Large-Scale, Small-Scale, and Hybrid Water Utilities in Cities of the Developing World: The Impact of Scale beyond “Economies of Scale”

D I S S E R T A T I O N
of the University of St. Gallen,
School of Management,
Economics, Law, Social Sciences
and International Affairs
to obtain the title of
Doctor of Philosophy in Management

submitted by

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from

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Dissertation no. 4191

Studentendruckerei Zürich 2013
The University of St. Gallen, School of Management, Economics, Law, Social Sciences and International Affairs hereby consents to the printing of the present dissertation, without hereby expressing any opinion on the views herein expressed.

St. Gallen, May 17, 2013

The President:

Prof. Dr. Thomas Bieger
For my parents
Georges and Lydia Vousvouras

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List of Abbreviations

$ Dollars

AAPS Autoridad de Fiscalización y Control Social Agua Potable y Saneamiento Basico de Bolivia

ADERASA Asociación de Entes Reguladores de Agua Potable y Saneamiento de las Américas

AIDS Acquired Immune Deficiency Syndrome

AM Before midday

ANDE Administración Nacional de Electricidad de Paraguay

ATC Average Total Costs

BOB Bolivian Bolivianos

BoP Base of the Pyramid

BRL Brazilian Real

C Costs

CAESB Compañía de Saenamento Ambiental do Distrito Federal

CAPA Cámara Paraguaya del Agua

CAPEX Capital Expenditures

CBO Community-based organization

CHF Swiss Francs

CIA Central Intelligence Agency of the United States of America

COPLAN Cooperativa Plan 3000

CORPOSANA Corporación de Obras Sanitarias de Paraguay

COSPHUL Cooperativa de Servicios Públicos “Humberto Leigue” de Santa Cruz

COTAS Cooperativa de Telecomunicaciones de Santa Cruz

cp. Compare

CRA Conselho de Regulação do Abastecimento de Água de Moçambique

CRE Cooperativa Rural de Electricidad de Santa Cruz

DAPSAN Dirección de Agua Potable y Saneamiento de Paraguay

EAWAG Eidgenössische Anstalt für Wasserversorgung, Abwasserreinigung und Gewässerschutz

e.g. For example

excl. excluding

ERSSAN Ente Regulador de Servicios Sanitarios del Paraguay

ESSAP Empresa de Servicios Sanitarios del Paraguay

etc. Et cetera
List of Abbreviations

FIPAG  
Fundo de Investimento e Patrimônio do Abastecimento de Água de Moçambique

FR  
Friday

GAF  
Governance Analytical Framework

GDP  
Gross Domestic Product

GEAM  
Organización “Gestión Ambiental”, Asunción

HH  
Households

HP  
Horse Power

HR  
Human Resources

ICEA  
Instituto para la Conservación de los Ecosistemas Acuáticos, Santa Cruz

IDB  
Interamerican Development Bank

IMF  
International Monetary Fund

incl.  
Including

ISO  
International Organization for Standardization

IT  
Information Technology

km(s)  
kilometer(s)

kWh  
Kilowatt per hour

m  
meters

MC  
Marginal Costs

MMAyA  
Ministerio de Medio Ambiente y Agua de Bolivia

MO  
Monday

MZN  
Mozambique New Metical

n/a  
not available

NGO  
Non-Government Organization

OPEX  
Operational Expenditures

PM  
After midday

p(p).  
Page(s)

PPP  
Public-Private Partnership

PR  
Public Relations

PVC  
Polyvinyl chloride

PYG  
Paraguayan Guaraníes

SA  
Saturday

SAEEP  
Serviço Autônomo de Água e Esgoto de Parauapebas

SAGUAPAC  
Servicios de Agua Potable y Alcantarillado de Santa Cruz

SAUR  
Société d’Aménagement Urbain et Rural

SEDAPAL  
Servicios de Agua Potable y Alcantarillado de Lima
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<td>Servicios Municipal de Agua Potable de Cochabamba</td>
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<td>SENASA</td>
<td>Servicio Nacional de Saneamiento Ambiental del Paraguay</td>
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<tr>
<td>SME</td>
<td>Small- and Medium Enterprises</td>
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<td>SOE</td>
<td>State-owned enterprise</td>
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<td>TÜV</td>
<td>Technischer Überwachungs-Verein</td>
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<tr>
<td>UN</td>
<td>United Nations</td>
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<td>UNICEF</td>
<td>United Nations International Children’s Emergency Fund</td>
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<td>US</td>
<td>United States of America</td>
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<td>USAID</td>
<td>Federal Aid Agency of the United States of America</td>
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<td>USD</td>
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<td>VAT</td>
<td>Value added tax</td>
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<td>VIPFE</td>
<td>Viceministerio de Inversión Pública y Financiamiento Externo de Bolivia</td>
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<td>WASH</td>
<td>Water, Sanitation, and Hygiene</td>
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<td>WHO</td>
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<td>WSP</td>
<td>Water and Sanitation Program (administered by the World Bank)</td>
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Abstracts

English
Despite the strong presence of small-scale suppliers in developing countries, urban water planners have preferred large-scale monopolies. Typically, the decision to use large suppliers is justified with economies of scale of supply and transaction costs in regulation. This study challenges the validity of the natural monopoly argument for urban water sectors, revealing with an analysis of two large-scale and two small-scale water utilities in Santa Cruz; Bolivia, and Asunción, Paraguay, that in the long run, operational costs and operational complexity have more impact on performance than do infrastructure investments. Therefore, a shift in focus towards capabilities is suggested, to balance the scale of operation with the low capability context of developing countries. Eventually, policy makers face a trade-off between supply and regulation costs. Large-scale systems typically have high supply and low regulation costs. In contrast, small-scale systems have low supply costs but require extensive efforts for regulation. A case study about formalized small-scale networks in Maputo, Mozambique, at last presents a hybrid model, with potentially low costs in both operation and regulation. This hybrid model relies on the decentralization of all supply-related tasks and the centralization of all transactions between operators and stakeholders under the umbrella of franchise platforms.

Deutsch
Español

Pequeños operadores de redes de abastecimiento de agua se encuentran ampliamente diseminados en los países en vías de desarrollo. No obstante, la operación en gran escala por monopolios domina la agenda de expertos. Los monopolios están justificados con economías de escala en la operación y con altos costes de transacción en la regulación. Esta tesis cuestiona la aplicación de “monopolios naturales” a la gestión de redes de agua en zonas urbanas. Se demuestra al ejemplo de dos grandes y dos pequeños operadores en las ciudades de Asunción y Santa Cruz que los gastos operacionales y la complejidad operacional tienen a largo plazo una mayor importancia que las inversiones en infraestructura. Por lo tanto, la tesis propone reenfocar el centro de atención en capacidades, los “capabilities”. En este marco, el tamaño de la operación de sistemas de agua se debería realinear al generalmente bajo nivel educativo en países en vías de desarrollo. Sin embargo este resultado causa un conflicto entre costos de operación y costos de regulación. Sistemas de gran escala se caracterizan por altos costos de operación y bajos costos de regulación. Por el contrario, los sistemas de pequeña escala se distinguen por bajos costos en la operación y altos gastos en la regulación. Ante este contraste, un modelo híbrido con bajos costos en la operación y regulación es presentado finalmente en base de un estudio sobre pequeñas redes formalizadas de agua en Maputo, Mozambique. Este modelo implica la descentralización de los procesos internos de abastecimiento de agua y al mismo tiempo la centralización de las relaciones entre los operadores y el entorno (gobierno, mercado financiero, proveedores) bajo el techo de una franquicia de agua.
Preface

In 2010/2011, I had the opportunity to participate in a consulting project analyzing private sector participation in water sectors at the Base of the Pyramid.¹ Travelling across different countries in Africa and Latin America, I was first shocked to observe how much people in southern regions of this planet struggle for access to safe water. Born and raised in Switzerland, I had always taken access to safe tap water for granted. The only significant water problems I remember occurred during my regular summer vacations in Greece, when my parents warned me against drinking tap water.

After my initial shock about the water situation on my journeys through Malawi, Kenya and Bolivia, my pessimistic attitude gave way to a positive one, and I became fascinated by the variety of solutions that private, small-scale entrepreneurs and community self-help groups have developed to overcome gaps in water access and water quality.

I was particularly fascinated by a young entrepreneur, Gustavo Heredia, in Cochabamba, Bolivia, who was the third-generation manager of a family business, a water pipes factory. In Cochabamba, more than 300,000 people, mostly internal migrants, have no access to the network of the main water utility SEMAPA. In 2000, the inequitable distribution of water caused major riots that resulted in the termination of a private concession contract. Heredia, however, never perceived the influx of migrants as a threat to the city infrastructure but rather as an opportunity for his business to grow. He started to build and sell small-scale water networks to communities of 140 households. The networks were managed by trained community members and could be connected at a later stage to the network of Cochabamba’s main water supplier, SEMAPA. In summary, Heredia’s model seemed to perfectly fill a demand-supply gap.

So why did a single entrepreneur, in cooperation with small communities, succeed in ensuring sustainable water access for low-income populations after several large-scale utility companies, public and private, failed to do so? As I investigated further, I discovered that the situation in Cochabamba was not as unique as I had expected. In fact, according to World Bank data, around 50% of urban Africa and around 25% of urban Latin America rely on small-scale water suppliers, including mobile water vendors, standpipe systems, and small-scale water networks.

On another journey to Brazil’s capital Brasilia, I met Cesar Augusto Rissoli, a manager at the CAESB water and sanitation company. In the 1990s, CAESB radically changed the architecture of its sewage network from a centralized, technology-driven concept to a modular, demand-driven concept (more information

¹ For more information, download the publication “Access to Safe Water for the Base of the Pyramid” on http://www.hystra.com.
later). Cesar showed me some impressive pictures from different living environments in urban Brazil, amongst them the favelas of Rio de Janeiro and the shanties along the Amazon riverbank in the city of Manaus. He asked me then: “Having seen these images, do you still think we can work here in the countries of the south with one standardized distribution model that was developed for the well-structured living maps of cities in the north of this planet? No, our cities and societies are different. We need models and technologies that fit into our reality!”

Against this background, this thesis challenges the view that large-scale monopoly supply is necessarily the best provision model, independent from the context cities are embedded in. It analyzes why in some areas of the developing world small-scale operators have been more successful in extending their networks to a broader population. I have become convinced over the course of the last three years that the urban reality in developing countries, with all of its geographical, social, and financial contradictions, requires the development of tailored water supply models in order to provide safe water for the “last billion” urban residents.

The thesis starts with an empirical problem statement, followed by a review of theoretical concepts that leads to the research question. The third chapter establishes the methodological basis for the case studies, including a definition of performance. The fourth chapter presents the results of the first series of case studies. I studied two operators, ESSAP and YBU, in Paraguay’s capital Asunción, and two operators, SAGUAPAC and COOPLAN, in the Bolivian city of Santa Cruz. The fifth chapter evaluates how the empirical findings from the field measure up to theory, particularly to the concepts of “economies of scale” and “transaction costs”. Chapter six then presents two hybrid urban water systems, SAEEP from Parauapebas (Brazil) and FIPAG systems from Maputo (Mozambique), as an alternative to large-scale and small-scale supply. Chapter seven elaborates on the basis of chapter six platform-managed small-scale utilities as an interesting third model beyond large-scale and small-scale supply.

But, before leading into the discussion, I would like to take the opportunity to express my acknowledgments to my family, in particular Carla and my parents, for their support, even during the most critical moments over the last four years. I also thank my supervisors, Corinne A. Pernet and Rolf Wüstenhagen at the University of St. Gallen and Bernhard Truffer at EAWAG, for critically backing the research project from the initial idea to the final results. This research project has been co-hosted by the aquatic research institute EAWAG. I am grateful to Heiko Gebauer for his comments and recommendations along the process. Moreover, I have felt privileged to enjoy the financial and administrative assistance from the Latin American Center at the University of St. Gallen and the SNF ProDoc program “The Dynamics of Transcultural Governance and Management in Latin America”. I dedicate a special “thank you” to Paula Burt and Chiaki Kinjo from AVINA as well as to João Miranda for co-organizing my interviews in Asunción, Santa Cruz, and Parauapebas. I also express my gratitude to Skyler Collins for improving the English used in this text. Last
but not least, I thank everyone who generously contributed with information to this project. I have very much appreciated your commitment. Now, enjoy the reading!


1 Empirical Problem Statement

The challenges around urban water supply in developing countries comprise empirical and theoretical aspects. On the one hand, a considerable share of the urban population in developing countries struggles with quantity and/or quality problems. On the other hand, water supply research efforts over the last decades, mainly focused on a dichotomy between private and public operations, have not ultimately resolved the empirical issues. In this chapter, I present today’s major challenges in urban water sectors in developing countries from an empirical point of view, while the succeeding chapter discusses the shortcomings of mainstream theoretical contributions. Around 30% of the urban population in developing countries lacks on-site access to water, and 20% of of those who do have on-site access receive contaminated water.

1.1 Status Quo

Water is an absolute necessity. It constitutes the existence of every human being. People with no access to safe water have no lasting chance of survival and are deprived of any dignity.

But, six hundred eighty-eight million people, or around 20% of the worldwide urban population and around 30% of the people living in developing cities, lack access to piped-in, on-premises water. Thirty-eight million of them (8% of the regional, urban population) live in a Latin American city, 195 million (65% of the regional, urban population) in a Sub-Saharan urban center, and 406 million (29% of the regional, urban population) in a city in South or East Asia. Differences within regions are considerable. Costa Rica, for instance, covers 100% of its urban population with piped-in water compared to just 21% in Haiti. The positive development is that since 1990 urban water network operators have provided around 700 million additional residents with access to water in Asia, Africa and Latin America. Seventy percent of this growth has occurred in South and East Asia, 20% in Latin America, and only 5% in Africa. The negative message is that the global proportion of the population without access to on-site water either outside or inside a dwelling has remained constant at 20% over the last two decades. Due to population growth, the number of people without household access to water has in fact risen globally by 241 million, 35’000 every day. Fifty-five percent of this increase has occurred in South and East Asia and 33% in Africa. In Latin America, figures have improved, indicating that the entire population growth in this region has been absorbed by new connections (WHO & UNICEF, 2010).

Those who have household water access often suffer from a lack of quality of piped-in water - due to insufficient treatment at the source or re-contamination during transport and at the household level. Measuring water quality is tricky and laboratory analyses are (often too) expensive. Generally, experts distinguish between micro-
biological (viruses, bacteria, protozoa, etc.) and chemical pathogens (arsenic, fluorine, etc.) (Cavin, 2011, p. 4). In reality, there is hardly any water free of contaminants but rather water with different levels of contamination. While some individuals might immediately react to a low concentration of contaminants, others might only feel bad after drinking water from a highly polluted water source. UNICEF and the World Health Organization have created the “Rapid Assessment of Drinking Water Quality” framework which helps to assess the quality of water from different sources. However, among the 1’600 cases in six countries assessed, only 10% come from a sample at the household level. Results indicate that about 20% of piped-in water is not sufficiently safe. Projecting these figures on a global scale would imply that, among the 1.65 billion people with urban household water access in developing countries, around 350 million face constant problems with water quality (WHO & UNICEF, 2011).

Figure 1 – Magnitude of Water Problems in the Developing World

Source: Adapted from WHO & UNICEF, 2010

1.2 Implications

The aggregate studies of water access and quality problems show that about 1 billion people, or around 43.5% of the urban population in the developing world, do still not have permanent access to safe household water (Figure 1). This deficit has dramatic consequences on human health, most notably children’s health. Annually, about 1.5 million children under five, more than 4’000/day, die from the causes related to diarrheal diseases – which is more than from AIDS, malaria, and measles combined (WHO & UNICEF, 2009).

From a financial point of view, the lack of both safe water and sound sanitation is estimated to be responsible for annual health treatment costs of US $7.5 billion (Prüss-Üstün, Bos, Gore, & Bartram, 2008, p. 21); this number does not even include economic productivity losses resulting from missed school and work days.

2 The six countries are Jordan, Tajikistan, India, Nicaragua, Nigeria, Ethiopia.
The poverty trap, however, may be overcome with measures that improve sanitation, hygiene, access to water, and water quality. Interventions to increase access to water may reduce the disease burden by 25%, and efforts to improve water quality (both at the source and the point of use) lower an individual’s probability of becoming ill by 31% (Fewtrell, Kaufmann, Kay, Enanoria, Haller, & Colford, 2005).

Policy-makers have traditionally expected large-scale utility companies to step in. Unfortunately, the combination of high costs and low revenues often prevents these large-scale operators from offering reliable service to urban residents in developing countries. Typical inefficiencies include high physical water losses, low payment collection rates, overstaffing, and corruption (Singh, Mittal, & Upadhyay, 2011, p. 89; Schouten & Buyi, 2010; Asthana, 2003). Likewise, water tariffs charged to residents hardly reflect costs of service. A review of 132 cases in 2004 shows that no water network utility investigated in South and Central Asia and fewer than 50% of the operators in East Asia and Sub-Saharan Africa recover their total costs through money received directly from consumers (Global Water Intelligence, 2004).

It is important to find out why the predominant western concepts have not resolved the problems in developing countries to the same extent as they have done in developed countries. This thesis will show that the existing models were implicitly tailored to the reality of cities in developed countries such that they cannot be applied in the same way to developing countries.

First, in developing countries, wealth and income gaps within populations are big (Todaro & Smith, 2006, pp. 193-261). Certain developed countries, such as the USA, may also have a high GINI coefficient, but unlike developing countries, developed societies have enough financial strength to subsidize access for those who cannot afford to pay for water services. In developing countries, the financial budgets are instead more restricted. The inability of developing societies to cross-subsidize the water service for the poor excludes major parts of the population from basic services.

Second, conventional, large-scale networks are adapted to the tidy “chessboard” cityscape in developed countries. In contrast, a flyover photograph of the favelas of Rio de Janeiro on Google Maps reveals how city landscapes in developing countries can be chaotic and unregulated (C.A. Rissoli, Interview, 8 October 2012).

Third, differing qualifications within the human workforce also reflect differences between the developed and developing worlds. Whereas water companies in developed countries can source from a rich pool of highly qualified professionals,

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3 A high GINI coefficient expresses a high income or/and wealth inequality within a specified, territorial unit.

4 The World Bank groups countries into four categories: High-income economies (US $12'276+), upper-middle-income economies (US $3'976-$12'275), lower-middle-income economies (US $1’006-$3975), and low-income economies (<US $1’005). The last three segments refer to developing nations. Most Latin American countries fall into the two middle categories, whereas most Asian and most Sub-Saharan countries are listed among the two bottom groups (World Bank, 2011).
well-educated candidates in developing countries are relatively scarce and expensive (Todaro & Smith, 2006, pp. 363-421).

