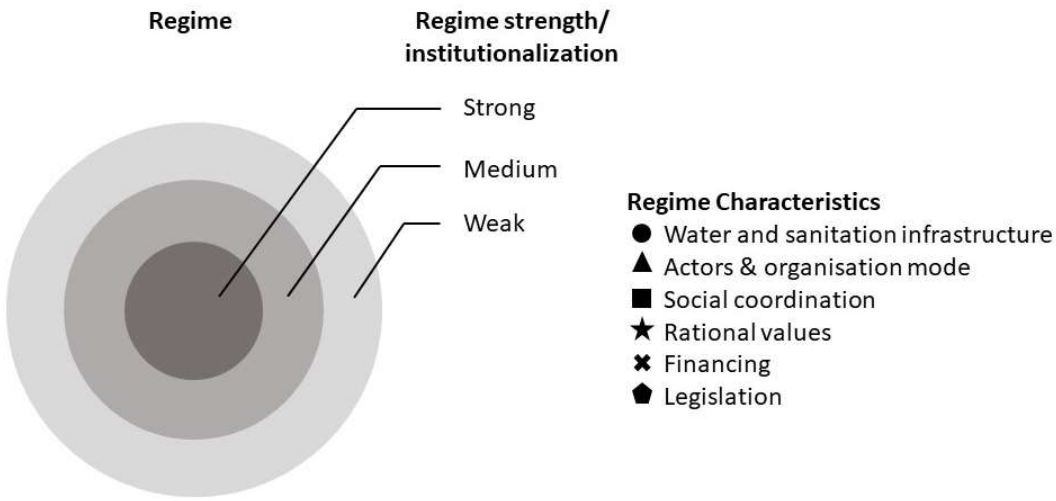

*Figure 7 The analytical framework for assessing regime strength including the selected regime characteristics that are arranged in relation to the respective regime core. The closer a specific regime characteristic is positioned to the core, the more institutionalized and stronger it is (**Paper I**).*

The regime characteristics were, in this paper, all seen as equally important for water and sanitation regimes, but their influence on the respective regimes depended on their institutionalization. The regime characteristics that were institutionalized to a lesser extent implied regime weaknesses that constituted opportunities for improvements and potentially transitions to water and sanitation for all. Both the municipal and community water regimes were found to be strong, whereas the individual water regime scored weak, but all of them included weaknesses (Figure 8). The strength of the sanitation regimes was also found to vary and all of them included several weaknesses. The municipal sanitation regime scored strong, the community sanitation regime was viewed as medium and the individual sanitation regime was weak (Figure 9).

This paper offers insights into windows of opportunities, i.e. weaknesses of the distinct regimes that can create space for a transition to water and sanitation services for all. For example, the municipal water and sanitation regimes would grow stronger through improvements of the financing mechanisms, such as increasing the efficiency and lower corruption. In addition, they would be strengthened further by incorporating the rational values that, here, were defined by the informants, i.e. involvement of the public, transparency and connection of low-income neighbourhoods. For the municipal sanitation regime, wastewater treatment needs to be implemented much faster than it currently is, i.e. standardization of technical solutions for sanitation services would strengthen this regime. For the community regime, both the water and sanitation regimes would be strengthened by standardized technical solutions. Especially the community sanitation regime, due to the more technically complex systems that wastewater treatment implies. In addition, improved financing mechanisms constitute an improvement opportunity also for the community regimes. Increased external funding would be one way forward, since the community regime is typically directed less finances than the municipal regime. Furthermore, for the community sanitation regime, increased social coordination among the actors would have the potential to strengthen this regime. The individual water and sanitation regimes contained many weaknesses. The following are some actions that would strengthen both of them: improved legislation, technical training and financial incentives to improve the quality of the service and decrease the price to poor citizens.

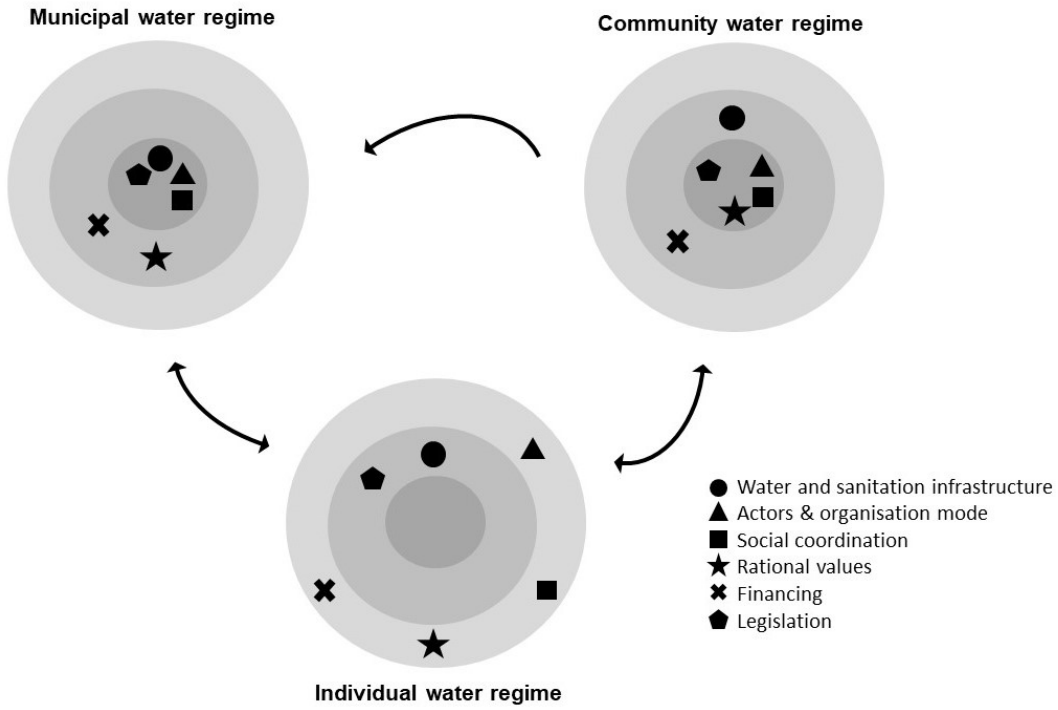

*Figure 8 Institutionalization of the regime characteristics for the different water regimes, i.e. evaluation of their respective regime strength. The arrows account for the fact that users may shift between regimes. Note that some households that enjoy piped water from the municipal or community regime might revert to the individual water regime, due to mal-functioning technical systems or lack of water within the network (**Paper I**).*

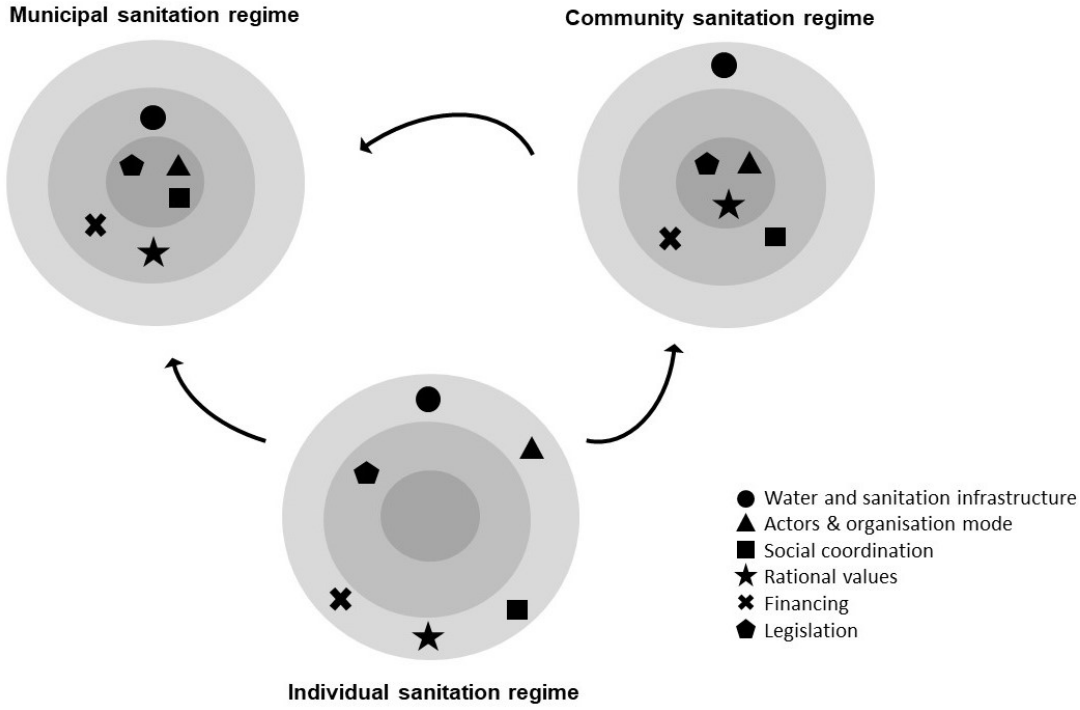

*Figure 9 Institutionalization of the regime characteristics for the distinct sanitation regimes, i.e. the regime strength, for the respective regimes. The arrows account for the fact that users may shift between regimes (**Paper I**).*

5.2 Community management

Together **paper II** and **III** aimed to contribute to increased in-depth knowledge regarding the existence and expansion of community-managed systems. The main findings of these papers are outlined below. Note, however, that this thesis does not recommend when community management is appropriate. Instead, it is up to each context to decide whether community management is desired or not. If community-managed systems are considered as desirable, the presented results can be used to support the implementation and operation of communal systems.

5.2.1 Internal prerequisites

Paper II aimed to answer the following research question: why and how some urban and peri-urban neighbourhoods self-organize and succeed in implementing and operating communal water and wastewater systems internally (without external support), whereas others do not? To do this, a multiple case study design of explorative character was selected (Yin 2009). Three distinct cases, i.e. Site A, Site B and Site C, that represented different types of CBOs and varying socio-economic characteristics were included (Table 7). They all represented unique opportunities for the first author to get to know the CBOs and their members in depth, i.e. gain trust and collect valuable data to work with. The aim was to develop a wide-ranging theoretical framework. and it was important to not limit the findings to a predetermined set of parameters.

*Table 7 Characteristics of the different case study sites and the water and sanitation service offered by respective CBO in January 2018 and associated costs (**Paper II**).*

Case study	**Site A**		**Site B**		**Site C**
Municipality	Sacaba		Quillacollo		Cochabamba
# of households	297		215		339
Property rights	Yes		Yes		Legalization process ongoing
Economic group[3]	Middle income		Low income		Low income
Biggest cultural group	Hispanic heritage		Indigenous heritage		Indigenous heritage
Type of CBO	Service cooperative (initially a water committee)		OTB (initially a water committee)		Junta vecinal
Water and sanitation service by the CBO	Two wells and one storage tank that feed a piped water network connected to the dwellings. Sewer system and a small wastewater treatment plant.		Water system including two wells that feed a piped water network to standpipes in the yards of the users or in-house connections.		Nothing
Quality	Non-continuous water supply with occasional high turbidity		Continuous water supply without regular water quality checks		NA
Future plans	Purification stage and communal rainwater and surface water collection		Sewer infrastructure and a wastewater treatment plant		Connection to the municipal enterprise
Tariff structure (For Site A the tariff increases with consumption)	Water	1.7 – 7 BS/m^3 (0.25 - 1 USD/m^3)	Water	2 BS/m^3 (0.3 USD/m^3)	NA
	Sewer	0.7 – 1.1 BS/m^3 (0.1 – 0.16 USD/m^3)			
	Wastewater treatment	23 BS/month (3.3 USD/month)			
Connection fee	Water	4117 BS (597 USD)	Water	4673 BS (678 USD)	NA
	Sewer	1890 BS (274 USD)			
Member fees	Inscription fee: 696 BS (101 USD)		2 BS/month (0.3 USD/month)		2 BS/month (0.3 USD/month)
Sanctions when missing activities	50 BS (7.2 USD)		10 – 100 BS (1.4 - 14.4 USD)		10 – 100 BS (1.4 - 14.4 USD)

[3] A qualitative measurement based on field observations.

Four prerequisites for implementation and long-term operation of community-managed water and sanitation systems were identified, i.e. leadership, agreed vision, collective action, and management. They were all seen as interconnected and taken as equally important, since they were common to all three case study sites (Figure 10). In addition, chronological case descriptions enabled identification of distinctive planning and management phases that were connected to the different prerequisites. It was found that the importance of the prerequisites varied over the following phases: initial implementation, long-term operation and subsequent improvements.

At each case study site, the prerequisites were then linked to different case-specific enabling factors that described how the respective prerequisites may be achieved (Figure 11), i.e. different enabling factors allow a community to fulfil the respective prerequisites. There was no single way of achieving, e.g. successful leadership, but rather multiple pathways for meeting these prerequisites for long-term community management. This was also why the enabling factors that constitute the respective prerequisites vary somewhat between the distinct phases. For example, agreed vision are not constituted of the same enabling factors for the distinct phases. Note that the flexibility of the enabling factors contributes to increasing the relevance of this framework, since they constitute an opportunity to accommodate the framework to different contexts.

The developed framework was meant to visualize the elements that are needed for community-managed water and sanitation systems to function over time. The aim was to lay the groundwork for theory-building regarding the internal factors that are needed for functioning community-managed water and wastewater systems. The framework may be used by policy makers and development practitioners to strengthen community management and support CBOs which have failed to implement or operate communal systems. The distinct phases enable categorization of neighbourhoods and CBOs to direct and customize external support. Neighbourhoods need different support depending on which of the distinct phases they belong to, i.e. external efforts should focus on the missing prerequisite(s) for the respective phase. Initial implementation is relevant for neighbourhoods that lack community management, where the residents may be triggered to self-organize and implement community-managed systems. Long-term operation should only be the focus if the targeted neighbourhoods already have implemented a communal system that is not in use or not properly functioning. Subsequent improvements are an important component in development programmes that target neighbourhoods that are already served by community-managed systems. If these communal systems are to function also in the future, the service needs to keep up with user demand, i.e. the system needs to improve over time. The enabling factors might serve as inspirations and potential measures that can be taken, but it is important to bear in mind that all CBOs have their unique ways of fulfilling the different prerequisites. When applying this framework in another context, earlier traditions of community management should be considered, and interventions tailored to build on local experience.

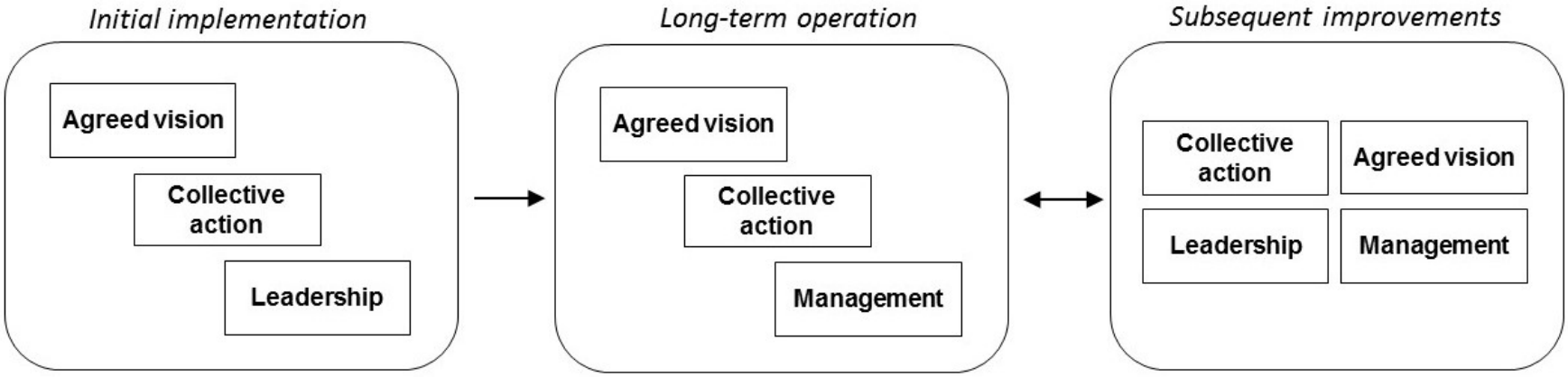

*Figure 10 Community-managed water and wastewater systems have three distinct phases, which depend on different prerequisites (**Paper II**).*