Fourth, water suppliers in developing countries often struggle with high levels of water scarcity. By 2030, around 50% or 3.9 billion people will live in an area affected by water scarcity (Lean & Geoffrey, 2009). The developing regions of Latin America, Africa, and South-East Asia (plus Australia) will be the areas most affected by water scarcity (International Water Management Institute, 2000).

Summarized, one should keep in mind the disparate conditions that water operators face in developed versus developing countries may be responsible for and justify the establishment of different theoretical models geared to different environments.
2 Theoretical Problem Statement

Over the last century, large-scale network suppliers have dominated the urban water landscape. However, because of the empirical shortcomings of large-scale supply, several waves of reform have emerged over the last thirty years. Public-private-partnerships are probably the most noted concept amongst those reforms. In the first two sections of this chapter, I discuss these different theoretical contributions and waves of reform, based on a review of more than 120 documents. As the existing theories and reforms have provided only limited knowledge for practical improvements, I shift with the third section the center of attention to the widely disregarded phenomenon of small-scale water supply. At the very end of this chapter, I will then formulate my research question.

2.1 Large-Scale Water Supply

Governments create large-scale suppliers often grounded on the idea of economies of scale in water supply. I added to this dominant concept two other theoretical arguments which are relevant to defend and explain beyond the objective of efficiency the existence of large-scale operators in practice (cp. Table 1).

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2.1.1 Natural Monopoly

A “natural monopoly” scenario and, linked to this, economies of scale, is probably the most frequently advanced argument for the running of large-scale water networks in cities (Nauges & van den Berg, 2008, p. 144; Solo, 1998). Even in highly rated student textbooks, water networks appear as a typical example of a natural monopoly (Mankiw, 2004, pp. 316-318). Natural monopolies provide products and services with marginal costs [MC] so low that the average total costs [ATC] decrease continuously with scale (“economies of scale”) (cp. Figure 2). The most important costs involved in
natural monopolies are fixed costs and, in particular, infrastructure costs. The only way to reduce costs is to increase scale. A single provider will always be able to deliver water at a lower cost than multiple operators can. Consequently, government regulation in cities should establish and protect a natural monopoly (Kim H. Y., 1987, p. 185).

Some scholars, however, contest the empirical validity of this argument. A study on 42 urban water providers in 28 municipalities in the Greater Seoul Area, for instance, finds significant economies of scale for twelve municipalities, constant returns on scale or slight economies of scale for twelve municipalities, and diseconomies of scale for four municipalities (Kim & Lee, 1998). Multiple other studies are not able to reject the null hypothesis of constant returns on scale or even perceive tendencies toward diseconomies of scale (Nauges & van den Berg, 2008, p. 145). Concerned with the ambiguity of results in studies examining the existence of economies of scale in large-scale providers, Youn Kim and Robert Clark tried to find out, in detail, how economies or diseconomies of scale in water and sanitation utilities emerge. Based on a sample of 60 water companies in the US, they concluded that economies of scale are more likely to appear in small providers with a high percentage of non-residential customers and with a geographically concentrated network. As explanatory factors that economies of scale appear in small rather than large providers, they highlighted for the latter high system losses, an expensive infrastructure, and high costs combined with low revenues for residential clients (Kim & Clark, 1988). These results mimic the reality of water networks in developing countries, where large-scale water operators in low-income contexts struggle with the same profitability issues concerning residential customers in peripheral/low-income areas of cities. Consequently, the fact that, in overall terms of efficiency, small-scale operators achieve better results than large-scale providers is not surprising (Kariuki & Schwartz, 2005, p. 27; Cowen & Cowen, 1998, p. 21).

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**Figure 2 – Natural Monopoly**

- ATC > MC
- \( C(x) < C(x_1) + C(x_2) + \ldots + C(x_n) \)
2.1.2 High Transaction Costs and Principal-Agent Problems

Appreciating the high social value of water, many societies expect governments to take a leading role in guaranteeing uniform water distribution and quality for citizens (Nauges & van den Berg, 2007, pp. 19-20; Cowen & Cowen, 1998, pp. 35-39; Solo, 1998). However, the model of multiple small-scale providers serving a city clashes with this expectation.

According to the principal-agent theory, human beings primarily try to maximize their personal benefits (Williamson O. E., 1973, p. 317). A water operator — the agent — could, for example, reduce the number of water quality lab tests from monthly to bi-monthly in order to save costs. The regulator, in contrast, also known as the principal, must ensure water quality. As a possible solution to this conflict of interest, the principal could increase the level of control. However, any transaction between two independent institutions, in this case the operator and the regulator, implies substantial costs of coordination, commonly referred to as “transaction costs” (Powell, 1990). These costs might be moderate in a town supplied by a single operator. However, in cities with multiple, partially informal, small-scale providers, the costs to control the sector can overwhelm the regulator’s budget. This risk is even more significant in developing countries, where financial resources for basic services are urgently needed. A lack of democratic control may ultimately diminish the reliability of service, the acceptance of service among citizens, and the environmental sustainability of the water sector.

2.1.3 Public Choice Theory

Public choice theory does not justify the existence of large-scale monopolies in urban water sectors, but it serves as a useful explanatory model for the prevalence of such monopolies. Methodologically emphasizing the individual, public choice theory perceives politicians as actors who permanently seek to maximize their personal interests. Unlike the “homo oeconomicus” who optimizes his financial status, politicians constantly strive for more power. In democracies, politicians receive their authority from the voters. As a consequence, their first concern is usually linked to the impact of particular actions on their election chances. Political policies, in contrast, are in Schumpeter’s tradition, only a by-product of politics (Mitchell, 1984; Mueller, 2004).

In the case of the water sector, several studies have made use of these concepts, relating, for instance, the inefficiencies of water utilities in developing countries to bureaucrats in public companies aspiring for more staff and higher budgets in order to become more influential (Schwartz, 2006, pp. 37-44). Similarly, other publications point out that, for politicians with short-term mindsets, the water sector serves as a powerful tool to gain votes when tariffs are systematically set below operating costs (Pollem, 2009, pp. 124-127).
Thus, from a public choice point of view, it would make no sense for a politician to apportion the water supply to different small-scale operators as such act could dilute his political influence on the sector. Even if the small-scale model proves more efficient for a particular city, politicians may continue to try to wield power over operations in the form of a single large-scale operator. Models different from the large-scale monopoly would therefore face, in line with public choice theory, heavy resistance from political interest groups (Solo, 1998).

2.2 Reforms to Large-Scale Water Supply

In response to the poor performance figures in developing countries, the model of bureaucratic large-scale supply has come under criticism over the last 30 years. Proposals for reforms have emerged. These reforms have primarily pushed for the introduction of market-based mechanisms to the water sector. Other proposals have included the vertical redistribution of responsibilities and tasks within the water sector.

2.2.1 The Bureaucracy Model

In developing countries, public institutions directly linked to the central government have traditionally owned, regulated, and operated urban water supplies. This model has received criticism for its low performance rates, with some policy-makers arguing that the mixture of politics with technical tasks creates conflict of interests which negatively impact performance (Braadbart, Van Eybergen, & Hoffer, 2007).

Bureaucratic institutions certainly face a lower risk of bankruptcy than do private institutions (Araral, 2008, pp. 529-533). As a consequence, bureaucrats have a reputation for seeking, in competition with other government branches, inefficient budget and staff increases (public choice theory), which represent greater privileges and importance (Schwartz, 2006, pp. 37-44). In this power and budget game, lower ranked departments benefit from an information advantage vis-à-vis higher bureaucratic charges (principal-agent theory) (Schedler, 2007, pp. 255-256).

Similarly, for opportunistic politicians, control of the water sector serves as a tool to gain votes via tariffs systematically set below costs. Consequently, in order to ensure long-term efficiency of water systems, it is necessary to separate operators and regulators both in financial and administrative terms from short-term political thinking. (Pollem, 2009, pp. 121-180).

Inefficient operations and low prices together constitute a fatal “low-level equilibrium” (p. 2) in which water providers lack money for extensions and maintenance of capital assets and customers feel reluctant to pay for the poor water service received (Spiller & Savedoff, 1999). As a remedy to these problems, reformers have proposed to separate the functions of ownership, regulation, and operation, thereby improving water sector performance through an incentive-oriented model (Schedler, 2007, p. 256).
2.2.2 Market-Based Reforms

The market-based mechanisms introduced in the water sectors of developing countries can roughly be divided into two categories: (1) public-private-partnerships and (2) efforts to create more institutional autonomy within the public sector.

2.1.2.1 Public-Private Partnerships

In the context of the “Washington Consensus” in the late 1980s and early 1990s, donor states and organizations started to link development aid to a market-liberal set of policy prescriptions, including, for instance, the privatization of state enterprises in the water sector (Williamson J., 1990). Profit-driven private actors were expected to facilitate new investments, the transfer of knowledge (Tati, 2005, pp. 316-317), and, most importantly, increased operational efficiency (Anwandter & Ozuna, 2002, pp. 687-688). For the privatization of the water supply, legislative, regulatory, and operational tasks are typically split between lawmakers, regulators, and private operators.

In the privatization process, the public sector and a private operator usually split tasks related to regulation and operation. The emerging contractual agreements between the two can differ in terms of ownership, scope of investment, time frame, and investment risks (Bayliss, 2003, pp. 508-516; Madhoo, 2007, pp. 91-99).

However, more than 20 years after the first wave of privatizations in the water sector, doubts about its impact have emerged. Around 39% of the private water supply investment projects were terminated early or simply expired – an indicator for a weak outcome – and around 17.5% had a mixed outcome (Marin, 2009, p. 26). Hardly any author can confirm a significantly better performance by a private water operator compared to public water operators – in Sub-Saharan Africa, Asia, or Latin America (Anwandter & Ozuna, 2002, p. 688; Madhoo, 2007, p. 99). Both public and private actors appear to struggle with inefficiencies that are unrelated to incentive-based structuring (Araral, 2008, p. 535).

2.2.2.2 State-Owned Enterprises

With the functional separation of asset management, regulation, and operations and the creation of financially and operationally independent state-owned enterprises [SOE], developing countries/cities can commit to market-based reforms in the water sector without contracting private market entities. The development of the SOE model stemmed from the dual challenges of the steady, opportunistic struggle for more power and higher budgets within bureaucratic institutions, which public choice theorists have described, and the singular profit-maximizing goal of private actors.

5 “Washington consensus” – is a reference to the Washington-based development organizations, most notably, World Bank, International Monetary Fund, US Government (represented by USAID), and the Organization of American States.
The success of the model requires that politicians, regulators, and the SOE itself function independently from each other in the most technical form possible (Pollem, 2009, pp. 121-180). Indeed, various quantitative and qualitative studies confirm the positive correlation between the autonomy of actors and the performance of water utility services (Braadbart, Van Eybergen, & Hoffer, 2007; Schwartz, 2006; Araral, 2008, pp. 535-547). But, political influences continue to heavily influence a majority of strategic decisions affecting the water sectors in developing countries. (Global Water Intelligence, 2004; Braadbart, Van Eybergen, & Hoffer, 2007).

2.2.3 Territorial Decentralization

Decentralization was another attempt to reform the water sector. The economic argument for decentralization rests on the basis of varying regional preferences and conditions (Pollem, 2009, p. 146; Blankart, 2003, pp. 563-566). Inhabitants of an arid region might demand, for instance, more water (e.g. for agricultural purposes) than residents in a humid area of the same country. Water providers in the former region should therefore consider pipes and production facilities of higher capacity than suppliers in the latter region. The consumer utility of the two groups would thus be higher if both regions regulated and governed a separate water system.

The case for decentralization in developing nations is more problematic than in developed countries. In low-income settings, administrative staff at the regional and especially at the local level often have low managerial and technical skills (Asthana, 2003, pp. 156-158). The scarce supply of qualified personnel typically prefers to work for the central government or in the private sector where career prospects and wages tend to be higher (Pollem, 2009, pp. 164-167). The combination of low-skilled staff, weak regulatory mechanisms, and political entanglements at the local level create an endemic situation in developing countries in which decentralization and corruption go hand in hand (Asthana, 2008). Estache and Kouassi (2002) show that corruption significantly decreases the efficiency of water companies. Multiple other quantitative studies on the decentralization of water sectors further indicate that the combination of weak managerial and technical capacities, a lack of effective monitoring systems, and widespread corruption at the local level worsens the performance of decentralized water suppliers (Abrate, Erbetta, & Fraquelli, 2010; Asthana, 2003; Anwandter & Ozuna, 2002).

Past decentralization efforts have, however, essentially ignored the culturally important community level in developing nations. Income, social, topographic, and further discrepancies do not exist only between different cities in developing countries but within cities (Solo, 1998). Districts where people live at standards comparable to

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6 Examples for the inclusion of communities in development practice and theory are: Group credits in micro finance; bottom up marketing design in the BoP protocol 2.0 (Simanis & Hart, 2008); Hernando de Soto’s characterization of communities as a replacement for law and order in informal environments (De Soto, 1992).
those of industrialized countries and other districts where people live in miserable shanties, lacking access to basic services, are often situated in close proximity in the metropolises of the developing world (Todaro & Smith, 2006). Performance often diminishes when responsibility for water is shifted from the national to regional or local levels. The question of what happens in developing communities when water providers operate further down at the community level remains however unanswered.

2.2.4 Impact of Reforms

In a nutshell, the mainstream research agenda has led to few improvements in the global water supply situation over the last 30 years. This is particularly true for the incentives-oriented approaches which focus on the inclusion of private operators as a simple remedy to past inefficiencies. Hardly any study has shown more efficient performance by private operators in comparison with their public counterparts. High- and low-performing examples of water supply services exist in both private and public sectors.

Only the separation of ownership, regulation, and operational functions within public or between public and private institutions has had a positive impact on performance. But, even if greater independence between functions seems to favor a positive development of urban water sectors; the list of failed privatizations and poorly working SOEs indicates that functional autonomy is a complementary but not a sufficient criterion for well-performing urban water sectors. The results of the recent reform efforts instead indicate a considerable empirical and theoretical potential for further improvements.

2.3 Theory Gap: Small-Scale Water Supply

The economies of scale theory predicts larger water networks to outperform smaller systems; however, the reality for developing countries often looks different with small-scale operators supplying large parts of cities.

In scientific and mainstream literature, little quantified empirical evidence exists on the prevalence of micro water operators. Most existing data is based on case studies for selected projects or cities. The majority of these publications were published by institutions actively involved in the projects rather than by qualified scientific authors in the form of journal articles, which require standardized peer-reviews before publication (Opryszko, Hauna, Soderlund, & Schwab, 2009).

The greatest effort in the field was performed by the World Bank between the late 1990s and the mid-2000s, and studied with a series of working papers the phenomenon of small-scale supply in developing countries. The most comprehensive
document is an article from 2005, which draws upon 400 documents with information on 10'000 small-scale water providers in 49 countries (Kariuki & Schwartz, 2005). The authors of the study claim that around 50% of urban Africa and around 25% of urban Latin America rely on small-scale water supply at the community level. In Latin America, small-scale solutions frequently take the form of piped systems, which deliver water to a few dozen or a few hundred households. In other regions, mobile distributors and point source systems dominate (Kariuki & Schwartz, 2005, pp. 6, 18-19; Kariuki & Schwartz, 2004, p. 8).

These differences in scale and form are usually attributable to variations in the legal framework, differing market opportunities, and the local availability of environmental, financial, technical, or other local resources (World Bank, 2009, p. 33; Solo, 2003, p. 8). In Mozambique’s capital, Maputo, for example, workers returning home from South Africa’s mines have utilized their accumulated financial wealth and technical expertise to build dozens of micro water networks in the city’s underserved districts (Blanc A., 2008).

In Latin America, variations of micro networks exist in Argentina, Paraguay, Chile, Colombia, Guatemala, Peru, Bolivia, Brazil, Ecuador, El Salvador, Honduras, Nicaragua, and possibly other countries (Dianderas, 2008; Melo, 2005). However, it appears that they have only come to scale in Asunción, Santa Cruz, and Guatemala City, where more than 50’000 households benefit from micro utility services (Solo, 2003, p. 11; Kariuki & Schwartz, 2005, p. 32).

The size of small-scale operators considerably varies between, but also within cities. Ninety-eight per cent of the small-scale networks in Maputo serve for instance less than 500 customers, but, 2% of such networks serve more than 500 customers which is roughly 19% of all customers (Blanc, Cavé, & Chaponnière, 2009, p. 14). In Asunción, the average network has 700 connections. Some systems reach up to seven thousand houses and the smallest operators manage around 100 connections (ERSSAN, 2012). The size of networks can moreover develop over time. In Santa Cruz, the water cooperative COOPLAN has grown in 25 years from 500 to 22’500 customers.

The World Bank defines small-scale businesses as enterprises serving fewer than 50’000 people, with fewer than 50 employees, and assets or sales below US $3 million (Kariuki & Schwartz, 2005, pp. 10-11). However, it is difficult to determine an unambiguous threshold for the term “small”. An average total cost curve for the entire industry of urban water network providers could possibly provide a good definition (cp. Figure 11). Any operator producing at a scale smaller than the lowest point of the curve would qualify as a small-scale operator, and any operator producing at a scale beyond the curve’s inflection point would qualify as a large-scale operator. Further, experts distinguish small-scale operators along the following three major criteria:

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7 The article also comprises small-scale electricity solutions and alternative forms of small-scale water providers, such as water trucks, push-cart vendors, and water kiosks.
- **Purpose of operation**: Micro networks are usually run either by private, for-profit initiatives (individual entrepreneurs, families, small firms, etc.), or non-profit community-based organizations [CBOs] (self-help groups, neighborhood associations, etc.). A study of nine countries in Central and South America identifies about twice as many CBOs than privately driven initiatives in the region (Dianderas, 2008, p. 33). Several studies, however, find that micro utilities managed by CBOs tend to work less efficiently and depend to a large extent on government or NGO grants—for infrastructure investments in particular—whereas entrepreneurs must rely on their own resources (World Bank, 2009, pp. 13, 42-44; Dianderas, 2008, p. 44; Kariuki & Schwartz, 2005, pp. 11-12,21). Private, for-profit networks often remain small, serving only some neighbors, while CBO projects are typically targeted for a larger audience from their conception (Kariuki & Schwartz, 2005, p. 20).