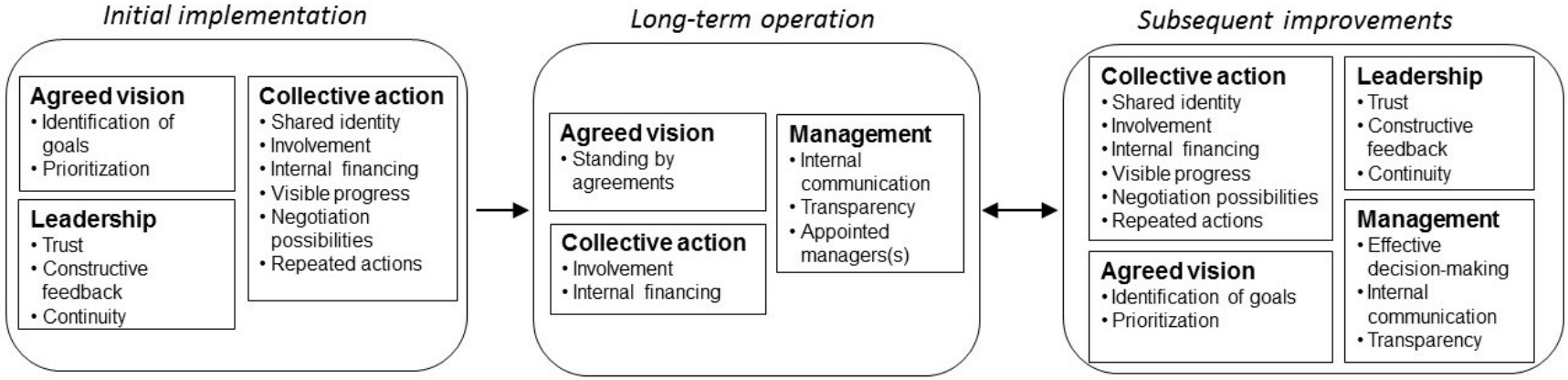

Figure 11 Framework developed for community-managed water and wastewater systems, consisting of prerequisites and associated enabling factors, which differ between the distinct phases of community management (**Paper II**).

5.2.2 External facilitating factors

The aim of **paper III** was to understand how external factors affect community-managed wastewater systems. Due to the broad and open research scope, a qualitative case study approach of the whole wastewater sector of the Kanata metropolitan region was selected. The intention was to take advantage of the long tradition of community management in the Kanata metropolitan region and the wide variety of experiences (Castán Broto and Neves Alves, 2018). A broad range of informants from different stakeholder groups were, therefore, included.

During the field studies, it was highlighted that a common vision for the wastewater sector was important for implementation and operation of community-managed wastewater systems. This was, however, lacking at the case study site. Some informants supported the existence of community-managed wastewater systems as a legitimate service provider, whereas others did not. Note, however, that the support for community-managed water systems was much greater than the support for community-managed wastewater systems. By many informants, community management was highlighted to be part of the Andean culture, i.e. a long-rooted tradition. For example, one CBO leader said this about community-managed projects: *"[…] this is our form of life, this is how we overcome our problems, what we need"*, and an employee at a local NGO in Cochabamba said the following about CBOs: "*[…] they are the ones that truly and effectively provide a service to all."* Despite this, many informants were, relatively, negative towards the idea of communal wastewater management and there were few community-managed wastewater systems. Many considered wastewater management as a responsibility of the state. A representative for CBOs stated the following about wastewater management: *"This is a state responsibility […]. At first, we do not have the space […]. Secondly, we do not have the economic resources that are the most important, and thirdly, the legal pressure […]."*Some CBO leaders were, however, positive towards communal wastewater services and they wanted to provide independent wastewater services, i.e. they wished to maintain their independence and control over their own systems. Although, they were frustrated over the unwillingness among the public officials to support community-managed wastewater systems.

In addition to pointing out the importance of a common vision, the data analysis identified nine facilitating factors that were grouped into thematic categories (Figure 12). They were all highlighted as important for promotion of community-managed wastewater systems. Apart from being grouped into these themes, no obvious links between the different facilitating factors were found. This paper did, however, not reject the idea that these factors were interrelated. Fulfilment of the facilitating factors is not seen as a prerequisite for implementation and operation of community-managed wastewater systems. Instead, they make implementation and operation of services easier, i.e. the more facilitating factors that are fulfilled, the easier it is.

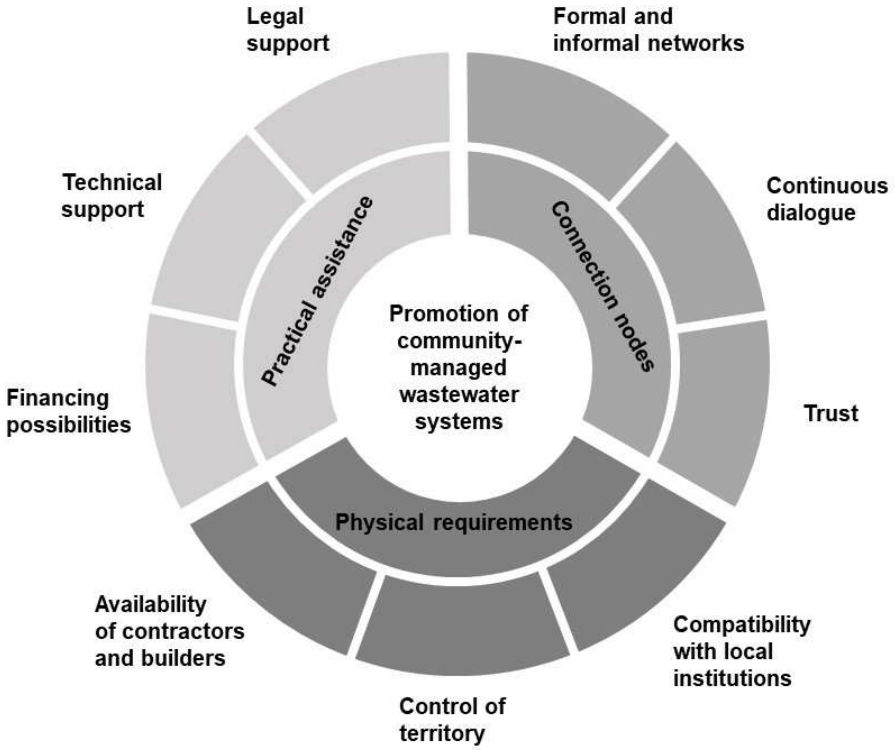

Figure 12 Together the identified facilitating factors and thematic categories promote communal wastewater management. The facilitating factors and thematic categories are positioned in the outer and inner circle, respectively.

To validate the presented results a questionnaire with key informants among local researchers and NGO professionals were performed. The respondents disagreed as to the importance of the overall attitude towards community-managed wastewater systems for future expansion. The questionnaire did, however, corroborate the lack of a common vision for the wastewater sector in the Kanata metropolitan region. It was emphasized that the support for community-managed wastewater systems was typically weak and centralized municipal systems were often seen as the main solution, but the opinions varied. For example, one respondent stated that many communities were very keen to implement and operate community-managed wastewater systems, but lack of supportive public policies hindered them. Others argued that neither municipal authorities nor CBOs wanted to take on the responsibility for the lacking wastewater management, instead it was often the central government that was pointed out as responsible. Another respondent stated that: *"No matter of social group and location, WWTP are considered as a problem that someone else should take care of. The problem is that no one wants to be this someone."* In addition, many respondents highlighted that wastewater management was easily forgotten by both municipal authorities and CBOs, since other neighbourhood improvements were prioritized instead.