- **The degree of formality and regulation**: In fact, it seems that the majority of network operators are in hands of some type of official document that allows them to extract and/or sell water. A study of nine Latin American countries finds legal permissions for two-thirds of the investigated cases, and another publication covering small-scale operators in Bangladesh, Cambodia, the Philippines, and Kenya, identifies some degree of legality for three-quarters of the cases studied (Dianderas, 2008, p. 33; World Bank, 2009, p. 33). However, these figures erroneously create an illusion of legal security for micro utilities. In reality, the sector is greatly under-regulated, and hardly any countries embrace, much less encourage, the emergence of a micro utility sector over the long term. The respective legal frameworks in various countries give priority protection to monopolistic providers and simultaneously expose private investments to the risk of expropriation (Solo, 1998). Only CBOs enjoy, in countries, such as Bolivia, some official status (Solo, 2003, pp. 22-26; Dianderas, 2008, p. 33). The degree of formality should therefore be considered on a continuum from “no formality” at all, to “limited formality”, where legal papers exist, but provide only limited or temporary value, to “absolute formality”, which provides full protection under the law. Most current water networks would probably fall under the former of the two categories.

- **Dependency from third-party actors**: In terms of technologies applied and water sources chosen, a wide variety exists (World Bank, 2009, p. 34). In general terms, there are operators that source water directly from an independent source in nature (surface water, groundwater, springs, etc.) and others that supply and depend on bulk water from the main water utility in the city or even from other third parties (Kariuki & Schwartz, 2005, p. 12).
So, how have these micro networks in Latin America and other parts of the world been able to successfully fill the service gap left by large-scale utilities for so many years? Large-scale providers and regulators typically proclaim that small-scale suppliers offer an inferior service at a high price (Solo, 1998).

However, the World Bank study from 2005 compares the water tariffs of 1'000 small-scale and large-scale service providers, revealing comparable price levels in two out of three regions studied. Only in South Asia are tariffs, charged by micro networks, significantly higher (Figure 3). These results are surprising in view of the low-cost recovery rates enjoyed by large-scale water companies in developing countries – 30% of total costs in 1994 (Cowen & Cowen, 1998, p. 21) – and therefore suggest a superior efficiency of small-scale over large-scale operators.

Regarding quality, there is not much statistical data available studying the relation between the size and the service performance of water operators. From a theoretical point of view, one could believe that large-scale operators perform with a higher degree of professionalism and hence deliver a superior service. However, it is also true that large-scale operators often rely on surface water of low quality – to cover the large demand – whereas small-scale suppliers typically source ground water of good quality at the point-of-production. Also, large-scale operators in developing countries generally lose large quantities of water in distribution. In Latin America, for instance, 43.5% of the water produced is lost (ADERASA - Grupo Regional de Trabajo de Benchmarking, 2009). Leakages and a discontinuous flow of water are major factors for contaminated water at the point-of-use. Hence, at this point, it can only be assumed that varying quality levels appear to exist at both ends of the spectrum, independent from scale.

Figure 3 – Comparison of Tariffs between Large- and Small-Scale Utilities

Source: Kariuki & Schwartz, 2005, p. 27

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8 The gap may trace back to different levels of water quality and therefore different water treatment procedures between the regions.
Nonetheless, the success of small-scale operators in low-income areas and the rejection of previously mentioned preconceptions, particularly in terms of costs, may justify the hypothesis that small-scale networks can outperform large-scale networks – at least in certain dimensions. This study does not intend to statistically replicate this hypothesis, but takes a further step, analyzing how and why performance differences between small-scale and large-scale operators emerge. More specifically, it compares small-scale with large-scale operators in the same settings, emphasizing the dynamics between size and performance of network suppliers. So far, the scientific discourse in this area has been influenced to a large extent by the economies of scale theory, while the empirical evidence for developing countries gives results that point in another direction. This thesis analyzes from a managerial perspective the shortcomings of the economies of scale theory in practice and considers other theoretical models for a more comprehensive picture of urban water sectors in developing countries. Water policy makers need to make decisions on the number and type of operators that provide a city with water. The thesis is meant to help policy makers in coming to a more informed decision.
3 Methodology

Following the research question which emphasizes the impact of scale on the performance of urban water utilities in developing countries, I started to frame in a next step an adequate research design. This research design included the development of a research strategy, the selection of a sample, the preparation and realization of the data collection process and data interpretation, and the anticipation of potential weaknesses connected to the chosen methodology.

3.1 Research Strategy

In order to break with past preconceptions and to remain flexible in view of possible surprises in the field, I conducted research in an inductive manner. This means that I derived the theory step-by-step from my case study observations. To ensure reading comprehensibility, I will present my results inductively through five steps. Firstly, I will define a comprehensive performance cockpit for urban water network operators in developing countries. This process includes the determination of performance indicators for five performance dimensions. Second, I will analyze four case studies, including one large-scale and one small-scale utility in two cities. Third, I will compare and contrast the results with existing theory, demonstrating the ambiguity of some widely accepted theoretical concepts. Next, I will analyze two hybrid operators, with the goal of overcoming the shortcomings of the large- and small-scale water network models. Lastly, I will derive from one of the hybrid cases studied an alternative model which combines the advantages of both worlds, small-scale and large-scale.

3.2 Sample Size and Selection

As an analytical tool, I decided upon a case study design rather than a larger sample mainly for two reasons. First, the world of small-scale providers is partly informal. Due to restricted data availability, a “high n” analysis would have been difficult to conduct. Second, the empirical evidence presented in Figure 3 already indicates some performance gaps between large- and small-scale operators. Instead of simply collecting evidence supporting presumed relationships between quantified variables, this study’s purpose is to provide depth to presumed relationships by discovering how and why performance differences emerge.

A particular risk of the case study design concerns sampling biases in choosing the cases (Moses & Knutsen, 2007, pp. 11-114). Specific criteria therefore guided the selection of the six case studies. The first set of case studies had the goal of comparing performance differences – and their causes – between large- and small-scale providers. As water supplies involve inherently local characteristics, I had to pick a large-scale and a small-scale provider from the same city in order to make the results comparable. I identified three cities in Latin America: Guatemala City, Asunción, and Santa Cruz. In these cities, small-scale networks had reached
significant scale (more than 50’000 connections per metropolitan area). Small-scale networks can be split roughly into two categories: community-driven networks and private, for-profit businesses. In order to represent this variety in my study, I chose a city from each category. Santa Cruz possesses a strong sector of community-driven, small-scale networks while for-profit, small-scale operators provide broad coverage in Asunción. In order to avoid a bias towards large- or small-scale operators in the selection process, I tried to choose in each city “best-practice” cases for both large-scale and the small-scale providers. All four operators chosen in the first stage have received some distinction or award within the last ten years.\(^9\)

The second series of case studies includes one example from Brazil and one from Mozambique. It was the goal of this series to find Pareto-efficient projects with either lower costs of operation or regulation compared to the two standard models of large-scale and small-scale supply. I eventually found two projects that corresponded to this objective. I selected the case study on Maputo from a project database filled with around 150 cases, used in a former consulting assignment, and I chose the Brazilian case on recommendation from one of the thesis supervisors.\(^10\)

### 3.3 Data Collection and Case Analysis

In total, I completed six case studies. During two research trips conducted in June/July 2012 and September/October 2012, I visited five water network operators in Paraguay, Bolivia, and Brazil and conducted more than fifty, semi-structured interviews.

A key challenge faced with the chosen case study design was the need to control subjectivity biases during the research process (Flyvbjerg, 2006, pp. 234-237). To reduce the level of subjectivity, I took several countermeasures. First, I triangulated the findings (Eisenhardt, 1989, p. 533), collecting data from three different sources. I obtained information directly from the utility personnel, from stakeholders in the environment of an urban water sector (e.g. regulator, NGOs, universities, etc.), and from secondary sources, most importantly local newspapers.\(^11\) Second, after the interviews and after the completion of the case studies, I shared my results with the main interview partners from the utilities in order to avoid a misinterpretation of the information collected. This review process led to some minor adaptations of the case studies. Third, I built the case studies upon quantitative (e.g. financial figures) and qualitative (e.g. power relations in the governance structure) data to understand how

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\(^9\) ESSAP, the large-scale utility in Asunción, ranks among the best performing public companies. The regulator ERSSAN recognizes the small-scale system YBU as one of the best “aguaterias” (private, small-scale operator) in Paraguay. In Santa Cruz, the largest cooperative SAGUAPAC has gained an ISO accreditation by TÜV Rhineland. COOPLAN pursues an ISO accreditation for the next years.

\(^10\) For the assignment see the publication “Access to Safe Water for the Base of the Pyramid”. Download at http://www.hystra.com

\(^11\) Including archives of ABC and “Ultima Hora” in Asunción / “La Razón” and “Cambio” in Santa Cruz.
decisions taken in the value chain reflect in the financial performance of an operator (Eisenhardt, 1989, p. 533).

Before departure, I developed a case analysis framework consisting of five basic elements (cp. Figure 4). The heart of the framework is a performance analysis (see the next section for a definition of performance). Four different perspectives shed light on the results of this performance analysis. I first examined the water operators in a historical context, identifying major developments over time. Then I analyzed governance processes, emphasizing how specific decisions emerge and in which power constellations. For this purpose, I used Marc Hufty’s “Governance Analytical Framework” [GAF], which focuses on the problems, the actors, the processes, the nodal points, and the norms of a governance process (Hufty, 2009). However, I extended the GAF for the specific context of the water sector by adding two elements – the “governance mode” and the “vertical form of organization”. After identifying the dynamics of decision-making processes, I combined a water utility supply chain to depict the actual decisions taken by water supply operators. The most relevant business decisions examined include finance, institutional arrangements, procurement, production, treatment, pricing, delivery, billing, PR and customer management, monitoring, maintenance, and sewage plus cross-sectional tasks such as information and human resource management. Last but not least, I added a quantitative element to the framework, studying how the decisions reflect in a cost/revenue analysis. I split the costs into two main blocks, capital and operational expenditures. The latter block roughly consists of three costs drivers, production, human capital and miscellaneous, each representing up to one third of the total operational expenditures.

Figure 4 – Case Analysis Framework

12 Discussions on public-private partnerships and on decentralization have dominated the research agenda over the last decades, as previously discussed. The “governance mode” describes in the tradition of Ronald Coase, Oliver E. Williamson, and Walter W. Powell, the institutional set up of social coordination (hierarchies, markets, networks) (Coase, 1937; Williamson O. E., 1973; Powell, 1990). The analysis of the “vertical form of organization” helps to understand at which or between which levels (national, regional, local, community) decision making takes place (Mayntz & Scharpf, 2005).
I drafted two types of interview guidelines. The first addressed the utility personnel, covering all elements of the case analysis framework. The second targeted specific stakeholders in the environment of an urban water sector, focusing on the evolution (past and future), the legal framework, the acceptance of the small-scale sector, and other contextual factors. This second form consists of two parts, a basic set of questions and questions flexibly adapted to the nature of the interview partners and the organizations represented. All questions served as a guideline and as a basis for the interviews, meaning that sometimes additional questions emerged during the interviews relating to interesting aspects that I had not anticipated. The two types of interview guidelines are presented in the annex.

I chose my interview partners in two stages. Prior to the field visits, I contacted potential interview partners whose names I had found while studying journals, newspapers, and conference reports. In the field, I asked my interview partners at the end of a meeting if they recommended any other persons as additional interview subjects. Over the entire process, I tried to find for all controversial topics interviewees on both sides of an argument. In Bolivia, I interviewed for instance representatives of the civic committee of Santa Cruz as advocates of the cooperatives and, conversely, Reimy Ferreira, a famous local opponent against the cooperatives. In Paraguay, I interviewed the President of the water regulator ERSSAN as a critic of the small-scale sector along with the President of the private small-scale operators association CAPA, as a lobbyist for the micro utilities.

I digitally recorded all interviews and entered answers directly into the sub-sections of the case analysis framework. The output is a collection of six case studies, featuring six operators in four localities, as presented in the annex of this dissertation. I later compared the results for the six utilities both within and between the localities, identifying and explaining similarities and differences in terms of performance, costs/revenues, the supply chain, governance, and historical context. In order to prevent biases in the validation of the information collected, interview partners were again involved in a mutual discussion and the questions were posed to them as to why and how certain performance differences between large-scale and small-scale operators emerge.

3.4 Explanatory Level and -Power of Results

A typical issue related to the selection of case study design is the researcher’s challenge in dealing on the one hand, with few observations and, on the other hand, with too many variables (Yin R. K., 1981; Moses & Knutsen, 2007, pp. 109-111). I took measures to reduce the impact associated with this problem.

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13 Coming from different backgrounds, some interview partners have only contributed to specific sub-sections of the framework.
First, I tried to form an adequate and well-arranged research framework. I chose, for instance, samples of large- and small-scale operators from the same city, reducing the number of independent variables. Second, I embedded my empirical findings from the field visits into a theory-building process, trying to substitute the lack of cases through a logical and convincing argumentation. Third, I gave extensive descriptions of the context, in which the case studies are bedded in, in order to transparently share under which conditions the findings of this thesis emerged.

Still, some important limitations prevail. The thesis studies urban water supply from a managerial perspective with operators being at the center of investigation. It thereby neglects to some extent the important regulatory perspective. This thesis highlights regulation as an important tool for a legitimate supply model but it does not present in detail what an effective and efficient regulatory mechanism should look like. To deepen and complement the findings of this thesis, it would therefore be necessary to conduct another research project on large-scale vs. small-scale supply with regulatory bodies being the center of investigation.

Furthermore, due to the restricted number of cases, it has not been possible to determine the degree to which the findings of this study are valid in different contexts. Varying environmental conditions, particularly situations of water scarcity or chemical contamination, may impact the performance of large- and small-scale operators. Moreover, countries or cities are not static and develop. This thesis, however, only gives a preliminary idea on how and at what point the performance of large- and small-scale operators shifts with development. In this sense, the results presented may be an important contribution to the field, but need to be shaped and complemented for different contexts and across a longer time horizon.

Finally, water network supply is an industry with path dependencies (Dominguez, Worch, Markard, Truffer, & Gujer, 2009, p. 33). Decisions in the past, concerning, for instance, the maintenance of infrastructure, have an impact on the performance of the utility in the present. I tried to incorporate the historical background with every case study into the analysis. Still, these descriptions of the historical context only give a rough idea of how history may have contributed to today’s utility performance. ESSAP, Asunción’s main provider, for instance, has already for years faced high water losses. Part of the losses may trace back to the lack of maintenance of the infrastructure during the decades of President Stroessner’s rule in Paraguay. Yet, another part of the problem relates to the on-going poor capability level in the organization, blocking any improvements in terms of water losses, despite the established financial independence of the organization ten years ago and despite considerable investments through international donors into the utility over the last decade. This thesis does not provide the data and tools necessary to evaluate the extent to which results in the present are influenced by decisions in the past or even earlier.
3.5 Definition of Performance

The term performance may be used by different authors and in varying contexts in a different way. This is why I will specify my understanding of performance, combining traditional definitions used by previous authors with the challenges of developing countries. I first structured these ideas into five dimensions and concretized the dimensions for the empirical use in the field in form of performance indicators.

3.5.1 Performance Dimensions

Four scientific communities have contributed to performance measurement in the water sector (cp. Figure 5). The economic community has promoted under the labels “New Public Management” theory and “Washington consensus” (in development-specific contexts) market-based reforms in water supply. They call for the creation of market incentives for utility operators to increase the effectiveness and efficiency in product and service delivery (Schedler, 2007; Marin, 2009; Araral, 2008; Williamson J. , 1990).

The successive rise of alternative forms of governance (to bureaucratic hierarchies) in the public sector, such as PPPs or multilevel governance models, has caused concern among the political-legal research community. All of a sudden, water supply decisions can be made or at least influenced by actors who lack democratic legitimacy and whose natural identity allows inequalities – whereas public bureaucracies are usually built upon the principle of equal citizenship (Papadopoulos, 2003; Schmelzle, 2008). The term “legitimacy” as an indicator for performance therefore stands for a coin with two different but complementary sides: input and output legitimacy. Input legitimacy, from a normative point of view, evaluates whether outputs affecting a population group were taken by institutions lacking user accountability or whether they resulted from a governance process in which the affected people were able to contribute (Habermas, 1994, p. 160). From an empirical point of view, input legitimacy relates to the approval rates that a specific governance regime effectively enjoys among a specific population. Output legitimacy, on the other side of the coin, analyzes to what extent the governance outcome objectively corresponds to the aggregated individual interests within a particular population (Schmelzle, 2008). This concept is often used together with the credo of pareto efficiency, meaning that a status quo can be improved by increasing benefits for a single individual or a group while maintaining welfare for all others at a fixed level (Scharpf, 1999, pp. 16-28).

Legitimacy has also become subject to an important discussion among development scholars, the third scientific community, concerning an effective aid agenda. Two opposed positions have emerged over the last decade. From a managerial point of view, development is the linear process of setting and focusing on specific targets while syncing strategies to reach those goals. According to this school of thought, the lack of development is due to a lack of clear targets and ineffective collaboration
among a high number of small-scale projects that both compete with each other and duplicate development efforts with little chance of long term sustainability. In response, the UN Millennium Development Goals and the Paris Declaration on Aid Effectiveness put forward a clear set of goals and aligning procedures, meaning to shift funds and efforts from thousands of small scale projects to a selected number of large-scale programs that are scalable and replicable around the developing world (Ferrero y de Loma-Osorio, 2010).

This managerial view of development has received criticism from constructivists and critical realists who challenge the linear theory of development processes. These constructivists and realists claim that human beings are not only a tool to reach targets but, more importantly, the key to development. Effective development can therefore only be achieved with the strong involvement and empowerment of individuals and communities (Ferrero y de Loma-Osorio, 2010), an idea that harks back to the normative concept of input legitimacy.

**Figure 5 – Performance Dimensions**

Last but not least, since the 1970 and 1980s, environmental catastrophes such as the contamination of Lake Erie and the Sandoz chemical spill in the Rhine River, the ecological community has gained increasing influence in the discussion on how to deliver scarce goods to users (Goodland, 1995, p. 2). The efforts of ecologists, the fourth scientific community involved, culminated at the “Earth Summit” in Rio de Janeiro in 1992 with Agenda 21 for environmentally sustainable development (Vlachos & Braga, 2001, pp. 13-14). Environmental sustainability has two
dimensions: the issue of what to do with undesirable by-products of human consumption – or, in other words, the control of pollution – and the risk of overexploitation of natural resources (Hart, 1997, p. 13).

The importance of environmental sustainability for the water sector is evident and has already been treated in the first chapter of this thesis (Vlachos & Braga, 2001). Around 2.8 billion people, or about 40% of the worldwide population, live in regions threatened by water scarcity, with developing countries being the most affected.

3.5.2 Performance Indicators

In order to conduct the case studies in my research, I needed to break down the five performance dimensions into performance indicators (cp. Table 2). These indicators had to fulfil at least three basic requirements. First, they needed to be “valid” and therefore represent each performance dimension in its full breadth. Second, they needed to be “impartial”, meaning that another researcher using the same indicators would come up with the same results (Euler & Hahn, 2004, p. 175). Third, they needed to be “practical”, suggesting the likelihood of collecting useful data in the field within a reasonable amount of time.

- Defining indicators for the dimensions “effectiveness” and “efficiency” already has roots in the water utility sector (Neely, Gregory, & Platts, 2005). Most benchmarking systems express “effectiveness” from a customer perspective, defining it as water coverage, service continuity, and water quality (Berg & Lin, 2007, pp. 4-6; ADERASA - Grupo Regional de Trabajo de Benchmarking, 2009). All three of these indicators have been added to this analysis. However, “water coverage” has been placed under the umbrella of the “scalability/replicability” dimension.

For water testing, the standard procedure is to take samples from the water source. Water testing from the network, in contrast, is often considered too complex and unreliable because water quality can deviate from one housing block to another. Inspired by the “Corruption Perceptions Index”, water quality has therefore been expressed by the perception of experts and users interviewed in the field.

- “Efficiency” usually involves financial, environmental and human capital aspects (Hassanein & Khalifa, 2007). The indicator for financial efficiency assesses the monetary input required to produce a defined amount, typically 1m³, of water. Environmentally, the second indicator measures how much water is required to deliver a specific amount of water to household destinations. Put another way, environment efficiency relates to how much water is lost in the production of a required amount of water (including physical
losses, collection efficiency, etc.). From a human capital point of view, efficiency is defined for the third indicator as the amount of staff employed per X connections.

- Performance indicators for “environmental sustainability” are relatively new in the water sector (Mehlhorn, 2005). As already shown, they should address input (exploitation) and output (pollution) issues (Hart, 1997, p. 13). On the input side, the respective indicator evaluates if a supply model guarantees that the water exploitation level does not exceed the natural level of renewable water sources in an urban micro context. On the output side, the second indicator shows if the supply model examined offers a solution to sewage as a potential contaminant of the ecological environment of cities.

- A legitimacy assessment should consist as well of an input and an output side. More concretely, it should evaluate the ability of operators to first, involve (input) and second, serve (output) the multiple interests of different stakeholders.

From an input point of view, two stakeholders with a potentially large impact on operators have been added to the assessment: the users and the general public. The latter is typically represented by the government. The first two indicators measure whether and how any of the two are directly involved in decision-making through participation or representation in one of the institutions of the water operator.

A premise to an effective involvement of multiple stakeholders groups is transparency or accountability. For this purpose, many legal water frameworks create (semi-)independent regulatory authorities. The third indicator measures the degree of accountability of a supply model toward regulation.

From an output point of view, the water utility should deliver satisfactory service in terms of quantity, quality, and continuity. However, these indicators have already been absorbed into the performance dimensions of “effectiveness” and “scalability/reproducibility”.

Instead, in the heated debates over water distribution in developing countries, it has become clear that large parts of the population expect service output provided by the operator to be equivalent for all social segments, regardless of income or identity (Papadopoulos, 2003; Schmelzle, 2008). A fourth indicator for “output equality” therefore assesses the ability of a supply model to provide an equal service to all city residents.

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14 The involvement of the general public in the analysis embraces multiple interest groups – employees, suppliers, etc.
The last dimension, “scalability/replicability”, consists of four indicators: The first indicator determines the actual scale of users in a water system; the second indicator assesses the growth rates of users within a water network over the precedent years; the third indicator emphasizes the specific obstacles that prevent operators from growth; and the fourth indicator revises the enabling factors that help water supply models to be replicated in other cities or countries.

Table 2 – Performance Indicators

<table>
<thead>
<tr>
<th>Effectiveness</th>
<th>Efficiency</th>
<th>Environmental sustainability</th>
<th>Legitimacy</th>
<th>Scalability / Replicability</th>
</tr>
</thead>
</table>
| • Service continuity  
  • Water quality (perception) | • Capital & operational costs per m³  
  • Water losses  
  • Employees / connections | • Sustainable water production  
  • Sustainable sewage solution | • User involvement in decision-making  
  • Involvement of the general public (government) in decision-making  
  • Accountability  
  • Equality of output | • Actual scale and growth rates  
  • Obstacles to scale  
  • Favoursable conditions for replication |
4 Empirical Analysis of Large- and Small-Scale Utilities

In June/July 2012, I travelled to Paraguay and Bolivia to study on the ground how the varying size of four water operators affects their performance. Do the operational processes of, the decisions taken, and the challenges faced by large- and small-scale operators differ and do such differences ultimately reflect in different performance levels? In this chapter, I summarize the main findings to these questions structured across the five performance dimensions. A detailed documentation of the case studies is presented in the annex.

4.1 Background of Water Sectors in Asunción & Santa Cruz

Apart from the key contacts in the utilities, I met in each city with between ten and twenty experts who complemented the information provided by the operators with data on the historical development of the city and in particular of its water sector. This background information is presented over the next four sections.

4.1.1 Overview of Asunción’s Water Sector

Paraguay’s capital Asunción is home to about 2 million people (metropolitan area), corresponding to 30% of the nationwide population (CIA, 2012). The urban population in Paraguay has increased by 3.4% (~+50’000 residents) per annum since 2000 (WHO & UNICEF, 2010). Today, 90% of the city’s residents have access to a piped, on-premises water supply (WHO & UNICEF, 2010). Around 10% of the population has a private water source.

The history of urban water supply in Paraguay can be divided into a pre- and after-2000 era. In the decades before the year 2000, urban water supply in Paraguay was primarily provided by the state utility CORPOSANA. However, CORPOSANA’s performance was rather weak and in Asunción (Plummer, 2002, pp. 150-151), it provided water to only 50% of the population. With the end of the Stroessner regime in 1989, a spirit of entrepreneurial freedom grew in Paraguay (Solo, 1998). New commercial liberty, readily available high-quality groundwater resources (Sotomayor, 2007), and a growing water demand in urban centers created a basis for the emergence of between 300 and 500 private water entrepreneurs around the country – the so-called “aguateros”. Aguateros run mini-networks of between 100 and 400 house connections on average (Drees-Gross, Schwartz, & Bakalian, 2004, p. 2; Solo, 2003, p. 11). Some networks however can reach up to 3’000 households and some operators have even succeeded in establishing networks at different sites (Troyano, 1999, p. 5; Melgarejo, 2000). By the year 2000, aguateros had built 115’000 new household connections or 10’000 new connections every year at the low cost of US $30 million or around US $250/connection (Melgarejo, 2000). Aguateros supplied water for between 300’000 and 400’000 people in Asunción alone by the turn of the millennium (Solo, 2003, p. 11). At the same time, CORPOSANA managed just 230’000 connections countrywide. In terms of acceptance, a 2002 survey found 90%

In the year 2000, the Paraguayan legislature passed a law creating ERSSAN, a new regulatory entity, and simultaneously threatening private property of small-scale operators in water supply. The private operators were asked to apply at ERSSAN for a 10-year operating permit, which they never did. CORPOSANA was transformed into a new water company with financial independence, named ESSAP, which assumed responsibility for water supply in areas that included more than 10,000 residents. The results of this transformation process have been unclear. Since 2000, the “aguateros” have stopped investing. Hence, private infrastructure has been suffering from a lack of maintenance and modernization (ABC Digital, 2012; ABC Digital, 2009). The private, small-scale operators have consolidated. Today, around 225 “aguateros” manage 75,000 connections in Gran Asunción. ESSAP’s performance, on the other hand, has improved. The network has grown, with around 4,750 new connections per year. And community-driven, small-scale networks have experienced the fastest growth of the last ten years (around 5,000 new connections/year in Gran Asunción) thanks to heavy subsidies from the government agency, SENASA.¹⁵

### Table 3 – Water Sector Asunción

<table>
<thead>
<tr>
<th>CITY</th>
<th>OPERATOR</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Population:</strong></td>
<td>Population reached with piped-in household water:</td>
</tr>
<tr>
<td>Around 2 million people live in the metropolitan area of “Gran Asunción”. The term embraces the connected cities of Asunción, Fernando de la Mora, Lambaré, Mariano Roque Alonso, Luque, San Lorenzo, Limpio, and Villa Elisa.</td>
<td>ESSAP 55%</td>
</tr>
<tr>
<td></td>
<td>“Aguaterias” 19% (YBU 0.25%)</td>
</tr>
<tr>
<td></td>
<td>Community groups 18%</td>
</tr>
<tr>
<td></td>
<td>Self-supply 8%</td>
</tr>
<tr>
<td></td>
<td>Population reached with sewage system:</td>
</tr>
<tr>
<td></td>
<td>ESSAP 25%</td>
</tr>
<tr>
<td></td>
<td>Sewage treated:</td>
</tr>
<tr>
<td></td>
<td>ESSAP 1.25%</td>
</tr>
<tr>
<td><strong>Population growth:</strong></td>
<td>Growth of new users:</td>
</tr>
<tr>
<td>Around 50,000 per year</td>
<td>ESSAP Around 4,750/year (23,750 people)</td>
</tr>
<tr>
<td></td>
<td>Aguaterias No growth – only consolidation (YBU 39/year)</td>
</tr>
<tr>
<td></td>
<td>Community groups 5,000/year</td>
</tr>
</tbody>
</table>

¹⁵ SENASA manages water supply in Paraguay in areas populated with fewer than 10,000 inhabitants.
4.1.2 Overview of Santa Cruz’ Water Sector

After the Chaco war in 1938, the Bolivian central government decreed that 11% of the national revenues from fossil fuel sales would be redirected to each of the nine fuel producing departments (provinces), leaving the rest to the central government. However, even in the beginning the law was never fully applied, and the people in Santa Cruz and other eastern low-land departments felt marginalized by the political and economic elite in La Paz. At that time, Santa Cruz was a small city, home to around 50'000 residents. With the department prefect and the town mayor appointed by the central government, business leaders in the city decided to establish the civic committee Pro Santa Cruz. This committee, consisting of the city’s most influential people and organizations, intended to represent the interests of the people of Santa Cruz vis-à-vis the central government. The polarization between the central government and the civic committee gave birth to a conflict between centralists and autonomists, which dominates the political landscape in the region even today.

Table 4 – Water Sector Santa Cruz

<table>
<thead>
<tr>
<th>CITY</th>
<th>OPERATOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population:</td>
<td>Population reached with piped-in household water:</td>
</tr>
<tr>
<td>Around 1.75 million people. The exact number is difficult to assess as the last census dates back to 2001. Representatives of the civic committee Pro Santa Cruz accuse the government of failing to prioritize a new census on purpose. They claim that such a census could justify a higher budget and direct more political power toward Santa Cruz, whose population has grown the faster than any other city in Bolivia.</td>
<td>SAGUAPAC 70%</td>
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<tr>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Population reached with sewage:</td>
<td></td>
</tr>
<tr>
<td>SAGUAPAC 44%</td>
<td></td>
</tr>
<tr>
<td>SAGUAPAC 100%</td>
<td></td>
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<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Sewage treated:</td>
<td></td>
</tr>
<tr>
<td>SAGUAPAC 100%</td>
<td></td>
</tr>
<tr>
<td>COSPHUL 100% (by SAGUAPAC)</td>
<td></td>
</tr>
<tr>
<td>Population growth:</td>
<td></td>
</tr>
<tr>
<td>Around 50’000 per year</td>
<td></td>
</tr>
<tr>
<td>Growth of new users:</td>
<td></td>
</tr>
<tr>
<td>SAGUAPAC Around 40’000/year</td>
<td></td>
</tr>
<tr>
<td>COOPLAN Around 5’000/year</td>
<td></td>
</tr>
<tr>
<td>Other cooperatives around 5’000/year</td>
<td></td>
</tr>
</tbody>
</table>
In the early 1960s, fueled by Santa Cruz’s continuing isolation, two cooperatives were established by local interest groups, filling the gaps in electricity and telecommunications services left by the state. At that time, water services were provided by an agency belonging to the prefecture of the province. However, with the construction of modern highways linking Santa Cruz to the rest of the country as well as to nearby Brazil, a period of economic growth began. Thanks to its diversified economy (agriculture, hydrocarbonates etc.), Santa Cruz became attractive to immigrants from poorer parts of the country – particularly in the 1980s when the tin industry in the western highlands fell into a crisis (Morales & Sachs, 1989, p. 60).

With the shift of economic power from the west to the east of the country, Santa Cruz’s population grew from around 250’000 in the 1970s to around 1’750’000 in the first decade of the new millennium. The city landscape expanded in 12 circles around the historic center. The water service provided by the public sector could not keep pace with the rapid growth. As a result, in the late 1970s, responsibility for the city’s water was transferred from the public sector to cooperatives.

### 4.2 Selected Cases

The utility sector is an industry with strong path dependencies. Decisions on investments in the past can have a strong impact on operations in the presence. Therefore, it will be important to interpret the findings of the thesis in the light of the following short accounts on the evolution of the operators from their creation to operations today.

#### 4.2.1 Large-Scale Network ESSAP (Asunción)

Asunción’s public water network dates back to 1954, the year Alfredo Stroessner took power in Paraguay. The network was built and operated by the state utility CORPOSANA. However, during the years of Stroessner’s dictatorship, the water operator’s performance was weak, and the network could not keep pace with the fast population growth in the city. In the 1990s, external donors pushed the Paraguayan parliament to create a legal framework for the privatization of urban water operations. In 2000, the bill 1614 created a regulatory entity, but by 2002 the political winds had turned against a privatization. CORPOSANA was instead transformed into a company under private law but with public ownership. Under this scheme, the new labeled company ESSAP paid an annual lease to the government for the usage of the network. In 2007/2008, however, the network assets were transferred back from the government to the operator with the consequence that ESSAP would be exempted from the lease and instead become responsible for CORPOSANA’s external debt.

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16 CORPOSANA, and later ESSAP, have been responsible for the water service in cities all over Paraguay (10’000+ residents). However, the organizational structure is heavily centralized at headquarters in Asunción.
The established autonomy in 2002 has led to a continuous professionalization and a series of improvements, including an updated customer service, a higher degree of automation in production, and the introduction of mobile data devices of billing personnel. Today ESSAP is ranked among the best-performing public companies in Paraguay. Nonetheless, serious problems, such as high water losses, poor water quality, and poor HR management still prevail and prevent the utility from supplying water at an operationally efficient cost.

4.2.2 Large-Scale Network SAGUAPAC (Santa Cruz)

SAGUAPAC, Santa Cruz’ largest water utility today, emerged in the 1970s as the successor of the prefecture’s water services office, taking over the existing network’s roughly 2’000 connections. Growth was slow in the first years due to the lack of financing. In the early 1980s, SAGUAPAC received its first loan from the World Bank, which facilitated the modernization and expansion of the network. SAGUAPAC successfully invested and repaid its debts, gaining the trust of the bank and other international creditors for further financing. Over the following decades, SAGUAPAC has steadily expanded its network, reaching 100% water coverage and 62% sanitation coverage in its licensing area. Over the years, SAGUAPAC has faced pressure from both the private and public sector. In the late 1990s, with support of Washington-based multilateral organizations, various Latin American cities, such as La Paz and Buenos Aires, contracted water services to private, for-profit organizations. SAGUAPAC needed to demonstrate top performance in order to safeguard its license. With the shift of political power toward the left-wing coalition of President Evo Morales in 2005, pressure today comes from the public sector, which occasionally accuses SAGUAPAC of acting like a private, for-profit entity that negatively impacts user prices. SAGUAPAC defends itself by emphasizing its position as an efficient, non-profit organization with a positive social impact.

4.2.3 Small-Scale Network YBU (Asunción)

Aricio Gamarra, founder of the private, small-scale system “YBU”, moved from the small town of Villarica to the capital of Paraguay when he was a teenager. Enthusiastic about the development of technology and computers, he decided to study electromechanics while he worked as a tailor. Seven years after graduation, in 1989, perceiving the shortcomings in the city’s water supply at that time, Aricio invested around US $30'000 (30 million Guarani in 1989) into a small-scale water network for 150 households, a so-called “aguateria”. At that time, water tanks pulled by donkeys served the area, located in the San Lorenzo district of Gran Asunción. YBU matched an unmet demand. Immigrants quickly learned about the new water operator, and more people came to live in the area. The new “aguatero” slowly expanded the network, reaching a total number of 1’000 connections by 2012. In 2000, with the introduction of the bill 1614, YBU registered its area of operation at
ERSSAN but did not sign a bilateral agreement. Unlike other entrepreneurs, Aricio Gamarra is convinced that in the short or middle term, a lack of formal legitimacy will not threaten his business. He therefore continues to invest. In 2006, for example, YBU expanded its network area by purchasing two smaller, neighboring water supply systems.

4.2.4 Small-Scale Network COOPLAN (Santa Cruz)

In February of 1984, the flooding of the Pirai river destroyed parts of the city of Santa Cruz. A heavily-affected impoverished community of 300 households resettled, under the government program “Plan 3000”, to a piece of land at that time located southwest of the city. In the beginning, the municipality trucked water to the area, but the service stopped after a year. The residents of the area contacted SAGUAPAC. At that time, however, the city ended at the third circle, and Santa Cruz’s main operator had little chance of connecting “Plan 3000” to the network in the near future.

Therefore, in 1986, the settlers created the water cooperative “COOPLAN”. The prefecture of Santa Cruz donated the installation of a first borehole, and the members of the cooperative started connecting houses on their own initiative and budget. Each of the 500 families involved had to contribute US $100. With the area becoming a main hub for new immigrants from the Western highlands, the cooperative has grown by around 875 new members each year and today connects at least 22’400 users. It is therefore considerably bigger than other systems run by private entrepreneurs or CBOs. The service quality, however, has not always been good, particularly before 2001, when COOPLAN was asked by the national regulation body to sign a concession contract that included service requirements. As a result of its poor performance and the new government regulations, COOPLAN started a process of professionalization by contracting a qualified workforce to manage and operate the cooperative. In 2004, the new management received a donation of 15’000 micro-meters from the Spanish Development cooperation and began, despite opposition from users, to install micro meters at every house connection. This initiative has led over the last years to major service improvements. Today, 99% of the households in the area receive bills based on micro measurement, and only 15% of the water produced is physically lost. For 2013, as a next important milestone, COOPLAN expects to inaugurate a new sewage system with a treatment plant immediately linking 10’000 connections (40% of the current user base) to a wastewater network with plans for expansion.