All of the facilitating factors were supported by the respondents, although to a varying degree. The medium scored ranged between 8.1 and 9.8 for all of them, except for legal support that had a medium score of 6.5 (1 means not important and 10 very important) (Figure 13). Technical support and financing possibilities for both implementation and operation costs were especially emphasized as important by the respondents. One respondent wrote: *"Decentralized WWTP […] requires much technical support and subsidies to keep the operation functioning […]."* Another example is the following quote regarding community-managed wastewater systems: *"They are constructed structures that are expected to function*

on their own. The people do not prioritize to operate and maintain these, due to that, almost none function as intended." In addition, many respondents claimed that the citizens of the Kanata metropolitan region typically are reluctant to pay for wastewater services. Despite these indications of varying importance, this paper did not rank the identified facilitating factors.

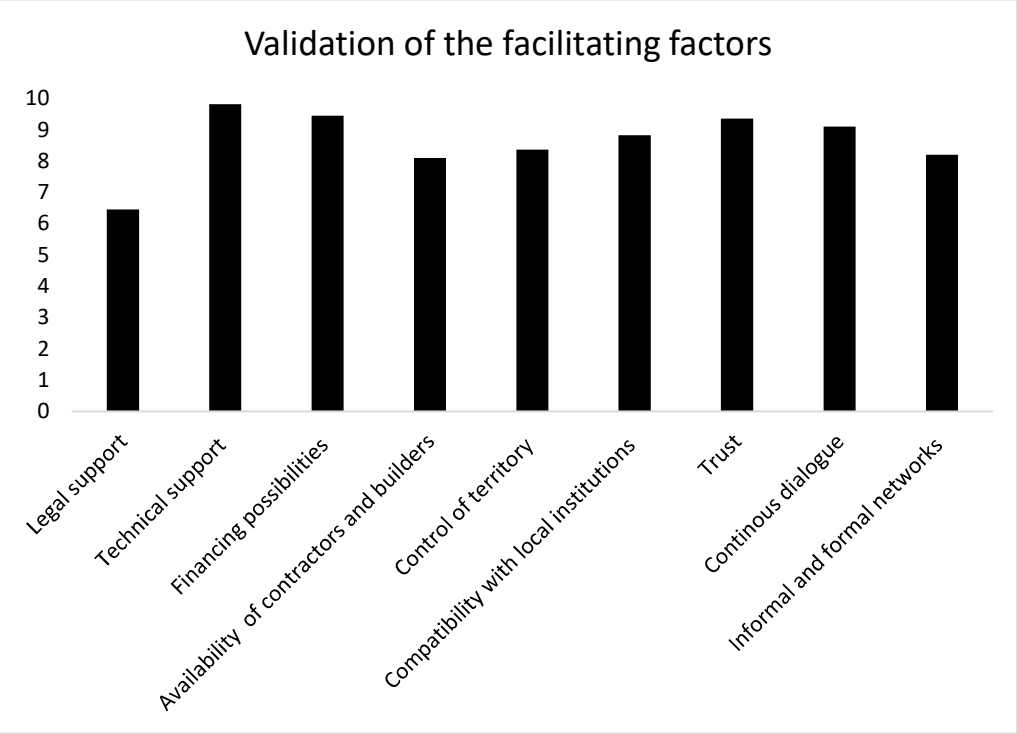

Figure 13 The medium score that the respective facilitating factors obtained in the performed validation questionnaire (1 was the lowest, whereas 10 was the highest score).

This paper aimed to lay the groundwork for increased theoretical understanding, as well as develop knowledge that easily can be used by local actors. Two main findings were concluded as important for promotion of community management. At first, a common vision for the wastewater sector that includes CBOs as legitimate providers of wastewater services is crucial. As an initial step in development programs that aim to promote community-managed wastewater systems, it is therefore important to get different stakeholders to agree on a common vision that is well anchored in their respective organisations. Secondly, a number of external factors, here called facilitating factors, were highlighted as important for functioning community-managed wastewater systems. The facilitating factors provide guidance to both policymakers and development practitioners, where communal wastewater management is considered as part of the solution for universal access to safe sanitation services. Depending on the context, it is up to each external support program to choose the facilitating factors that are the most important, or if all are targeted.

5.3 Adoption of household sanitation

The aim of **paper IV** was to develop an adoption framework for pour-flush toilets. It was designed as a theory-building single case study of ethnographic character, and the existing behavioural model by Rogers (2003), outlined in Chapter 2, was used as a starting point. Initially, the study focused on improved household sanitation, but along with the execution of the study, the scope was narrowed down

to pour-flush toilets. Since, a key result of the study was that pour-flush toilets was the preferred sanitation alternative at the study site.

All the informants explicitly expressed that they viewed waterborne toilets connected to a sewerage network as the best alternative. "*There is no other alternative*", as various informants said, despite knowledge and experience of latrines and dry toilets. It was not only the toilet in itself that created the demand for waterborne sanitation, but also the bathroom with running water as a whole. Shower and personal hygiene were mentioned by many as part of their dream bathroom. One informant said: "*I would like to have [. . .] a complete bathroom*, *with shower and wash basin*". Furthermore, demand was affected by the local characteristics of the study site (such as population density, safety and physical characteristics), and the larger context in which it was situated. The informants wanted to have the conventional system that wealthier areas in Cochabamba have. Many informants said that they wanted to have the same system as in the city centre. One informant put it like this when she was asked about what system she preferred: *"[. . .] like in any other place [. . .]",* in which she meant a waterborne toilet. In addition, the majority of the informants did not see any benefit with other sanitation systems. All the informants had experience of latrines and dry toilets, but when asking about this they expressed dislike or desire to change. Many described latrines as inconvenient, unpleasant, smelly, un-hygienic and low-status alternatives. One informant who was building a pour-flush toilet during 2014 said like this about her prior improved latrine: *"[. . .] it is unpleasant [. . .] you do not wash with water [. . .] therefore the flies".*

A number of factors were found to be important in the process of pour-flush toilet adoption and these were classified as drivers or barriers. The initial analysis concluded that only a few drivers and barriers initiated or hindered adoption. Drivers and barriers were, therefore, considered as latent factors that were present during the whole adoption process. Many of them did not affect the ultimate adoption decision at the case study site, but over time some factors started to function as triggers and initiated adoption, due to changed attitude or characteristics (e.g. a violent assault nearby or age of daughters). Drivers triggered adoption when their relative importance increased and some barriers initiated adoption when they were lowered or removed. In addition, some barriers blocked the adoption process (instead of just slowing it down), and constituted veto-barriers (Table 8). Triggers were linked to motivation to implement a pour-flush toilet. For example, some households were directly motivated to implement a bathroom when they moved permanently to a house lacking a toilet. Other households lived for several years without a bathroom and they first got triggered and motivated to implement a bathroom when they performed other housing improvements. In contrast, veto-barriers were connected to lack of opportunity and ability to adopt. The veto-barriers were, for instance, physical construction constraints or a sick family member that hindered sanitation improvements. Removal of veto-barriers did not imply immediate adoption; it rather enabled the user to continue the interrupted adoption process. Note that it was the factors that functioned as triggers and veto-barriers that clearly separated different adopters.