4.3 Comparative Performance Analysis

I structured the key findings of the comparisons in the two cities across the five performance dimensions, highlighting differences between the big and the small. Efficiency or legitimacy problems and a lack of environmental sustainability may be responsible why none of the two has ultimately resolved the urban water challenges
in the developing world. I tried to emphasize in this chapter the raw empirical results from the field, reflecting and enriching them in the next chapter with theoretical arguments.

4.3.1 Efficiency

I split the analysis of efficiency into two main parts. I first compare the capital expenditures and second the operational expenditures between the large-scale and the small-scale networks. The operational expenditures consist of two main cost blocks, production and human capital:

1. **Capital Expenditures**: Figure 6 divides the accounted, annual expenditures into capital assets as a portion of total expenditures for all four operators. The figures range between 19.5% for COOPLAN and 32% for ESSAP. ESSAP has made infrastructure investments that it failed to make over decades – a failure that partly explains the poor condition of the network today.

Expressed in cubic meters (billed in), ESSAP spends around US $0.16 on capital expenditures, SAGUAPAC and YBU spend around US $0.1, and COOPLAN spends slightly more than US $0.06 (cp. Figure 7). However, due to accounting ambiguities, these figures must be interpreted with caution. ESSAP, for instance, has only vague records indicating the total value of its capital assets. Therefore, the company managers do not know exactly how much money should be put aside for capital spending to ensure long-term viability of the infrastructure. Moreover, in each of the four cases, it is unclear if the percentages cover the overall value of the capital or just the net investments of the utilities – gross investments reduced by user contributions, NGO and government grants, etc.

![Figure 6 – Share of Capital Expenditures to Total Costs](image)
In any case, the most interesting data input comes from the small-scale system YBU. The system started 20 years ago with an initial investment of US $30’000 for production facilities and the distribution network, which, at that point, served 150 households – at a rough cost of US $200 per connection. As a private entrepreneur, Aricio Gamarra never received any subsidies. Financial statements that I obtained from the regulator, ERSSAN, reveal that YBU charges around US $18’500, or 27%, of its total annual costs on the depreciation of capital. It is important to remember, however, that YBU has something of an incentive to overstate public, financial data in order to pay fewer taxes and to obtain regulator permission to charge higher tariffs. Data from 157 more small-scale providers in Asunción back the representativeness of the case and depict the ratio of mean capital to total expenditures at roughly 28% (R. D. Lezcano Cáceres, Interview, 20 June 2012).

A comparison of the technical specifications of networks indicates that the two large-scale water utilities, ESSAP and SAGUAPAC, source water from less accessible sources than the small-scale systems (cp. Table 5). SAGUAPAC taps water from a water aquifer 350 meters deep whereas COOPLAN’s boreholes reach only 250 meters. ESSAP manages a production and treatment plant with water from the contaminated river Rio Paraguay whereas Asunción’s small-scale systems rely on high-quality groundwater. This phenomenon is reflected in consumption figures. Users of the two small-scale systems tend to be more residential, consuming between 4 and 10 cubic meters less water per month than users of the large-scale networks. Therefore, small-scale operators can source water from smaller, more conveniently available water reserves. Moreover, the example of YBU shows that small-scale systems have a potential to save production and trench costs by using pipes with smaller diameters.

Figure 7 – Capital Expenditures per Cubic Meter

![Capital Expenditures per Cubic Meter](image-url)
Table 5 – Technical Network Specifications and Demand Structure

<table>
<thead>
<tr>
<th>Water Source</th>
<th>Pipe Diameter</th>
<th>Pipe Length per User</th>
<th>Average Consumption</th>
<th>Residential Users</th>
<th>Network Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAGUAPAC</td>
<td>Groundwater (350 m)</td>
<td>3-12 inches</td>
<td>18.5 meters</td>
<td>23.5m³/month</td>
<td>87%</td>
</tr>
<tr>
<td>ESSAP</td>
<td>Rio Paraguay</td>
<td>3-16 inches</td>
<td>15.2 meters</td>
<td>24.3m³/month</td>
<td>n/a</td>
</tr>
<tr>
<td>COOPLAN</td>
<td>Groundwater (250-300 m)</td>
<td>2-10 inches</td>
<td>15.6 meters</td>
<td>19.2m³/month</td>
<td>93%</td>
</tr>
<tr>
<td>YBU</td>
<td>Groundwater (112-152 m)</td>
<td>1.6-4.3 inches</td>
<td>33.1 meters</td>
<td>14.6m³/month</td>
<td>99%</td>
</tr>
</tbody>
</table>

2. Operational Expenditures: A comparison of operational costs indicates that in Asunción and Santa Cruz small-scale operators are able to offer each cubic meter at a cost of less than US $0.30 whereas the two large-scale providers in those cities have higher costs of between US $0.35 and US $0.40 – excluding taxes (cp. Figure 8).\(^{19}\)

In order to explain the causes for this cost differentiation, it makes sense to split the operational expenditures [OPEX] into different parts. Generally, two cost drivers, production and salaries, account for at least 55% of the total OPEX. Production costs consist mainly of energy and chemicals. Utility providers with high water losses have higher production costs to satisfy a fixed demand (cp. Table 6).

The case studies reveal that both large- and small-scale providers potentially produce at a similar cost (around US $-Cent 5/m³). Nevertheless, as already pointed out by other authors (Kim & Clark, 1988), smaller systems seem to have fewer troubles in managing water losses. The case in Asunción adds empirical evidence to this hypothesis. ESSAP’s cubic meter of water costs around US $0.08 more to produce than a cubic meter of water produced by the small-scale system YBU. The difference corresponds to ESSAP’s 51% water losses with a value of around US $ 0.08 (cp. Figure 9).

\(^{17}\) For a detailed analysis, it would be necessary to know the distribution of different pipe diameters across a system.

\(^{18}\) Target pressure

\(^{19}\) In order to make the figures comparable between for- and non-profit operators, I added a margin of 12.5% (US $-Cents 4.7 at the actual turnover) to the only for-profit operator’s (YBU) costs. See Figure 10 plus description for more details.
So why does Santa Cruz’ large-scale system SAGUAPAC achieve significantly less water loss than its large-scale counterpart in Asunción, and why do large systems find it more challenging to control the water losses? For an answer, one must look first into the costs of human capital. During the interviews I conducted during these cases studies, it became clear that SAGUAPAC regards its human capital as one of its great strengths – possibly its greatest strength. SAGUAPAC pays very competitive salaries (average: US $1’500/month\textsuperscript{20}) and continuously invests in staff training and education. SAGUAPAC jobs are highly regarded in Santa Cruz. The water supplier’s employment process is challenging, and only the best candidates are selected. High salaries, an attractive office building, and continuous education seem to be factors that motivate the average employee to spend 15 years at SAGUAPAC. The superior qualifications, stability, and motivation of SAGUAPAC staff members eventually appear to go along with high operational efficiency but also with higher human capital expenses (cp. Figure 10).

<table>
<thead>
<tr>
<th>Table 6 – Water Losses</th>
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<tr>
<td></td>
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<tr>
<td>Water Losses</td>
</tr>
<tr>
<td>Network Losses</td>
</tr>
<tr>
<td>Billing Losses</td>
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<tr>
<td>Financial Impact (US $-Cents)</td>
</tr>
</tbody>
</table>

\textsuperscript{20} Including all human capital expenses: Salaries, social security, travel expenses, trainings, etc.
In Asunción, in contrast, the observations and the interviews conducted show another picture. The large-scale provider ESSAP invests considerably less in its employees (average: US $700/month). Likewise, working for ESSAP has little prestige in Asunción. Career opportunities are usually linked to political opportunism and few opportunities or incentives are given to high-performing employees. With each new president elected in Paraguay, the water supply operator’s staff and the strategies change. The perceived corruption among employees is high and the level of qualifications of staff is low. ESSAP has to continuously repeat repair works because previous interventions were insufficiently conducted. Despite considerably increased investments compared to past decades (a US $50 million World Bank loan for the renewal and the expansion of water and sanitation is being invested) and a newly created specialized management unit, water losses have remained steadily high – at around 50% of total production – over the last five years.
At the small-scale system YBU, salaries amount to only US $-Cents 9.4/m³. To make operations viable and to compensate for the entrepreneur’s workload and business risks, one has to add a profit margin. I added a 12.5% profit margin on total costs. This margin provides the entrepreneur at the current scale with US $8’000/year. US $8’000 are in Paraguayan a decent salary - the nominal GDP/person in Paraguay is US $3’357 (IMF, 2012). It is 1.5 times as high as the salary of his employees (roughly US $5’200/year), respectively three times as high, taking into account that the “aguateria” represents 50% of Aricio Gamarra’s working time.21

With the added profit margin, YBU spends about the same amount of money on human capital per cubic meter billed as the large-scale operator ESSAP spends. Compared to large-scale operators, however, small systems face a lower degree of complexity. One can, for instance, imagine that the running of a large-scale production plant, the management of hundreds of employees, the control of corruption, the monitoring and maintenance of enormous networks – parts of them in informal neighborhoods – and the complex coordination of all these activities require high management and operational skills. Private, small-scale networks, in contrast, are clearly arranged and depend on the skills of a single entrepreneur or manager who runs the system with the support of a few low-skilled, inexpensive employees. Despite identical human capital expenditures per cubic meter, YBU’s staff members are therefore able to manage the system much more efficiently than ESSAP’s employees.

In terms of staff efficiency, the Santa Cruz’ large-scale utility SAGUAPAC outperforms the other three operators, employing 1.75 fewer people for every 1’000 connections than COOPLAN, the other case study cooperative in Santa Cruz (cp. Table 7). However, efficiency gains come with the cost of increased human capital expenditures, which are 3.75 times higher than COOPLAN’s. Whereas both small-scale operators, COOPLAN and YBU, can pay low salaries and remain efficient because their businesses are less demanding, ESSAP’s production efficiency diminishes alongside with its low salaries.

To summarize, both large- and small-scale providers have the potential to produce and distribute water in an efficient way. However, the complexity faced by large-scale utilities seems higher. To control this degree of complexity, the large-scale systems need to hire a highly qualified workforce or invest in the development of staff skills. High internal valuation of skills, though, results in higher human capital expenses. Compared with small-scale providers, large-scale providers tend to have a higher OPEX either through higher production costs linked to high water losses or through higher human capital costs linked to the valuation and development of staff competencies.

21 The “aguateros” typically run multiple businesses. Some entrepreneurs engage in farming, others in real estate, etc.
Table 7 – Staff Efficiency

<table>
<thead>
<tr>
<th></th>
<th>SAGUAPAC</th>
<th>ESSAP</th>
<th>COOPLAN</th>
<th>YBU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staff Size / 1'000 connections (water &amp; sewage)</td>
<td>2.75</td>
<td>3.5</td>
<td>4.5</td>
<td>3.5</td>
</tr>
<tr>
<td>Human Capital Costs per Month and Employee (US $)</td>
<td>1'500</td>
<td>700</td>
<td>400</td>
<td>575</td>
</tr>
</tbody>
</table>

3. Community-based Organizations vs. Private Entrepreneurs: As mentioned earlier, several studies have asserted that community-driven, small-scale providers tend to operate less efficiently than private providers and often rely on external financial resources (World Bank, 2009, pp. 13, 42-44; Dianderas, 2008, p. 44; Kariuki & Schwartz, 2005, pp. 11-12,21). The history of COOPLAN distinguishes successful, efficient community-run networks from their inefficient counterparts. Founded in the mid-1980s by 500 local dwellers with support from the regional government, COOPLAN was, until the last decade, an example of how networks should not perform. The network was run by community leaders with no administrative or technical expertise. The structure of the network provided no effective managerial control or separation of powers, so money would disappear into the pockets of a few.

In the early 2000s, faced with COOPLAN’s critical service and lack of sustainability, the cooperative’s members began to realize the need to professionalize the network’s organizational structure. The functions of the administration board, supervisory board, management, and staff were strictly separated, and members decided to hire professional staff with no links to board members or political parties. Since the start of the professionalization process, service has improved tremendously. This experience shows that, in contrast to small-scale networks run by private entrepreneurs, community-run systems are particularly susceptible to poor management and abuse if they are operated without the support and control of strong, independent institutions (in this case the administration and supervisory board). However, these institutions again carry an additional cost. COOPLAN, for instance, pays its board members around US $75’000 per year or US $-Cents 2-3 per cubic meter at the operator’s current capacity.

4.3.2 Effectiveness

Do the observed efficiency advantages of small-scale operators come at the cost of lower degrees of effectiveness? From the cases studied, no such conclusion can be derived. According to users and experts interviewed, all four utilities reliably deliver water 24 hours a day.
With regard to quality, water from SAGUAPAC and YBU is generally considered potable at its point of use. The water supplied by ESSAP, in contrast, is not regarded as trustworthy among a large share of its clients. While some interviewees admitted to drinking tap water, others, including a company manager, declared that they thought the water was contaminated. The water delivered by COOPLAN, on the other hand, appears to be of reliably high quality. However, 36% of the water samples tested internally revealed an insufficient level of residual chlorine. Therefore, the water runs a risk to contaminate in a potential contact with a pollutant. Summarized, the case studies confirmed the hypothesis that water quality is not a matter of scale. Best and worst practice examples seem to exist at both ends.

4.3.3 Legitimacy

With a legitimacy assessment, I evaluate the ability of operators to first, involve and second, serve the multiple interests of different stakeholders. Within this scope, I put an emphasis on the degree to which the general public and the providers’ users are able to participate in decision-making and on how the service provided conforms to the criterion of equality. I have already given a more detailed explanation of the several facets of the term legitimacy in Chapter 3. Table 8 gives a first overview of the results of this legitimacy assessment. The plus and minus signs indicate if the size and the governance set-up of the operators evaluated are suitable or not to attain the functions measured. The qualifications “low”, “medium” and “high” express to which degree the size and the governance set-up of the selected operators are suitable to fulfill the functions measured.

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<tr>
<th></th>
<th>OUTPUT LEGITIMACY</th>
<th>INPUT LEGITIMACY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Equality of Output</td>
<td>Involvement of Users in Decision-Making</td>
</tr>
<tr>
<td>ESSAP</td>
<td>+</td>
<td>Low</td>
</tr>
<tr>
<td>SAGUAPAC</td>
<td>+</td>
<td>Medium</td>
</tr>
<tr>
<td>YBU</td>
<td>-</td>
<td>Low</td>
</tr>
<tr>
<td>COOPLAN</td>
<td>-</td>
<td>High</td>
</tr>
</tbody>
</table>

**Table 8 – Legitimacy Results**
1. **Accountability to regulatory bodies:** In developing countries, regulatory bodies often suffer from a weak financial status and know-how. The regulatory agency in Paraguay, ERSSAN, has existed for 10 years and its counterpart in Bolivia, AAPS, for six years. The more operators there are, the more difficulties regulators face in monitoring and enforcing water sector rules. Paraguay’s capital Asunción, for instance, has around 400 small-scale water systems (cp. Table 9). The networks partly overlap, the quality of the service is uncertain, and hardly any operator except the public, large-scale provider ESSAP pays the “compulsory” regulation fee (O.L. Sarubbi, 20 June 2012). As a result, the regulator is overloaded and underfinanced while accountability in the small-scale operator model remains low. In contrast, in Santa Cruz, around 10 providers with an average size of about 35 times bigger than the average provider in Asunción serve the city, and operator accountability is considerably higher; there, the regulatory agency AAPS maintains a more or less close relationship with all major cooperatives. These case studies clearly show that the nature of the pure small-scale operator model conflicts with high levels of accountability.

<table>
<thead>
<tr>
<th>WATER SYSTEMS</th>
<th>AVERAGE SIZE</th>
<th>STATUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asunción</td>
<td>400</td>
<td>~ 920 connections</td>
</tr>
<tr>
<td>Santa Cruz</td>
<td>10+</td>
<td>~ 35’000 connections</td>
</tr>
</tbody>
</table>

2. **Equality of output:** Large-scale provision models usually deliver a uniform product and uniform service to all customers, whether rich or poor. Even though some differences in service might exist from district to district, the gaps are certainly not as big as under a small-scale provision model with 400 different operators. In Asunción, the differences between providers can be enormous, and for citizens it’s a matter of luck whether the provider in the particular residential district delivers high- or low-quality water. In the absence of a strong regulatory body, the small-scale provision model produces unequal results. The lack of effective regulation and competition leaves users with few alternative avenues to receive reliable, high-quality water service.

3. **Involvement of users vs. involvement of the general public in decision-making:** The case studies involving SAGUAPAC and COOPLAN confirmed some previous critiques of community governance in the water sector by revealing serious legitimacy problems stemming from conflicts between water cooperatives and political systems (Bakker, The Ambiguity of Community:
Debating Alternatives to Private-Sector Provision of Urban Water Supply, 2008, pp. 245-247). The cooperative model transforms users into owners and therefore governors of a water system. Ultimately, users may ask their representatives or the operator’s management to implement a particular strategic decision, even though a principal-agent conflict that favors the agent may exist.

However, in the arena of user participation, it is often forgotten that under the cooperative model, people who do not belong to the cooperative but might also have some legitimate interest are not necessarily taken into account. Such outsiders might be new migrants with a desire to connect to a water system or future generations who will need to consume water in fifty years. Without the involvement of the general public in the form of government, there is no guarantee that cooperatives will integrate new migrants or respect a sustainable level of water production or sustainable prices.

Bolivian cooperatives have repeatedly come under criticism for these issues, with detractors objecting to the lack of democratic control and the lack of protection of society’s weakest members (R. Ferreira, Interview, 13 July 2012). Responding to public pressure, SAGUAPAC has begun running multiple projects for low-income households in efforts to present itself as a socially responsible water utility. After all, part of the criticism from the public sector might also be the product of a “public choice” attitude – as defined in Chapter 2.

Publicly owned, large-scale providers, as ESSAP, are instead perceived as democratically legitimized institutions. Thanks to the representation of the general public with politicians within the management or board structure, operators may better balance the interests of different stakeholders. Users of ESSAP however have less leverage than members of the cooperatives SAGUAPAC and COOPLAN. They can influence ESSAP’s operations and overall water policies only indirectly through the vote of politicians in elections.

Small-scale entrepreneurs, as YBU, have the lowest degree of input legitimacy. Normally, they involve neither the users nor the general public. Beyond the scope of the regulator, they operate with a high level of autonomy.

4. Political vs. User Legitimacy: Table 8 shows that both, large- and small-scale providers face specific legitimacy problems. The large-scale utilities usually have a low involvement of users in decision-making (excluding cooperatives!), and the small-scale providers typically struggle with low degrees of accountability and involvement from the general public. So, if both types of providers have legitimacy problems, why is it that small-scale providers as YBU and private large-scale operators as SAGUAPAC fear the lack of legitimacy and the public, large-scale operator ESSAP in Asunción does not?
A reason for this discrepancy could be found in the varying nature of the four indicators (cp. Table 8). Two indicators have a direct impact on political stakeholders, and the other two have a direct impact on the user base. The involvement of the general public, the influence exerted by the political system, and the degree of accountability are typically indicators that characterize the level of participation of stakeholders from the political sphere – defined as “political legitimacy”. The equality of the output and the involvement of users in decision-making, on the other hand, “only” affect the users themselves – defined as “user legitimacy”. For an operator, gaining approval from politicians is key to survival and growth. Without political legitimacy, an operator runs the risk losing investments and jobs. Alternatively, a provider that integrates the political stakeholders, but fails to incorporate users in governance processes can still be successful, at least in the short term. Users can influence this operator only indirectly via governmental institutions. Therefore, political legitimacy enjoys a higher priority among utility providers than user legitimacy does.22

4.3.4 Environmental Sustainability

To assess environmental sustainability, I examined two specific issues in the case studies. First, how did the provider size affect the sustainability of urban water resources, and, second, what kinds of solutions did large-scale and small-scale operators offer in regard to sewage?

1. Sustainability of Water Resources: The sustainability of water resources depends on both the natural recharge of water resources in a given location and the volume of extraction by water providers, industrial/commercial self-suppliers, and other users (Welty, 2009). These variables differ from city to city, affected by a series of factors such as climate, the structure of the economy, or consumer behavior. A natural production level can be sustainable in one city and unsustainable in another (with fewer water resources). The most important factor is the influence of the government or an independent body that balances different interests and enforces sustainable water management. The public goal is to ensure a continuous supply of water over generations. Table 9 again illustrates that in cities with a high number of independent water exploiters, the

22 Political legitimacy can eventually lead to the formalization of operators in public registers – defined as “formal legitimacy”. However, formal legitimacy in developing countries does not always provide universal investment and job guarantees as the laws that create a structure of formality may be amended at any moment. During the preparation of this study, Asunción’s large-scale water company ESSAP, for instance, did not enter into a binding agreement with the state water regulator but seemed less worried about its status than SAGUAPAC, which felt constant pressure from the government despite its full formality under Bolivian law.
control of water resources is extremely difficult in comparison with a model where only one water utility taps the available resources. For water regulators, dealing with and monitoring dozens or even hundreds of operators at the same time is challenging and expensive. In Asunción, for example, the regulator has only a vague idea of the influx and efflux of the city’s water balance. In the context of weak regulators in developing countries, large-scale provision offers greater chances to ensure sustainable access to water resources.

2. Sewage: Due to high upfront costs and an estimated lower demand compared to water demand, small-scale operators usually do not find it worthwhile to invest in a conventional sewage network system. According to data from Paraguay’s national regulator ERSSAN, only 3.5% of the small-scale water systems in metropolitan Asunción also offer a sewage network. For large-sized operators like ESSAP and SAGUAPAC, operators that can distribute the high fixed costs over a larger scale, the investment is more feasible – even though ESSAP currently treats only 5% of the sewage it collects.

COOPLAN’s network has grown from 500 users to over 22'000 connections in 25 years so that it has become possible to finally inaugurate in 2013 a proper sewage network, including a treatment plant. Still, the argument that large-scale providers are better prepared to provide sewage solutions is only valid as long as technical innovations for small-scale settings are ignored. The observed degree of innovation in sewage among the cases studied was rather low. However, tailored solutions like a community-shared bio digester could make sanitation even for small-scale networks a worthwhile business.

4.3.5 Scalability & Replicability

As stated earlier, 30% of the urban population in developing countries does not have access to piped-in water in their homes or yards. Therefore, in my analysis, I paid attention to the specific obstacles that prevent operators from gaining more and faster scale and to the factors that enable a project to be replicated in other cities of the developing world. Large- and small-scale systems clearly face different obstacles. Table 10 summarizes the results. The “X” sign highlights factors that prevent operators from gaining scale or replication in another place. The tick stands for factors that help operators to grow or reproduce the model in another locality.

The large-scale providers studied are challenged by the fact that the revenues for water consumption by low-income users do not cover the cost of operation. Any effort of extending the network in low-income areas consequently diminishes the operator’s overall financial performance. At the large-scale network SAGUAPAC, for instance, a user with a household consumption of 15m$^3$ per month spends US $5.75. However, the operational costs (including taxes but without CAPEX) for the service amount to approximately US $6.54. As a result, SAGUAPAC loses around US $0.79/month or
$9.48 per year with such low-demand domestic users. With 159'000 residential users and an average residential consumption of 20m$^3$/month, SAGUAPAC’s cumulative losses amount to US $1.09 million per year. As non-residential customers and residential customers with sewage connections cross-subsidize the losses, SAGUAPAC has an incentive to increase coverage among this type of customer base and not among low-income/low-demand users. ESSAP, the large-scale system in Asunción, faces even worse losses of US $0.94/month or $11.22/year on customers from the reduced tariff category.

For the small-scale providers, which tend to have a more efficient cost structure, figures look different. Each month COOPLAN loses only US $0.2 per 15m$^3$ residential user, and the losses are the product of a currently unsustainable pricing policy. (The private small-scale system YBU makes an operational profit of US $5.7 (before capital) on every household with a 15m$^3$ monthly consumption level. For this reason, the entrepreneur behind YBU, Aricio Gamarra, has had a strong incentive to extend his customer base – which partly explains the fast growth of small-scale systems in Asunción in the 1990s (cp. Table 11).

Yet private, small-scale providers suffer from a lack of political and often formal legitimacy. From a legal point of view, investments in growth are risky and external financing is difficult to obtain. As shown, small-scale providers can make good money. So why is it that water network providers such as YBU (around 1’000 connections) remain small and geographically very limited? The story of Asunción’s water entrepreneurs provides a good indication of typical obstacles for small-scale providers. Prior to the year 2000, no legal framework existed in Paraguay for the water sector and small-scale water suppliers filled the gaps left by large-scale providers – connecting 10’000 new households every year. The small-scale providers helped improve water coverage but in a chaotic and uncontrollable way.

<table>
<thead>
<tr>
<th>Table 10 – Obstacles to Scale &amp; Enabling Factors for Replication</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>OBSTACLES TO SCALE</strong></td>
</tr>
<tr>
<td>Cost Recovery</td>
</tr>
<tr>
<td>ESSAP</td>
</tr>
<tr>
<td>SAGUAPAC</td>
</tr>
<tr>
<td>YBU</td>
</tr>
<tr>
<td>COOPLAN</td>
</tr>
</tbody>
</table>

Source: Based on case study data and Hammond, Kramer, Katz, Tran, & Walker, 2007.
Table 11 – Price Margins of Operators for Low-Income Customers

<table>
<thead>
<tr>
<th>Operator</th>
<th>PRICE (15m³) – incl. taxes</th>
<th>OPERATIONAL COST (15m³) – incl. taxes</th>
<th>MARGIN/ MONTH</th>
<th>MARGIN/ YEAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAGUAPAC</td>
<td>US $5.75</td>
<td>US $6.54</td>
<td>- US $0.79</td>
<td>- US $9.48</td>
</tr>
<tr>
<td>ESSAP</td>
<td>US $4.78</td>
<td>US $5.71</td>
<td>- US $0.94</td>
<td>- US $11.22</td>
</tr>
<tr>
<td>COOPLAN</td>
<td>US $4.6</td>
<td>US $4.8</td>
<td>- US $0.2</td>
<td>- US $3</td>
</tr>
<tr>
<td>YBU</td>
<td>US $11.3</td>
<td>US $5.60</td>
<td>+ US $5.7</td>
<td>+ US $68.4</td>
</tr>
</tbody>
</table>

Consequently, in 2000, a new legal framework was established, which restricted private property in the water sector to 10-year operational licences. Even though the law has not been fully implemented, the growth of small-scale systems has stopped almost entirely. Today, the water demands of the 50’000 immigrants to Paraguay’s capital are absorbed either by small-scale community systems (subsidized through the government agency SENASA) or by large-scale provider ESSAP. Without political and formal legitimacy (cp. Table 8), it has become too risky for private, small-scale providers to make major infrastructure investments. Moreover, private entrepreneurs find it increasingly challenging to obtain credit from banks or other finance institutions as long as the legal status of private small-scale networks has not been resolved. Nowadays, many entrepreneurs try to minimize maintenance costs and capital investments in order to save their profit margins for as long as possible. Legitimacy and a favorable legal framework are thus key factors to enabling growth and the reproducibility of the small-scale model in other locations.

Further enabling factors for replication include the availability of water resources, a minimum degree of buying power among users, and an adequate skill level among staff members. Easy access to water resources is particularly important for small-scale providers as they cannot afford to invest in expensive sourcing facilities. In all the cities I studied, small-scale providers relied on easily available groundwater resources. It is unlikely that clusters of small-scale network providers would spontaneously emerge in areas where access to water is challenging, such as the desert city of Lima, Peru.

Furthermore, among the water community it has become widely accepted that domestic water expenses should not exceed a certain threshold, usually 5% of household income (Cain, 2009, p. 13). For this reason, water networks will hardly ever be able to profitably extend coverage to citizens in extreme poverty. Efficient small-scale networks, however, have the potential to extend water networks to lower tiers of the income pyramid. With an average consumption of 15m³ per month, the large-scale networks in these case studies can provide water profitably to populations with an income higher than US $1’700/year. The two small-scale providers outperform the large-scale networks in terms of efficiency and have the potential to include income tiers down to US $1’300 per year.
Finally, the potential for growth and replication also depends on an organization’s employee skill sets. I have already discussed the need for a highly skilled workforce in large-scale organizations; the success of privately-owned, small-scale networks, on the other hand, depends on the competence and skill set of a single entrepreneur. Successful organizations are more likely to emerge in areas with a sufficient supply of qualified human capital and entrepreneurs.

4.4 Conclusions

From an efficiency point of view, the two small-scale providers I observed were able to supply water at a lower cost (around US $0.05/m$^3$) than their large-scale counterparts. Small-scale networks have an infrastructure tailored to the needs of low-demand/low-income residential customers whereas monopolistic providers operate networks with a bigger capacity (more powerful production equipment, wider pipes, etc.) designed to meet the needs of high-demand, usually non-residential users. The management of large-scale networks – the operation of production plants, the monitoring of the network, the management and monitoring of human capital, the fight against corruption etc. – is complex. Large-scale water utilities either experience high water losses or invest in human capital to overcome inefficiencies. Both paths increase the costs of operation compared to smaller systems. Moreover, efficiency advantages of small-scale operators do not come at the cost of lower effectiveness, though both large- and small-scale providers sometimes struggle with problems of water quality and uninterrupted service.

In terms of legitimacy, both large- and small-scale operators have weaknesses. Large-scale providers typically find it challenging to include users in the decision-making process. Small-scale providers, on the other hand, fail to incorporate political systems into the governance process either directly or indirectly. The lack of political legitimacy of small-scale operators also reflects in a low environmental sustainability. For weak regulators in developing countries, monitoring the environmental behavior of hundreds of operators is too complicated and costly. While the legitimacy problems that large-scale providers face constitute a long-term issue, the lack of political legitimacy can immediately create investment ambiguity for small-scale systems. The lack of legitimacy is therefore an urgent issue for small-scale operators.

The lack of efficiency of large-scale operators and the lack of political legitimacy of small-scale providers are key obstacles to growth and replication for both of the two models. Table 12 recaps these results indicating with the tick and the “X” sign if the size of the operators is suitable to attain the defined performance goals or not.
Table 12 – Performance of Large- and Small-Scale Utilities

<table>
<thead>
<tr>
<th></th>
<th>LARGE-SCALE OPERATORS</th>
<th>SMALL-SCALE OPERATORS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficiency</td>
<td>X</td>
<td>✓</td>
</tr>
<tr>
<td>Effectiveness</td>
<td>✓ / X</td>
<td>✓ / X</td>
</tr>
<tr>
<td>Legitimacy (Political)</td>
<td>X (✓)</td>
<td>X (✓)</td>
</tr>
<tr>
<td>Environmental Sustainability</td>
<td>✓</td>
<td>X</td>
</tr>
<tr>
<td>Scalability / Replicability</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>
5 Implications of Empirical Results for Existing Models

Having summarized the empirical situation on the ground, I tackled the issue as to how the findings compare with the existing theoretical arguments on operators’ size. I particularly emphasized the question of why the concept of economies of scale appeared to fail among the cities studied, which part of the economies of scale argument did not apply, and would another theoretical model be able to describe the reality of water supply in a better way?

5.1 Limitations of the Economies of Scale Argument

Scholars typically invoke two claims to justify large-scale utilities in the water sector. First, economic textbooks describe urban water supply management as an example of natural monopolies with very high fixed costs and negligible variable costs (Mankiw, 2004, pp. 316-318). Therefore, utilities can only reduce average costs through an increase in scale that justifies the establishment and protection of large-scale monopoly providers (Kim H. Y., Economies of Scale in Multi-product Firms: an Empirical Analysis, 1987, p. 185).

Second, water, as a good of fundamental social relevance, must be put under regulation of the general public, typically represented by the government (Nauges & van den Berg, 2007, pp. 19-20; Cowen & Cowen, 1998, pp. 35-39; Solo, 1998). The regulation process implies transaction costs. The more providers, the higher transaction costs. Large-scale, monopoly supply is thus the most efficient and effective regulation model in terms of transaction costs.

From the case studies conducted in Asunción and Santa Cruz, however, it became clear that at least in terms of efficiency, large-scale operators are not necessarily superior to small-scale operators. The two small-scale providers examined had lower overall expenditures than their large-scale counterparts (cp. Figure 7 & Figure 8). The discrepancy between theory and practice can be traced back to two flawed theoretical foundations of the natural monopoly argument concerning the structure of the fixed costs and the long-term flexibility of infrastructure investments.

5.1.1 Structure and Flexibility of Fixed Costs

In a natural monopoly scenario, by far the most relevant costs are the fixed costs (Mankiw, 2004, pp. 316-318). The fixed costs of natural monopolies differ from those of other suppliers through high investments in capital assets. Many practitioners and scholars in the sector have absorbed the natural monopoly argument, claiming that fixed costs account for more than half of water suppliers’ total costs (Bishop & Weber, 1996, p. 16; Turnquist, 2010, p. 11).

High shares of CAPEX to total costs are more likely to be found in small systems where the infrastructure costs must be distributed over a small volume. Take, for
instance, the example of Zollikon, a small municipality in the suburbs of Switzerland’s biggest city, Zurich, where the local water supplier manages around 6’000 connections. At such small scale, the capital assets on the balance sheet amount to roughly 90% of the total costs (Netzanstalt Zollikon, 2010).

In large-scale systems, however, the situation looks different. Most costs (60%-90%) may be fixed in the short run, but at least half of these costs refer to operational (particularly salaries) and not capital expenditures (E. Mück, Interview, 4 January 2013). Capital expenses typically account for only 20% to 50% of total expenses (J. Brunner, Interview, 7 January 2013). For example, around 210’000 households exist in Zurich, Switzerland’s largest city. The public water supplier manages capital assets of around US $219 million on the balance sheet and calculates fixed costs at around 80%-90%.23 The annual report for the year 2011 shows that capital expenditures account for 30% of the total costs. Considering the contributions by users and the public sector to the capital expenditures (approximately 25% of total investments over the last five years), the share of CAPEX increases to about 36.5% of total costs (Wasserversorgung Zürich, 2012).

In such a scenario, where more than 63% of the costs are operational, there is no exclusive way to reduce costs through an increase in scale. Most of the operational – in the short run fixed – costs (including personnel, spare parts, etc.) do depend on scale and can be expanded or cut over time. Against this argument, the differences between network industries and other competitive markets with high capital costs diminish. Examples are car manufacturing, insurance, or real estate businesses (Primeaux, 1986, pp. 5-7).

Yet, how has the application of the natural monopoly theory to water operators become accepted while its empirical validity seems to be less clear? Among the texts studied in the course of this thesis, hardly any author backs the assumption of economies of scale with quantitative data. Economist Walter J. Primeaux (1986, pp. 175-176) in contrast points out in his book about direct competition between electric utilities in 10 communities in the US that, contrary to the theory, prices are actually lower where multiple suppliers operate.

Several authors have therefore warned about a general application of the economics of scale concept to network industries (DiLorenzo, 1996). They claim that competition in network industries was common in the 19th century and that the acceptance of natural monopolies in practice traces back to the early decades of the last century. In the context of two world wars and the rising importance of the state, lobbyists from different sectors tried to obtain monopoly protection from governments – e.g. real estate, agriculture, air transport (Gray, 1940). While some industries failed, many network industries (gas, cable television, communications, electricity, water) became protected public utilities.

23 Assuming an exchange rate of US $1 = CHF1.
Coming back to the case studies in Bolivia and Paraguay, the numbers collected indicate that the range of capital costs for both large- and small-scale operators is between 19.5% and 32% of the average total costs/m³ billed (cp. Figure 6). These results are not surprising for the two large-scale operators studied, as the prior example of Zurich showed similar values. Yet, it is remarkable that even the small-scale systems examined succeed in keeping the share of capital expenditures low, especially in contrast to the previous example of a small municipal water supplier in Switzerland. The small-scale systems COOPLAN and YBU have applied a cost-conscious attitude, restricting the expenditures to the most basic and tailoring the infrastructure to the needs of a low-income/low-consumption population (see next section).

With the operational expenses accounting for 68% to 81.5% of total costs, operational differences between large-scale and small-scale providers become much more relevant than theoretically assumed under the natural monopoly theory with very rigid fixed costs. In other words, the observed gap in operational costs between the large-scale and small-scale operators studied is important because the impact of the OPEX on the total costs structure is much higher than anticipated under the natural monopoly theory.

The underestimation of operational costs is linked to an underestimation of the importance of operational complexity. Large-scale operators run technically complex production facilities; they monitor extensive networks, partly situated in informal neighborhoods, and they coordinate the leadership of hundreds of employees, including corruption prevention. The management and operation of such complex organizations requires highly qualified personnel.