*Table 8 Triggers and veto-barriers determine the adoption process (Adapted from **Paper IV**).*

Categories	Factors	Explanation
Triggers	Permanent move to a new house lacking toilet	Pour-flush toilets are seen as indispensable by some, especially by those with much previous experience of waterborne toilets
	Timing with other housing improvements	Housing improvements lead to the prioritization of sanitation and/or a decrease of the cost for sanitation adoption
	Introduction of targeted savings and lending schemes	Some NGOs and banks directly propose financing schemes to households to make funds available for sanitation implementation
	Price incentives	Availability of subsidies affects affordability and willingness to pay (e.g. co-financing from NGOs)
	Insecurity for daughters	Fear of assaults and animal bites when practicing OD and perceived hygienic danger of using dry pits for females
	Lack of space for latrines	Insufficient space for latrine construction force adoption (at the study site latrines are usually moved when full instead of emptied and require therefore more space than pour-flush toilets)
Veto-barriers	Physical construction constraints	Physical characteristics of the site that block adoption (steep slopes etc.)
	Severe illness	Affects the ability to adopt through less finances and limited possibility to self-construct (e.g. alcoholism, chronic illness)
	Despair	Some people give up before trying to adopt due to difficult circumstances (poverty etc.)
	Extreme machismo	Hinder the decision power of women who want to adopt

Based on adoption time and common triggers and veto-barriers, the included informants were divided into the following adoption groups by Rogers (2003): first adopters (<1 year), early majority (1-6 years), late majority (7-11 years), laggards (≥12 years) and non-adopters. Note, however, that what Rogers (2003) calls innovators are referred to as first adopters since the adoption of pour-flush toilets was not considered an innovation in the context of Cochabamba. Early adopters were fused into the group early majority. In addition, the presence of veto-barriers that block adoption for some households suggest that adoption will not reach 100 percent without targeted intervention. Hence, a non-adopter category was added to the framework in order to include unsuccessful cases of adoption. All the adoption groups were assumed to adopt sanitation over the course of time, except for the non-adopters that due to the presence of veto-barriers needed targeted interventions that helped them to overcome the present veto-barriers. Within each adoption group specific adoption patterns were noted with corresponding triggers or veto-barriers. In addition, comparison of the socio-economic characteristics of the informants and adoption groups found examples of common differentiating characteristics among the informants within the same adoption group (Figure 14). The adoption groups were aimed to be applicable for pour-flush adoption outside this case study, although the adoption time and distribution of informants might not be representative.

This paper highlighted the importance of triggers and veto-barriers for increasing access to safe sanitation services. The active adoption decision was the main rate-determining stage and all informants, except for non-adopters, had both the ability and opportunity to adopt a pour-flush toilet, but the majority did not adopt immediately. They needed to be pushed or pulled into action. The developed adoption framework for pour-flush adoption can be used to target specific household groups within sanitation programs and thus speed-up access. The adoption time may be shortened by activating the triggers that are characteristic for each adoption group. The identified adoption groups with common triggers and veto-barriers, therefore, enable customized policies and sanitation programs. First adopters do not need external

motivation campaigns or support, since they will adopt sanitation independently of external initiatives. Early majority, late majority and laggards may be triggered to adopt faster than they normally would have. For example, it would be fruitful to coordinate programs regarding housing improvements with sanitation initiatives. Laggards only adopt when they are forced to, so this group will probably be difficult to reach, but they might be triggered by enforced legislation and control. Non-adopters, on the other hand, need special attention due to lack of ability and opportunity. Due to other challenging aspects of life, which shadow the prioritization of sanitation, they do not adopt any improved sanitation system. To reach this group it is important for sanitation programs to collaborate with other social service, such as health care and family counselling.

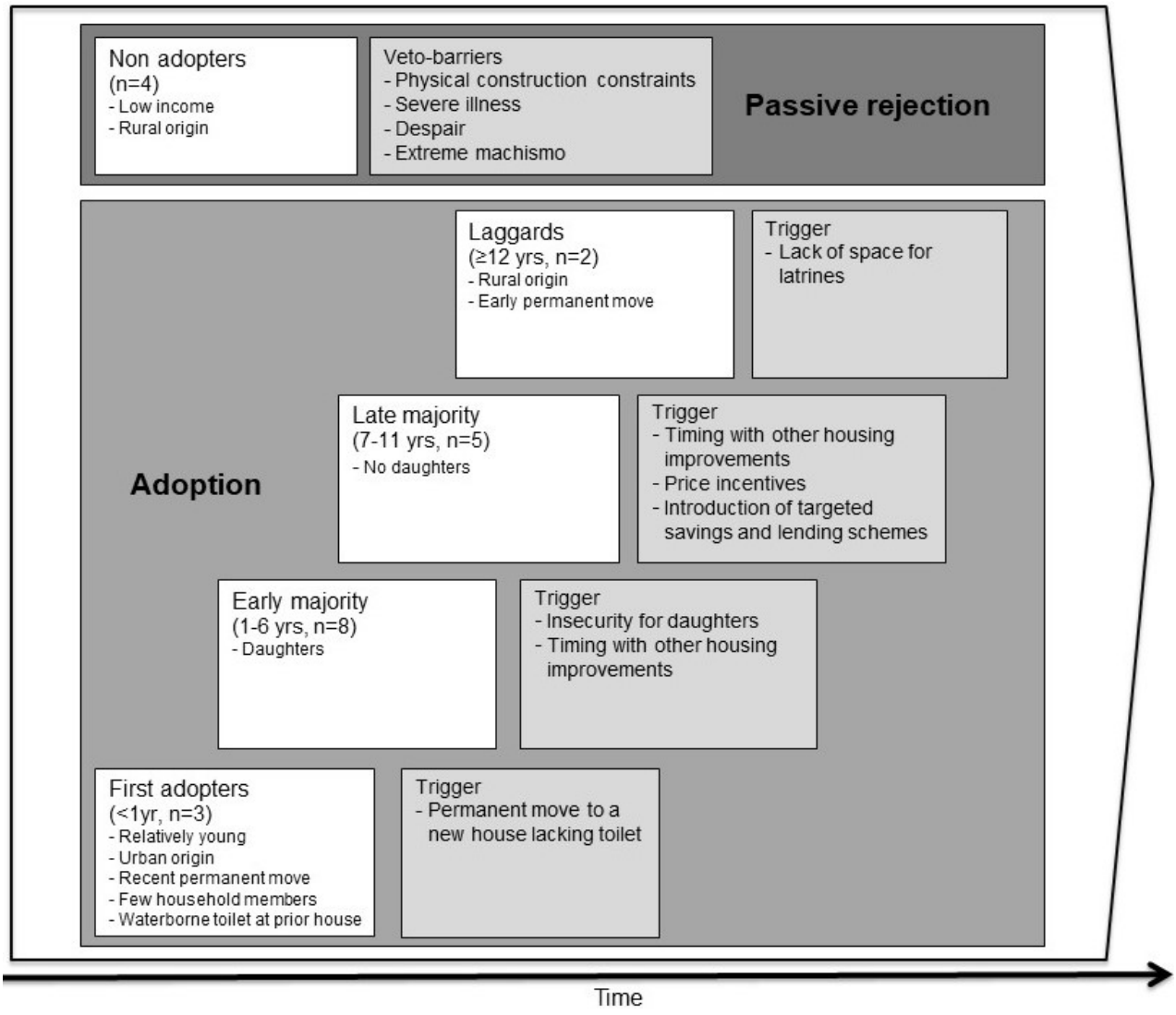

*Figure 14 Adoption groups, including respective triggers or veto barriers and differentiating characteristics (**Paper IV**).*

6 Discussion

This chapter briefly summarizes the conclusions of the included papers, as well as connects back to the respective research questions. At first the legitimacy of the selected research approach is reviewed to increase the credibility and relevance of the results (Flick, 2009; Yin, 2009). This is then followed by discussing this thesis' contribution to existing theory and practical implications for the development sector. Finally, suggestions for future studies that would strengthen the presented results further are given.

6.1 Review of the methodology

The qualitative research design of this study enabled research initiation with relatively open research questions and a broad research scope. The explorative character then made it possible to identify extreme embedded cases that were unique for the Kanata metropolitan region. In line with qualitative research procedures, the author stayed open towards potential findings (Suddaby, 2006; Eisenhardt, 1989), i.e. she took advantage of the flexibility of qualitative studies (Maxwell, 2005; Eisenhardt, 1989). For example, along with the data collection it became evident that CBOs and individual households played an important role for water and sanitation provision in the Kanata metropolitan region. Due to this the initial broader stakeholder focus (**paper I**) were limited to CBOs and individual households (**paper II-IV**).