Small-scale networks have a technically simple architecture. They often depend on the skills of a single manager or entrepreneur supported by a few low-qualified employees. The monitoring of these small networks and the staff employed is uncomplicated. Small-scale operators naturally find it easier to keep water losses low and operations streamlined (cp. Table 6).

As predicted by the economies of scale theory, average costs decrease for a small scale operation because self-supply has disproportionally high capital costs and is therefore more expensive than sharing the costs of water supply within a system. For a large scale, the average costs however appear to again rise, reflecting a higher degree of management complexity for large operators (Kim & Clark, 1988; Nauges & van den Berg, 2008, pp. 17-18). While the scarcity of studies makes it impossible to draw a detailed average cost curve (cp. Figure 11), including point of inflection and shape of the curve, it has become evident that the direction of the described cost relation differs from the one of a natural monopoly – whose shape is continuously decreasing (cp. Figure 2).

24 The figures exclude taxes.
5.1.2 Structure and Flexibility of Capital Costs

The natural monopoly model adapted to the water sector implies high, long-term fixed costs and, in addition, a fixed set of capital costs. It suggests that independent from scale, operators have to use a minimum set of production, treatment, and distribution equipment whose costs are given for every provider. Small-scale systems therefore have higher capital costs, as they must recover the fixed costs with fewer consumption units available.

In developed countries, this equation may apply up to a certain extent – as observed from data of a water operator in a Swiss municipality. However, the case studies, and in particular the example of the private, small-scale system YBU, show that in developing a country’s infrastructure, costs can be reduced to a very basic level. In developing settings, the technology is only fixed in the short-run. In the long run, water utilities can reduce the capital assets to the basic needs of small, low-income communities (cp. Figure 6).

In developing countries, small-scale operators keep the costs low by using infrastructure tailored to households with smaller consumption levels (cp. Table 5). Different from large-scale systems, they can, for instance, tap more accessible water reserves and install distribution pipes with lower diameters (reducing material and trench costs). Aricío Gamarra, owner of the small-scale network YBU, built the basic production (borehole with 112 meter profundity) and distribution facilities 20 years ago with only US $30’000; at that time, the network served 150 households (US $200 investment per connection).

At a capacity of 140 to 150 connections, around 22% of the investments of small-scale water networks trace back to excavations, 33% to the production equipment, and 44% to the distribution system (25% pipes; 75% household connections) (G. Heredia, Interview, 11 January 2011). With 66% of the costs related to distribution (production and construction), it becomes clear that only a minor part of the assets is relatively fixed, contrary to what the natural monopoly theory predicts.

However, on the basis of the data collected, it is not possible to determine if, on a citywide scale, the capital costs of all small-scale networks together are lower than
those of a monopoly network. Still, the cases have shown that the infrastructure can be adapted in response to the size and characteristics of the population. A moderate, “fixed” investment of around US $10’000 is already enough to establish the basic production facilities for a small-scale network.

In developed countries upfront capital costs of small-scale systems can instead add up to US $10’000 per household. In Thalwil, a small town with 17’500 inhabitants at the lake of Zurich, Switzerland, the local operator estimates the infrastructure costs for the production and distribution assets at roughly US $100 million. This thesis determined the cost gap between small-scale operators in developed and developing settings to be related to several reasons (A. Bucher & G. Hagmann, Interview, 18 January 2013):

- **High labor costs** make constructions in developed countries very expensive. In Thalwil, one pipe meter has an equivalent value of approximately US $1’000. Of this amount, roughly US $500-$800 corresponds to labor costs.

- The high costs of labor are an incentive for water operators in developed countries to increase the degree of automation of processes. The systems operate almost independently. The staff just supervises the facilities, reacts upon an emergency, or works in the back office. A high degree of technological automation raises the costs of infrastructure. Operators in developing countries instead rely to a higher degree on human workforce.

- Systems in developed countries achieve higher performance goals in terms of quality, pump pressure, service security and other indicators. In Thalwil, for example, the water system operates with a network pressure between 3 and 10 bar whereas pump pressure in the case studies fluctuates between 1.5 and 2.5 bar. In Thalwil, the operator treats the water with modern, but expensive UV technology. In small-scale networks in developing countries, the treatment process is often restricted to cheap, but effective chlorination. While small-scale networks in developing countries typically operate close to full production load, operators in developed countries must calculate with substantial production margins in order to guarantee 100% service security in peak hours. The higher performance goals in developed countries typically trace back to more restrictive laws.

- In Europe, legal water frameworks often force operators to build drinking water systems that are able to provide sufficient volumes of water to the fire service in the event of an emergency. The pipes of operators in those countries have therefore bigger diameters, even in smaller systems. In Thalwil, the primary network consists of pipes with a diameter of 60 inches – compared to

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25 Acquisition value
approximately 10-15 inches in the case studies. In addition, the local water operator of Thalwil possesses enormous water reservoirs only to respond to major fire events in the municipality.

5.2 The Importance of Capabilities

While over the last 30 years many researchers in the water community have discussed the impact of incentives on performance, empirical results from the field show that research should turn the focus to the input side of supply management. In other words, whether a utility operates efficiently depends more on the capabilities, or, in management terms, the “core competencies”, of a utility than on the exogenous incentive structure.

The underlying capability approach traces back to Nobel Prize laureate, Amartya Sen, and stands in contrast to the dominant output-oriented concepts of development, which simplistically focus on income in the form of the GDP/capita as the only relevant indicator for development. The capability approach, in contrast, places human capabilities in the centre of development. It empowers human beings to freely choose between different ways of living. Even though Sen does not provide a list of specific capabilities or functionings, his thoughts led to the elaboration of the Human Development Index (Kuklys, 2005, pp. 9-10).

Sen differentiates among commodities, capabilities, functionings, and utility (Clark, 2005, p. 3). Commodities, such as water, labor, or money, take the role of a necessary input. However, commodities themselves are not the goal, and countries, organizations, or human beings need to transform commodities in order to reach a specific functioning. Functioning is here defined as a desired achievement - for instance the efficient operation of a water operator - and capability as the ability to reach this achievement (Alkire, Qizilbash, & Comim, 2008, p. 2). The functioning eventually leads to the fulfillment of a utility, such as the satisfaction of the population’s water needs.

The capability approach has been applied to different disciplines, management being one. In the 1980s, an outside-in perspective with Michael E. Porter’s five forces model dominated the discourse on strategy. According to Porter, to succeed, firms had to position themselves in a profitable market niche, preferably with high market barriers, few substitutes or imitations, little bargaining power by customers or suppliers, and few competitors (Porter, 1979).

In the 1990s, an inside-out perspective was added to the debate, claiming that a firm’s success depended on a set of core competencies that enable firms to offer superior products and services to their competitors. A core competence consists of the know-how and the practical experience necessary to outperform in different contexts (Rüegg-Stürm & Johannes, 2002, pp. 56-58). Commonly, company success is explained by visible factors, such as a particular pricing strategy, generous
customer service, or a smart product design. However, these explanations only open the frame for a bigger question, namely the following: What are the underlying conditions that enable companies to offer lower prices or generous customer service? The “success lies deeper, in a set of strategic business decisions that transformed the [in casu: Wal Mart] company into a capabilities-based competitor”. For long-term success, a company, and particularly its employees, needs to build up a set of capabilities, such as “speed”, “consistency”, “acuity”, “agility”, and “innovativeness” (Stalk, Evans, & Shulman, 1992, p. 58; 63). The firm can promote the development of such capabilities through, for instance, investments in human capital (e.g. trainings) or through the creation of a positive learning environment (e.g. an open-minded working space).

Strategy literature has generally accepted the positive impact of knowledge on the performance of organizations (von Krogh, 2002, p. 244). The divergent examples of the two large-scale utilities, SAGUAPAC and ESSAP, illustrate this relationship. SAGUAPAC has been aware of the value of its employees for years. It pays competitive salaries and continuously invests in the development of its employees. SAGUAPACs attractive office building has an open interior design, meant to stimulate transfer between the different departments. The utility promotes a strict anti-bribe policy, reflected in a poem about honesty by Ruy Barbosa hanging on the wall of every office. In Santa Cruz, SAGAUAPC is considered among professionals as an attractive employer, and employees stay with the firm an average of 15 years. Vacancies are usually re-staffed with internal candidates, fostering organizational stability. Most of the people interviewed in Santa Cruz for this thesis regarded the careful development and care of human capital in SAGUAPAC as a major factor for the operational efficiency of the utility. SAGUAPAC’s appraisal of human capital pays with efficient performance indicators. SAGUAPAC loses only 25% of its water produced, 20% of which are physical network losses (cp. Table 6).

In ESSAP - Asunción’s large-scale operator - on the other hand, management staff usually changes with every new president elected. A meritocratic culture does not exist, and important positions are often awarded for political favors. The salaries are too low across the organization to attract desirable graduates, leading to an overall low skill level among employees. ESSAP has to repeat network repairs after only short periods of time. The perceived incidence of corrupt practices in the company is high, reflected by the slow service procedures – “to speed up a process, some extra money can help”. ESSAPs low capability level shows up in high water losses of 51%. Despite considerable efforts and investments to improve distribution through the creation of a management department for the control of water losses and through the renewal of the infrastructure, the average percentage of water losses has remained

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26 Based on data from top-performing utilities in developing countries, a benchmark of 23% of water losses has been proposed as a target by World Bank professionals. Utilities in developed countries have on average losses of 16% (Tynan & Kingdom, 2002).
constant over the last five years. Due to such water losses, ESSAP loses US $0.08 with each cubic meter consumed.

This experience suggests that experts should consider more the impact of capabilities. To efficiently overcome the complexity of large-scale operations, utilities need to build up and maintain an adequate capability structure through investments in the quality of their human capital (Worch, Kabinga, Eberhard, Markard, & Truffer, 2012). The detailed set of required capabilities can vary from case to case, ranging from technical over social competences to the ability of the employee to make informed ethical decisions. The process of developing capabilities has been discussed by other authors (Dominguez, Worch, Markard, Truffer, & Gujer, 2009).

Nonetheless, investments into the capability structure have a cost, reflected by higher spending on human capital for competitive salaries, continuous trainings, etc. (cp. Figure 10). The buildup of a superior capability structure is, in this light, only one option that urban water planners have in order to reach operational efficiency. Developing countries typically suffer from low education levels and high incidences of corruption (Todaro & Smith, 2006, p. 367). To deal with this low-capability environment, urban water planners can promote an alternative small-scale operation model, transforming water provision into a low-capability business. In this model, they would only replicate what is already common in other more competitive sectors. Apple, for instance, designs its smart products in California and produces them cheaply in China. The underlying logic here is that high-capability jobs are best operated in high-capability countries, whereas low-capability tasks are best placed in low-capability countries.

Large-scale water provision is in this sense a model tailored to the high-capability environment of the developed countries, replicated in the contrary context of developing countries. In fact, large-scale operators have trouble dealing with the complexity of business in an environment with a low-skill work force and corruption. In developing countries, qualified candidates are scarce and expensive. Small-scale providers have adapted to the low-capability reality by reducing the complexity of water network operation. Thanks to the simplicity of their networks, they do not need to look for an expensive, highly qualified workforce. Operators can easily monitor all activities and rely on support from low skilled human capital to keep the operations efficient.

5.3 Costs of Supply versus Costs of Regulation

From a pure supply efficiency point of view, according to what has been said in the last section, urban water planners in developing countries should implement a small-scale supply model to avoid the expensive buildup of capabilities in large-scale utilities. Water, however, is different from other goods because it represents the basis of human life. The government is expected to take an active role in guaranteeing fair and safe distribution among all members of a society, including future generations. In
this context, regulating agencies have been created over the last decades in many countries, either at the national or at sub-national levels.

Regulation, however, generates costs linked to the transactions between the regulator and the operator(s). These costs are influenced by different factors, such as the number of operators, the intensity and scope of regulation, the transaction channels, the self-compliance of operators, or the formality of the city landscape (cp. Figure 12). The transaction costs tend, for instance, to be high in a city whose water operators are largely active in informal areas, relying on personal contact with the regulator, and where the scope of regulatory tasks is wide, but the degree of self-compliance low.

Overall, with other factors fixed, transactions costs increase with the number of operators. However, it is unclear in what form the average regulation costs develop depending on the number of operators. Do they increase constantly with the number of operators, do they decrease at the first units (due to economies of scale in regulation) and increase from a certain number of operators on (complexity costs), or do they first increase slightly and exponentially rise at a higher number of operators?

These open questions reveal a data gap of this thesis in the area of regulation. The information collected highlights processes and structures around the operators. For a complete picture of urban water sectors, it would however be necessary to repeat the research exercise with regulators being the center of attention to investigate the structure and development of regulation with regard to scale. Still, despite this gap, it will be possible to gain important insights assuming at this stage, on the basis of the Asunción case, constantly increasing regulation costs with scale.

Figure 12 – Influencing Factors on Transaction Costs
Bringing the two sides together, the decision to adopt a specific model therefore amounts to a trade-off between supply and regulation costs (cp. Figure 13). In a large-scale model, the capability requirements are high, so operationally efficient operators continuously spend money for the buildup and maintenance of competencies. As there is only one operator and one regulator who, over time, become used to each other’s procedures, the transaction costs are comparatively low.

In a small-scale model, the capability requirements to run the network are low and the operators do not need to build up exceptional competencies. Moreover, they operate an infrastructure tailored to the specific needs of the users served. The regulation efforts in contrast are, in such a model, enormous and expensive, but necessary to coordinate a legal water framework between the regulator and a chaotic puzzle of hundreds of independent operators.

To find a way out of this gridlock, an alternative model should ideally feature both low costs of supply and low costs of regulation. I therefore sought, in a second stage of this research project, alternative models of water network provision, which may represent an improvement to the two described models by either reducing the regulation or the supply costs. In this search, I relied on a project database with around 150 cases from a former consulting assignment and on the advice of my thesis supervisors. First, I found in Brazil the so-called condominial design for urban water (and sanitation) networks, meant to reduce supply costs through the replacement of individual with condominial connections. I made a second discovery in Maputo in the light of a chaotic, informal small-scale sector. The public asset holder, FIPAG, is pursuing in Mozambique’s capital a project towards a formalized small-scale water sector with the potential to control the costs and challenges of regulation.

Figure 13 – Trade-Off between Regulation and Supply Costs

<table>
<thead>
<tr>
<th>Regulation Costs</th>
<th>Supply Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small-Scale Model</td>
<td></td>
</tr>
<tr>
<td>Large-Scale Model</td>
<td></td>
</tr>
</tbody>
</table>
6 Empirical Analysis of Hybrid Utilities

In September/October 2012, I traveled to Parauapebas in the Brazilian Amazon, in order to study the potential of the condominial network design on reducing the supply costs of large-scale utilities. But, confronted with the limitations of the Brazilian case, I shifted in a second phase my attention to Maputo (Mozambique), the locality of the second case study, where I had discovered a model with a greater potential of low supply and regulation costs. Again, a detailed documentation of the case studies is presented in the annex.

6.1 Condominial Water Network in Parauapebas

Along the lines of the case study framework used in Asunción and Santa Cruz, the Parauapebas case starts with an overview of the urban context, with a particular focus on the water sector. I then evaluate the potential of the condominial design, both in general and applied to Parauapebas, to sustainably provide low supply and regulation costs.

6.1.1 Overview of Parauapebas’ Water Sector

Twenty-five years ago, the “Companhia do Vale do Rio Doce”, now known as VALE, built the city of Parauapebas near the rapidly developing Carajas mine – today the largest iron ore mine in the world. The city transformed quickly into an “El Dorado” for migrants eager to capture a slice of the mining fortune. Today, Parauapebas, with around 165’000 residents, is one of the fastest growing cities in Brazil (+6.4%/year).

In the early 1990s, the demand for a proper infrastructure for basic services rose in conjunction with the population growth. By 1993, 75% of the approximately 25’000 inhabitants did not have any access to a piped water supply. The World Bank, VALE, and the municipality therefore agreed to construct a conventional water and sewage system. The project was pre-financed through a US $14.5 million World Bank loan managed by VALE and amortized over time with 25% of the royalties regularly paid by the mining company to the city. However, in 1996, after the construction of the production facilities, the partners (World Bank, VALE, and the municipality) realized that the remaining money would not be sufficient to finance the planned distribution network. The private firm “Condominio Empreendimentos Ambientais” was invited to present a proposal of an innovation in Brazil’s WASH [water, sanitation, and hygiene] sector, the so-called condominial system. Under the condominial model, the entire network would be split into small housing blocks, or condominiums, of around 15 users. Each condominium would share one connection to the main network and have a specially-designed infrastructure tailored to local needs. “Condominio Empreendimentos Ambientais” promised to cut the costs of the network by more than
70%. The local partners eventually accepted the proposal for the establishment of a condominial delivery system. Construction works completed in 1997.

As the municipality did not have any expertise in water and sanitation, it entrusted the operation of the network to “Condominium Empreendimentos Ambientais”. At the same time, the city created a regulatory unit, the “Municipal Water and Sanitation Service”. By 2005, however, a new local government took power, and the private operator fell into political disgrace. The Municipal Water and Sanitation Service assumed control, blending the functions of legislation, regulation, and operation all within the city government. Due to the de-prioritization of water metering and cost-adequate pricing and billing by local politicians, water service in Parauapebas has dramatically deteriorated in the years since 2005.

Table 13 – Water Sector Parauapebas

<table>
<thead>
<tr>
<th>CITY</th>
<th>OPERATOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population:</td>
<td>Population reached with piped-in household water:</td>
</tr>
<tr>
<td>Around 165'000 people live in the city of Parauapebas.</td>
<td>58% Municipal Water and Sanitation Service + around 27% clandestine connections; rest self-supply (mostly domestic boreholes)</td>
</tr>
<tr>
<td>Population reached with sewage system:</td>
<td>Around 7%</td>
</tr>
<tr>
<td>Sewage treated:</td>
<td>100%</td>
</tr>
<tr>
<td>Population growth:</td>
<td>Growth of new users:</td>
</tr>
<tr>
<td>Around 10'500 incoming residents every year (+ 3'500 new households/year) – <em>basis year 2005</em></td>
<td>Around 2’300 new connections per year – <em>basis year 2005</em></td>
</tr>
</tbody>
</table>

6.1.2 Concept of Condominial Water Networks

Condominial sanitation systems arose in Brazil in the 1980s/1990s as an alternative to conventional sewage systems. The main promoter of condominial networks, José Carlos Melo, wanted to create a sanitation solution tailored to the technological and social realities of developing countries. He was convinced that policy makers in the water sector had just imported the models and technologies of textbooks from developed countries, without a prior consideration of the particular needs of cities in the developing world. However, those cities were and are different. The urban planning in developing countries may be chaotic and the income differences between
citizens are often big. Therefore, José Carlos Melo wanted to create a water supply adapted to the Brazilian reality (C.A: Rissoli, Interview, 8 October 2012).