The included embedded case study sites were aimed to represent extreme cases that included both successful and unsuccessful experiences of community management and adoption of household sanitation. The geographic settings and socio-economic data also varied for the embedded cases. In addition, the selection was influenced by the willingness among the residents to share their life experiences, i.e. trust for the author. The data collection depended on informants that were eager to "teach" the author about water and sanitation issues, since in-depth and comprehensive data collection requires that trust is established between the informants and interviewer (Hammersley and Atkinson, 2007). To minimize the subjectivity, the research approach was continuously reviewed and established recommendations regarding qualitative studies and procedures were followed (Flick, 2009; Yin, 2009). In addition, the quality of this research was evaluated through the use of the following quality criteria outlined by Yin (2009): construct validity, internal validity, external validity and reliability.

Construct validity calls for the use of adequate data collection measures, i.e. minimization of subjective data collection. Due to this, multiple sources of evidence were used in this thesis and established data collection methods were followed. It was important to accommodate the collection procedures to the goals of the distinct papers, as well as to the different study contexts and their informants. For example, different types of interviews were used in the respective papers in order to accommodate to the specific informants and their respective knowledge and experiences. In addition, to increase the construct validity, the key informants were also asked to validate parts of the collected data before the main analysis (Flick, 2009). Overall, the study aimed to present a clear chain of evidence, i.e. enable the reader to understand how and why the respective results were concluded (Gibbert et al., 2008).

Internal validity concern explanatory studies and the establishment of causal relationships (Yin, 2009). To fulfil this, this study aimed to include detailed information on the analysis procedures, as well as develop new theory and insights that was supported by all the empirical evidence (Eisenhardt, 1989). This led to detailed descriptions of the data analysis in the respective papers. In addition, all collected data that was relevant for the research questions of the respective papers was included in the data analysis. It also included to stay open towards contrary findings that were not expected or in line with other collected data. For example, surprising and contradicting evidence was especially noted and listed during both the data

collection and analysis in order to not be forgotten. This list was then taken into account and scrutinized during the data analysis. For example, the developed frameworks in this thesis are broad enough so that they are supported by all informants and observations. Relevant alternative explanations that contradicts them were not found.

External validity refers to the domain to which the results can be applied, i.e. if the findings are valid elsewhere, outside the study context (Yin, 2009). To develop findings that were valid for the case study site of the Kanata metropolitan region, distinct cases and a wide range of informants were included in this thesis. As written above, parts of the collected data were also validated by key informants. In addition, the results of this thesis also aimed to bring learnings to similar contexts through selection of a typical case (Yin, 2009), i.e. the water and sanitation sector of the Kanata metropolitan region can be seen as characteristic for low and middle income cities. It is, however, important to bear in mind that this type of studies cannot be subject to statistical generalizations.

Reliability, according to Yin (2009), implies that a study can be repeated and conclude the same results, i.e. decrease errors and biases. To fulfil this, it was important to describe in detail how the data was collected and analysed, i.e. the methods in the respective papers are aimed to be as clear and transparent as possible. In addition, references to the used methods are provided in the respective papers. Note, however, that in practice, repetition of case studies is difficult (or impossible), since they include real-life cases. It is, however, important to be transparent with the key features of the data collection and analysis (Eisenhardt, 1989).

In addition to the outlined quality criteria in case study methodology, literature is emphasized as crucial for high-quality research. The inclusion of literature is, however, easily neglected or forgotten in qualitative studies, as a result of the flexible and open research approach (Dubois and Gadde, 2002; Suddaby, 2006; Flick, 2009; Yin, 2009). Due to this, literature searches were performed at all stages of this research. Literature was incorporated at the initiation of this thesis, as well as throughout the research process as a way of reviewing the content and direction of the thesis. In addition, literature was used to checking the validity of the results, such as the developed frameworks (Gibbert et al., 2008).

6.2 Contributions to theory

In this thesis transition studies were initially used to understand the development of the water and sanitation sector of the Kanata metropolitan region. This highlighted that there was not one delivery approach that was appropriate, instead various delivery modes and actors complemented each other over spatial boundaries and time. Secondly, community management and adoption of household sanitation that had been found to play a crucial role were studied in-depth. The contributions to these respective knowledge fields are outlined below.

6.2.1 Transition studies and regime analysis

The aim of **paper I** was to contribute to filling the knowledge gap regarding ST regimes and their development (Holtz et al., 2008; Fuenfschilling and Truffer, 2014; Fuenfschilling and Binz, 2018; Geels, 2018; Köhler et al., 2019), especially for low and middle income countries (Hansen et al., 2018). In agreement with recent studies, such as van Welie et al. (2018), it was concluded that transition studies need to allow for multiple service regimes that operate in parallel, either co-existing or competing. **Paper I** identified municipal, community and individual regimes in the Kanata metropolitan region, but these regimes may also be relevant for other settings, since they represent distinct governance structures that are all widespread in low and middle income cities. They do, however, differ from the service regimes identified by van Welie et al. (2018) that instead distinguish service regimes based on technology type. In

addition, **paper I** also highlighted the need to separate between water and sanitation regimes. In the Kanata metropolitan region there are great differences in both coverage levels and weaknesses between the respective water and sanitation regimes.

Furthermore, an analytical framework, adapted from Fuenfschilling and Truffer (2014) and McConville et al. (2017), for assessing regime strength and identify opportunities for improvements was developed in **paper I**. The identified regime weaknesses implied opportunities for transition to universal access to safe water and sanitation services. Each regime included several weaknesses, i.e. various ways to initiate regime change and transition. It should, however, be noted that processes at different levels and scales reinforce each other (Geels 2012). There might be need for various intervention programs that together trigger a shift in the water and sanitation regimes. The findings of **paper I** also contributes to increased understanding regarding the full service chain for water and saniation services in low and middle income cities (Srivastava et al., 2019). The regime analysis gives a detailed understanding of the diversity of the existing water and sanitation provision in low and middle income countries, especially for the urban poor. It highlights all service providers, including the alternative actors that mainly serve low-income areas.

6.2.2 Community management

There are many studies that list important factors for well-functioning community-managed systems (Hoko and Hertle, 2006; Tigabu et al., 2013; Alexander et al., 2015), but fewer studies that develop general patterns and explanations to the existence and functionality of community managed water and sanitation systems (Allen et al., 2010; Mandara et al., 2013; Satterthwaite et al., 2015; Das, 2015; le Grand and Zoomers, 2017; Kumar, 2018). The studies presented in **paper II** and **III** tried to contribute to filling this knowledge gap. In addition, these papers tried to extend theory-building regarding community management to self-initiated community-managed systems in urban areas. The majority of current studies focus on community-managed systems which have been initiated by external development programmes in rural areas (Alexander et al., 2015; Chowns, 2015; Hoko and Hertle, 2006; Tigabu et al., 2013). Although, support to self-initiated community-managed systems would have the potential to rapidly increase access to safe water and sanitation services in urban areas.

Paper II developed a framework that identified internal prerequisites and enabling factors, which were connected to distinct phases over time: initial implementation, long-term operation and subsequent improvements. All of the prerequisites, i.e. leadership, agreed vision, management and collective action, can be found in various publications, but they are not grouped together as in **paper II**, nor linked to distinct phases. Leadership is supported by studies on local governance of water resources (Huntjens et al., 2012; Hutchings et al., 2015; Kyessi, 2005; Ostrom, 2011) and sanitation systems (Dickin et al., 2017), as well as work on change within organizations (Al-Haddad and Kontour, 2015; Kotter, 2012). An agreed vision, i.e., having a clear aim that contributes to reaching it, is a widely recognized prerequisite for change (Haque et al., 2016; Jaros, 2010; Parish et al., 2008). Collective action is supported by research on governance of common-pool resources, such as that of Ostrom (2011). In addition, there are various studies that focus on specific elements of collective action that are seen as crucial for change processes (Roberts and Portes, 2006; Al-Haddad and Kontour, 2015). The need for management for long-term operation is also widespread knowledge and supported by much literature (Hoko and Hertle, 2006; Tigabu et al., 2013; Alexander et al., 2015). The framework, including internal prerequisites and distinct planning and management phases, bring all these important factors together and lead to an overall understanding of community management. It is based on the Kanata metropolitan region, but due to the similarities with other low and middle income cities, it also bring important learnings to similar contexts.

Many studies emphasize the importance of the societal and political landscape for widespread community management, including the interaction and/or co-existence of distinct water providers (Marston, 2014; Chowns, 2015; Hutchings et al., 2015; Prabhakaran et al., 2016; Allen et al., 2017; Cabrera, 2018), but fewer studies specify what links and aspects outside of the CBO that actually are important. **Paper III** tried to contribute to increased understanding regarding external factors and their effect on communal wastewater management. At first, the importance of a common vision for the acceptance and expansion of community-managed wastewater systems were highlighted. In addition, nine external facilitating factors were identified as crucial for the implementation and operation of communal sanitation services. The findings of **paper III** can be considered as an important contribution to theory regarding communal wastewater management and its links to external factors, especially due to its focus wastewater management that have received much less attention than community-managed water systems (Mara et al., 2010; Isunju et al., 2011; Banana et al., 2015).

The separate focus on internal and external factors in **paper II** and **III**, respectively, contribute to a holistic understanding of community management. Together these papers aim to identify the crucial elements of external support programs. External support, such as technical training and financial support, are often highlighted as important for community-managed systems (Calzada et al., 2017; Foster, 2013; Harvey and Reed, 2006; Hutchings et al., 2015), but there are no agreed consensus regarding crucial components of external support programs (Miller et al., 2019). **Paper II** and **III** together lay the groundwork for theory-building. The internal prerequisites in **paper II** point out what is actually needed, whereas the external facilitating factors in **paper III** highlight factors that make the implementation and operation of community-managed systems easier. Note, however, that **paper II** studied community-managed water and sanitation systems, whereas **paper III** focused on communal wastewater systems.

6.2.3 Adoption of household sanitation

The role of households in sanitation adoption is increasingly recognized as important (Mara et al., 2010). It is, however, crucial to increase the in-depth understanding regarding what constitute demand (Jenkins and Scott, 2007; Whittington et al., 2012). The study presented in **paper IV** tried to fill this gap. First, waterborne toilets were identified as the only desirable sanitation alternative at the study site. While many studies assume this as self-evident, this paper made this conclusion explicit. Secondly, an adoption framework that included adoption groups that were connected to specific triggers or veto-barriers was developed.

Many studies have listed drivers and barriers (Jenkins and Curtis, 2005; O'Loughlin et al., 2006; Rodgers et al., 2007; Devine, 2009; Keraita et al., 2013; Sara and Graham, 2014; Gross and Günther, 2014; Obeng et al., 2015). There have also been attempts to determine the relative importance among drivers and barriers for improved sanitation. For example, Okurut and Charles (2014) found cleanliness, health and hygiene and privacy to be key motivations and topography and lack of money represented the main barriers at the selected study sites. In addition, Lagerkvist et al. (2014) emphasized personal safety, avoidance of discomfort, cleanliness and convenience of children as especially important drivers. These drivers and barriers were all found in **paper IV**, but instead of listing drivers and barriers for adoption of household sanitation, an adoption framework was developed. This framework only includes the drivers and barriers that actually initiate, respectively, hinder sanitation adoption, i.e. triggers and veto-barriers. It therefore gives a more holistic understanding of implementation of household sanitation than listing of drivers and barriers. It clearly contributes to increased understanding regarding the processes behind changes in sanitation coverage.

6.3 Practical implications

In line with others, such as Rijke et al. (2013) and Misra and Kingdom (2019), this thesis claims that a mix of approaches and actors are needed to rapidly speed-up the access to water and sanitation services. Today, planning efforts do, however, typically fail to acknowledge the important role of alternative actors, such as CBOs and individual households. Instead, they focus on municipal and state actors (Srivastava et al., 2016). To change this, new knowledge needs to be incorporated into the current urban planning processes. The developed frameworks in thesis are part of this new knowledge that can be used as a guiding tool for policymakers and development practitioners that want to support alternative actors.

The analytical framework for assessing regime strength in **paper I** can guide and support policies and development programs that aim to strengthen multiple regimes, as well as specific service regimes. For example, in the Kanata metropolitan region, improved financing structures, involvement of the public, increased transparency and faster connection of low-income neighbourhoods would strengthen the municipal regimes. The community water and sanitation regimes would be strengthened by standardized technical solutions and more effective social coordination. Furthermore, the individual water and sanitation regimes would be strengthened by various measures, such as inclusion of private actors in supportive policies, technical training and financial support to improve the quality of the service and decreasing the costs for poor citizens. The identification of weaknesses, such as these, might be an important tool for policymakers and development practitioners. The analytical framework for assessing the regime strength and identify weaknesses may be adapted to other contexts and used elsewhere. In addition, regime analysis of the water and sanitation sector, facilitates identification of potential development scenarios. For example, in the Kanata metropolitan region, the municipal regimes will most certainly stay strong, but the future of the community regimes depends on how the common vision regarding the roles of CBOs as a formal service provider develops. The individual regimes are diminishing, but it is not likely that they disappear abruptly. Instead, there might be mixed approaches and partnerships between private and public actors.

The framework, including internal prerequisites and distinct planning and management phases, of **paper II** enables customization of external support to CBOs. Neighbourhoods need different support depending on which of the distinct phases they belong to, i.e. external efforts should focus on the missing prerequisite(s) for the respective phase. In addition, the external facilitating factors that are identified in **paper III** can also be used to support and strengthen communal wastewater systems. For example, collaboration initiatives between CBOs and municipal actors may be promoted by motivating a continuous dialogue between distinct actors, strengthening of formal and informal networks and trust-building activities. In addition, **paper III** points out the importance of a common vision for the acceptance of communal wastewater systems. In the Kanata metropolitan region, a common vision regarding the wastewater sector is missing. One way forward would be visionary exercises that involved all concerned stakeholders.

The developed adoption framework in **paper IV** can be used as a tool for designing policies and interventions that aim to accelerate the diffusion of pour-flush toilets. The identified adoption groups enable customized support programs. Early adopters do not need external motivation campaigns or support since they will adopt sanitation independently of external initiatives. Instead early majority, late majority and laggards may be triggered to adopt faster than they normally would have. For example, coordinating sanitation programs with housing improvements would probably have a positive effect on the sanitation coverage. All the informants (except for the group of non-adopters) adopted pour-flush when they were satisfied with their overall housing situation, or in parallel with other constructions. In

addition, may price incentives and targeted savings and lending schemes trigger the late majority to start constructing pour-flush toilets. Laggards only adopt when they are forced to, so they may not be triggered by demand programs. This group will probably be difficult to reach, but they might be triggered by enforced legislation and control. Particular attention should be paid to non-adopters facing veto-barriers and alternatives explored for removing these barriers. This group requires targeted interventions, especially programs that are coordinated with social services. In addition, **paper IV** highlighted that the strongly entrenched desire for a waterborne toilet must be recognized by sanitation planners. Alternative technology would require promotion, since the households already have a clear preference. While alternative wastewater collection and treatment systems should be explored, they should offer the same levels of comfort and convenience that users look for in a conventional waterborne system.

6.4 Future research

Future studies may include development and verification of the presented results through both qualitative and quantitative studies. Additional qualitative cases would increase the complexity and relevance of the theories that are built. Eisenhardt (1989) argue that inclusion of several cases benefits theory-building through enabling comparison and identification of patterns, i.e. cross-case patterns. For example, would additional case studies in other parts of the world and/or under distinct geographical settings and socio-economic characteristics develop the results of this thesis. It is, however, important to note that analytical generalization aim to develop theories that are empirically grounded, and that is not the same as statistical generalization. Instead, statistical testing imply checking whether a hypothesis/theory can be applied to a larger context or not (outside of the study sample). Quantitative testing of the results presented in this thesis could, for example, be randomized trials of CBOs managing communal services or conducting questionnaires with large groups of respondents in varying settings and contexts. Statistical testing, such as these, would widen the scope and applicability of the findings even further. It could also lead to highlighting of important characteristics that need to be fulfilled, if the distinct theoretical frameworks are to be valid. For example, if some of the results are only relevant for households and/or neighbourhoods of certain characteristics (e.g. income group, population density, type of housing and geographical settings).

One way to connect to the results of this thesis to quantitative data, such as socio-economic characteristics, would be to connect these results to already existing quantitative data. Currently, it is, however, difficult to find statistics for the regional and local level in many low and middle income countries, such as the Kanata metropolitan region. Some quantitative data is not openly published, and there is also too much information to go through online. In this thesis, the lack of data limited the understanding of the context, as well as the analysis, since the presented findings could not be connected to neighbourhood and household characteristics to large extent. One idea for future studies is to collaborate with other research projects. This would enable coordination and data sharing of quantitative and qualitative data between the different projects. In addition, increased collaboration with ministries and NGOs that collect and administrate statistics would also enable access to quantitative data that already has been collected. During the field work it was noted that some of the local actors had access to statistics and estimations that were based on internal communication between distinct actors. Many were, however, unwilling to share this type of data, due to future publications of their own. Furthermore, additional interdisciplinary collaboration platforms would be one potential solution to increase the access to statistics that actually exist. This type of platforms could aim for their members to share both experiences and data. Another alternative for inclusion of both qualitative and quantitative in future studies would be to perform qualitative data collection in combination with quantitative collection procedures, i.e. mixed methods research. For example, theories that are developed through qualitative methods can be tested and connected to quantitative data that is collected through surveys.

It is also important that future research include data on important issues, such as gender equality and democratization that are crucial to consider in water and sanitation projects. Women typically play a key role at the household level for access to water and sanitation (Satterthwaite et al., 2015; Angoua et al., 2018). In addition, they often play an important role for small-scale independent water providers, but this is typically not acknowledged by literature and policies, not even by the small-scale actors themselves (Alda-Vidal et al., 2017). Instead, women often have limited impact on CBOs and community management (McGranahan, 2015). CBOs may preserve existing inequalities and power structures within the served communities (Cleaver et al., 2005; Cleaver and Toner, 2006; Widmark, 2007). It, therefore, urgent to consider aspects such as participation and involvement on behalf of women in water and sanitation initiatives. In this thesis, important issues like these are excluded, due to the lack of data. It would, however, be interesting to connect the results of this thesis to issues regarding discriminatory practices, e.g. if the results that can be used to support CBOs benefit inclusionary practices or not. Widening the scope to important issues like these may also find important factors that would benefit inclusive community management that are now missing in the developed frameworks.

One way to investigate discriminatory practices, such as gender inequality and undemocratic procedures, within water and sanitation provision would be to apply the lens of intersectionality. This would enable reflection regarding exclusionary practices and lived experiences, rather than generalizations for the respective social groups (Hofmann, 2017; Castán Broto and Neves, Alves 2018). For example, women might experience structural barriers differently, due to differences in other socio-economic characteristics. Some informants, in this thesis, argued that the CBOs were used for personal gain, e.g. corruption and political power. There were examples of leaders that, after being leaders of CBOs, were offered jobs and political positions, due to pressuring the members to participate in political marches and the like. In addition, many informants stated that the members had, in practice, unequal access to the leader posts of CBOs, e.g. many women argued that it was difficult to get involved, due to cultural hinders and structural barriers. Other barriers involved hinders for residents with less education, e.g. illiteracy that makes it impossible to writing up notes etc. Some informants also expressed a fear to participate, due to risk of failure and public embarrassment. Gender issues were also highlighted as important for adoption of household sanitation. For example, many females were eager to implement sanitation facilitates, but without support from their partners it was be difficult. To include the perspective of intersectionality would be one way forward that would include these important issues that have been mentioned by some of the informants. It would aim to understand how different factors and aspects are interrelated, including their connections to exclusionary practices, instead of just listing structural and cultural hinders.

7 Conclusions

Urban areas constitute an increasing challenge for public service providers throughout low and middle income countries, due to rapid urbanization and population growth. Municipal enterprises fail to connect all citizens to their water and wastewater systems, often excluding low-income neighbourhoods. There is, however, limited in-depth knowledge regarding the development of water and sanitation sectors in low and middle income cities (Geels, 2018; Köhler et al., 2019; Srivastava et al., 2019). In addition, much literature argues that there is a lack of understanding regarding delivery approaches that serve low-income neighbourhoods (Allen et al., 2010; Satterthwaite et al., 2015; Calzada et al., 2017; Dickin et al., 2017). The first research question of this thesis was therefore the following: In what way do different population segments access water and sanitation services in the Kanata metropolitan region, Bolivia? **Paper I** found that there were three main ways for citizens to access water and sanitation service in the Kanata metropolitan region, i.e. municipal, community and individual regimes. CBOs that constituted the community regimes played an increasingly important role, especially during the last decades. Note, however, that the majority of the CBOs only managed water infrastructures. Wastewater management was typically considered to be the responsibility of municipal actors. It was also found that individual households played an important role for assuring universal access to safe sanitation services. There were many new and relatively poor neighbourhoods with high coverage rates of sanitation facilities.

Embedded case studies were used to answer the second research question: how and why are small-scale water and sanitation systems implemented, operated and improved over time? **Paper II** developed a framework, including internal prerequisites and distinct planning and management phases, that contributes to added knowledge regarding how and why community-managed water and wastewater systems are implemented, operated and improved over time. It highlighted the internal prerequisites that communal systems depend on. **Paper III** identified external facilitating factors that promote communal wastewater management through making implementation, operation and improvement of community-managed wastewater easier. It allowed for increased understanding regarding how community-managed wastewater systems are affected by the societal and political context in which they are located. **Paper IV** developed an adoption framework for household sanitation, i.e. it adds knowledge regarding why households implement sanitation facilities. It led to an in-depth understanding of the underlying adoption mechanisms through connecting distinct adoption groups with different triggers and veto-barriers. Note, however, that this second question was limited to community management and adoption of household sanitation, due to their importance for assuring universal access to safe water and sanitation services in the Kanata metropolitan region.

The results of this thesis may be argued to be context-dependent and valid only for the Kanata metropolitan region, due to the qualitative case study approach. The findings do, however, offer important learnings for similar contexts, since the selected case study is an illustrative example of urban water and sanitation management in low and middle income countries, i.e. a typical case (Yin, 2009). In addition to contributions to theory development, this thesis also brings important learnings to the development sector. The developed frameworks may be used by policy makers and development practitioners to strengthen specific service regimes, particularly the CBOs and individual households. The analytical framework for assessing regime strength may also be used to evaluate water and sanitation regimes and identify windows of opportunities, i.e. weaknesses that open up for improvements and transition to safe water and sanitation services for all. The results regarding community management enable customization of external support to CBOs that have or will implement communal water and sanitation systems. In addition, the adoption framework for household sanitation can facilitate sanitation programs, e.g. promotion campaigns

that trigger more households to adopt sanitation facilities and targeted interventions that facilitate sanitation adoption by the most vulnerable groups. To conclude, this thesis contributes to a holistic understanding of the underlying causes to the occurring coverage levels of water and sanitation services. It increases the knowledge regarding water and sanitation regimes in low and middle income countries, as well as unravels the roles of CBOs and individual households and their importance for speeding-up the access to safe water and sanitation services

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