Condominial sewage systems were built in several Brazilian cities, including Recife, Salvador o Petrolina (Melo, 2010). It even became the exclusive model for the capital, Brasilia, where the houses of both high-ranking government officials and low-income dwellers are linked to a condominial sewage network. The use of condominial systems to supply water is much less widespread. Parauapebas is the only city with an exclusive condominial water supply system, but other South American cities, including Rio de Janeiro, Lima, and La Paz, have experimented with condominial systems for water distribution. José Carlos Melo believes that condominial sewage is more widespread than condominial water systems because of the lack of development of Brazil’s sanitation sector.

The term “condominial” indicates a model in which neighbors within a housing block (cp. Figure 14), the so-called “condominium”, share a water or sewage branch connected to the main water or sewage network. Condominial systems differ from conventional systems, in which individual branches connect houses to the main network (Melo, 2007, pp. 39-40). The condominial design has two key advantages. First, it reduces the length of the main network, typically the most expensive part of the water system. Condominial branches with smaller pipe diameters replace the expensive individual connections. Second, the pipes and connections are constructed in accordance with the geographical requirements of a specific condominium, which allows for a reduction in excavation costs. In some condominiums, the pipes are situated within the users’ land plot, while in others they are situated outside the property. Both the smaller diameters and the optimized location of pipes help to reduce the cost of excavations. Typically, around 50% of the savings associated with the use of the condominium systems come from the reduction of the length of the main network, and the other 50% from the lighter construction works.

Conceived as a water supply solution tailored to the conditions of the developing world, a social dimension informed the original design of the condominial system. Often, high connection prices or opposed cultural habits prevent residents in low-income areas from connecting to available conventional sewage systems. (L. Mindreau, Interview, 23 October 2012). Therefore, the condominial design has been applied alongside community mobilization activities, which involve community members in the planning and even the construction of the network. However, in many areas community involvement has been lackluster. Whereas community participation in planning continues to be part of the condominial concept to a certain degree, resident involvement in construction has been dropped in most cases. Moreover, the problem of low connection rates does not apply to water in the same way it applies to sanitation because every human being requires water.
6.1.3 Implementation of Condominial Water Networks in Parauapebas

After the construction of a production and treatment plant in 1996, it became clear that the US $7.8 million World Bank loan to develop the water sector in Parauapebas would not cover the costs of building a distribution network at a calculated cost per water connection of US $167 (excluding the costs of the production and treatment facilities). Based on previous positive experiences with condominial sewage systems in Brazil, Parauapebas city authorities, the mining company VALE, and the World Bank decided to hire Jose Carlos Melo’s firm “Condominium Empreendimentos Ambientais” to establish and initially operate a condominial water network. The company immediately reduced the length of the main network by 85% – from 287km to 43km. Keeping other performance goals fixed, the condominial design cut the cost per connection by US $123, with 44% of the savings accountable to smaller pipes and 56% accountable to lighter excavations (Melo, 2005, pp. 39-54).

The amount of money saved did however not include the costs of community mobilization, necessary to involve the population and to adapt the architecture of the network to the specifications of each condominium. In a condominial project in La Paz, these costs were estimated at US $28/connection (Foster, 2001, p. 7). If expenses for social mobilization in Parauapebas were comparable, the condominial network would still have been built at a considerably lower cost (57%) than the originally proposed conventional grid system (cp. Table 14).

The condominial model generates substantial savings in terms of capital expenditures. However, it does not differ from a conventional model when it comes to operational expenditures, which account, at least among the case studies observed, for 62%-87% of all costs (cp. Figure 6). A smart condominial design cannot save a provider from an inefficient overall cost structure. In 2005, water operations in Parauapebas were transferred from the private concessionary firm to the municipality. Despite the innovative, condominial network infrastructure concept, network operations have deteriorated since that date. The percentage of people with...
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micro measurement has decreased from around 77% in the year 2000 to approximately 47%. Physical water losses officially amount to 40% of water produced, but actual production volume figures and the revenue structure suggest water losses of around 60%.

The amount of loss increases with the number of client accounts that are not settled. The number of users who pay their bills decreases before elections in particular. My visit in early October 2012 overlapped with municipal elections in Brazil. In the months prior to elections, the share of accountholders who paid their bills on time dropped below 30% while operational expenses doubled. The billed cubic meter of water has an operational cost of US $1.35 (excluding taxes). Tariffs charged to users are far from covering these costs. Therefore, municipal budgets must cover operational deficits (in 2012 around US $4 million).

As any additional user would further stress the financial performance, the percentage of the population covered by SAEEP has not increased beyond 60%. The number of people without access to piped-in water increases by around 3'600 per year. The bottom line is that even with the most progressive network technology, problems of scale cannot be solved if the operator manages the network in an inefficient and unsustainable manner.

Overall, the condominial model has repeatedly been exposed to criticism both from within and outside of utilities. In a project at SEDAPAL, Lima’s monopolistic water provider, the condominial model was established for low-income populations only and involved strong community participation even in construction. Local politicians misunderstood the model and started to denounce the condominiums as an inferior alternative to conventional water systems which had continued to be the option for the wealthier parts of the city: “Why should the poor use a different water grid than the rich, and why should they be required to physically participate in construction?” (L. Mindreau, Interview, 23 October 2012). Hampered by these political tensions, the local water utility SEDAPAL has not pursued the model any further in the Peruvian capital. In Brasilia, the operator CAESB avoided this legitimacy trap by turning the condominial model into the only alternative for both the rich and the poor.

<table>
<thead>
<tr>
<th>Table 14 – Costs/Connection of Conventional versus Condominial System</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CONVENTIONAL SYSTEM</strong></td>
</tr>
<tr>
<td>Excavation</td>
</tr>
<tr>
<td>Pipes</td>
</tr>
<tr>
<td>(287 kms main network)</td>
</tr>
<tr>
<td>Community Mobilization</td>
</tr>
<tr>
<td>TOTAL&lt;sup&gt;27&lt;/sup&gt;</td>
</tr>
</tbody>
</table>


<sup>27</sup> Excluding costs of micro meters.
Another source of criticism often comes from the inside of utilities. The condominial model shifts the working routine for employees from a technology-push to a demand-pull approach. In a conventional model, employees are expected to build and operate a standardized “textbook” network, independent of social and economic variables affecting customers. In a condominial model, in contrast, employees are expected to first contact the users to incorporate the geographical particularities and the users’ needs in the design of each condominium. This shift in procedure removes employees from their protected working environment and exposes them to the criticism of users. The process of changing from a conventional to a condominial provider can therefore provoke heavy internal resistance (K. Neder, Interview, 8 October 2012).

6.2 Formal Small-Scale Systems in Maputo

The second case on Maputo begins as well with a review of the urban context and its water sector. I then use the familiar case analysis framework to evaluate the impact of the model implemented in Maputo (and its sister city Matola) on the five performance dimensions.

6.2.1 Overview of Maputo’s Water Sector

In the context of a civil war (1977-1992), constant population growth, and internal weaknesses, Maputo’s main utility has traditionally left a large portion of the city’s households without access to water. As a result of this supply gap, entrepreneurs in the late 1990s started to establish small-scale networks in the low-income periphery of the capital. These entrepreneurs were often migrants returning from the South African mining industry with enough money accumulated to start a small-scale business back home in Mozambique. Over the last 20 years, around 450 operators have emerged, which is a relatively unique phenomenon on the African continent. These networks manage around 45’000 household connections (100 connections/system) for 225’000 people plus 800 community standpipes.

However, only 10% of the operators manage their business professionally with more than 200 clients, controlling at the same time roughly 50% of the market (Blanc, Cavé, & Chaponnière, 2009, pp. 14-15). Opponents of the small-scale industry inculpate the few professional entrepreneurs of maintaining an oligopoly in order to enforce the relatively high prices of around US $1/m³ of water.

In 1999, in line with a global privatization wave, water operations in Mozambique’s capital were awarded to a private consortium labeled “Aguas de Moçambique” under a 15-year concession scheme. The water multinationals SAUR from France and Aguas de Portugal became the main shareholders. After catastrophic flooding in the city in 2000, SAUR withdrew from the agreement after the regulator for water and sanitation CRA denied approval for an increase in tariffs. Five years after the
establishment of the consortium, the results were disappointing – with Aguas de Moçambique providing water to only 35% of the city population (household connections and standpipes). More than 25% of the low-income population instead benefited from household connections offered by private, small-scale operators.

With its foreign expertise, FIPAG, the public asset holder in the water sector, then sparked a paradigm shift by beginning to perceive small-scale networks as an opportunity rather than a threat. Three years ago FIPAG started to construct small-scale networks – operated by formal, private franchisees – in Maputo’s periphery. So far, eight systems providing water connections for 30'000 people (6’000 households) have been built. The first phase of the development scheme projects 16 networks to supply water around 320'000 people. In 2011, Aguas de Moçambique, in constrast, was re-nationalized under the new name Aguas de Região de Maputo.

Table 15 – Water Sector Maputo

<table>
<thead>
<tr>
<th>CITY</th>
<th>OPERATOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population:</td>
<td>Population reached with piped-in household water:</td>
</tr>
<tr>
<td>Around 1.875 million people live in Mozambique’s capital, covering the metropolitan areas of Maputo and Matola. Around 700’000 or 37% of the citizens reside in Maputo’s low-income periphery.</td>
<td>23% Aguas de Região de Maputo</td>
</tr>
<tr>
<td></td>
<td>12% independent small-scale networks (30% of the low-income periphery)</td>
</tr>
<tr>
<td></td>
<td>1.5% formal, small-scale networks (5% of the low-income periphery)</td>
</tr>
<tr>
<td></td>
<td>25% standpipes (15% Aguas de Região de Maputo, 10% independent small-scale operators)</td>
</tr>
<tr>
<td></td>
<td>26% purchase from neighbors or other resellers</td>
</tr>
<tr>
<td></td>
<td>15.5% other sources</td>
</tr>
<tr>
<td>Population reached with sewage system:</td>
<td></td>
</tr>
<tr>
<td>&lt; 20% Municipal sewage system</td>
<td></td>
</tr>
<tr>
<td>n/a independent small-scale networks</td>
<td></td>
</tr>
<tr>
<td>Sewage treated:</td>
<td></td>
</tr>
<tr>
<td>50% Municipal sewage system</td>
<td></td>
</tr>
<tr>
<td>Population growth:</td>
<td>Growth of new users:</td>
</tr>
<tr>
<td>Around 65’000 per year</td>
<td>Around n/a per year by Aguas de Região de Maputo</td>
</tr>
<tr>
<td></td>
<td>Around 3’500 per year by independent small-scale networks</td>
</tr>
<tr>
<td></td>
<td>Around 4’000 per year by formal, small-scale networks</td>
</tr>
</tbody>
</table>
6.2.2 Concept of Formal Small-Scale Networks in Maputo

The condominial model proposes a decentralization of the CAPEX. The potential impact of this model is limited because all operational tasks, which account for more than 70% of total supply costs, continue to be managed centrally. The small-scale water provision model as practiced in Mozambique’s capital is a more radical approach that decentralizes both CAPEX and OPEX (cp. Figure 15).

Three years ago, the public asset owner FIPAG devised a franchise model of small-scale networks in reaction to the uncontrollable and chaotic growth of small-scale providers and the inability of the large-scale operator to extend its coverage to the periphery. At each location, FIPAG constructs a small-scale plant and a primary network worth US $240’000 for a potential 3’000 to 5’000 connections. Thereafter, FIPAG calls for tenders. The small-scale entrepreneur with the lowest tariff bid and a good track record receives a five-year concession contract in exchange for a 15% royalty (license fee) paid on water production.

The small-scale operators independently organize and pre-finance the extensions of the secondary and tertiary network to the households. Upon the implementation of the new service, they receive a subsidy from FIPAG of around US $115 per connection. The users contribute US $34 to the connection cost. The operations are monitored and coordinated by FIPAG through a series of performance indicators, such as water losses, water quality, number of clients, or amount of water production. As royalties (license fees) are paid on the basis of production measured at the source, the operators have an incentive to keep the service efficient. Eight out of 16 projected small-scale networks have been put into service by 2011.

Figure 15 – Degree of Decentralization and Cost Impact of Different Supply Models
6.2.3 Implementation of Formal Small-Scale Networks in Maputo

I evaluated the implementation of small-scale systems coordinated by Mozambique’s public infrastructure holder FIPAG on performance. In doing so, I emphasized the dimensions “efficiency” and “legitimacy” to respond to the special objective of this case study series, “finding a model that combines low supply with low regulation costs”.

6.2.3.1 Efficiency

The eight networks established in Maputo have reached an actual scale of approximately 750 connections per network. At this size, the CAPEX weighs heavy on the shoulders of existing users, with an average burden of US $469 per household. FIPAG, however, has designed the infrastructure for a capacity of up to 5'000 connections, potentially reducing the CAPEX per connection below US $200 at this scale.

The operational expenditures of the small-scale networks are low, at around US $0.25/m³. However, unlike independent operators, FIPAG’s small-scale providers are supported by a managing platform that monitors the operations and links operators to stakeholders, particularly to the government and finance organizations. At the current scale, this platform has a cost of US $0.08/m³, raising the total costs of operations to US $0.033/m³ (cp. Figure 16). It is not clear how platform costs will evolve once the small-scale networks further increase in scale.

With 46.5% of total production, the water losses are unexpectedly high. It has not been clarified in detail why this number differs from other small-scale experiences with fewer water losses. First results point at a low quality of the meters installed, at the strong prevalence of illegal connections in Mozambique in general (Chaponniere & Collignon, 2011, pp. 7-8) and at the relatively low impact of production on overall costs. The FIPAG small-scale networks distribute the water with gravity. The energy usage of the systems is therefore low. Water losses in the case have a smaller impact than they do in systems with an electricity-driven distribution of water.

On any account, the losses are still considerably inferior to the 64.5% faced by Maputo’s main utility, former Aguas de Moçambique. Most importantly, the operational costs of the formal small-scale operators are more than 50% lower than they are at the large-scale operator in the city (The International Benchmarking Network for Water and Sanitation Utilities, 2007).

Overall, the project is financially viable (including CAPEX and OPEX), generating around US $3’250 profits per network per year. This implies that the formal entrepreneur would have to pay US $26’150 to FIPAG for managing the platform and for financing 93% of the infrastructure. A comparable informal entrepreneur, however, earns around US $14’500 in profits a year (Blanc A., Small-Scale Private Water Supply Service Providers in Maputo, 2008, p. 13). In order to recruit network operators with attractive conditions, FIPAG therefore charges entrepreneurs only 15% of the turnover (on the basis of the water produced). The US $7’600 that
entrepreneurs currently transfer to FIPAG cover only 30% of FIPAG’s total expenses. Around US $17,500 remain as profits for the formalized entrepreneur. Therefore, at its current size with eight plants, FIPAG loses around US $148,500 each year – exposing the platform owner to the risk of losing US $2.25 million over the systems’ 15-year shelf life. Even at full capacity (16 plants with 5,000 connections), the losses would still amount to about US $1.92 million. In light of this financial disequilibrium, it would be no surprise if the project ended after the implementation of the first 16 plants. The competition from the unregulated operators is thus a real challenge for FIPAG as it works against financial sustainability and, most importantly, against scalability.

Figure 16 – Operational Costs per Cubic Meter (including FIPAG)

![Graph showing operational costs per cubic meter]

6.2.3.2 Legitimacy

The shift between perceiving small-scale supply as an opportunity rather than a threat came as a result of the idea of offering low-income residents a legitimate alternative to informal small-scale supply. The independent operators in Maputo had indeed filled an important gap, but there was no independent control over the quality or pricing of the water supply. The introduction of FIPAG as a public entity, establishing and franchising small-scale systems, and enforcing democratically legitimized quality and pricing standards all represent major advancements. Compared to the chaotic water dissemination by unregulated, informal small-scale suppliers, the accountability of service has improved under the new model through the simplified interaction between the franchisor FIPAG and the national regulator, the “Conselho de Regulação do Abastecimento de Água” [CRA] (cp. Table 16).28

28 Even though, CRA has not assumed yet the active role in the project it should.
Table 16 – Legitimacy Results (including FIPAG)

<table>
<thead>
<tr>
<th></th>
<th>OUTPUT LEGITIMACY</th>
<th>INPUT LEGITIMACY</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Equality of Output</td>
<td>Involvement of Users in Decision-Making</td>
<td>Involvement of the General Public in Decision-Making</td>
<td>Accountability to Regulatory Body</td>
<td></td>
</tr>
<tr>
<td>ESSAP</td>
<td>+</td>
<td>Low</td>
<td>Medium</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>SAGUAPAC</td>
<td>+</td>
<td>Medium</td>
<td>Low</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>YBU</td>
<td>-</td>
<td>Low</td>
<td>Low</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>COOPLAN</td>
<td>-</td>
<td>High</td>
<td>Low</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>FIPAG</td>
<td>-</td>
<td>n/a</td>
<td>Medium</td>
<td>+</td>
<td></td>
</tr>
</tbody>
</table>

The project positioning within the entire urban water landscape of Maputo is however critical. The FIPAG small-scale providers are an exclusive model for low-income populations whereas the wealthier areas of the city continue to receive water from the monopoly provider, “Aguas de Região de Maputo” (formerly “Aguas de Mozambique”). Over time, the project runs the risk of becoming subject to criticism denouncing the creation of a two-class society – as occurred with the condominial project in Lima (as described earlier).

6.3 Conclusions

The examples of Parauapebas and Maputo have shown that it is possible to balance, to some extent, the performance targets of efficiency and legitimacy (cp. Table 17). Even if financial sustainability has not yet been attained at either site, the condominial and the franchised small-scale supply models highlight how decentralization to the community level can contribute to a more efficient CAPEX and OPEX. Although internal financial disequilibrium impedes fast scaling in Maputo specifically, in general, the model of franchised small-scale systems seems to have some potential to scale or replicate. Such a model combines the efficiency advantages of small-scale water provision with the formality and legitimacy of large-scale, monopolistic providers. Even if environmental sustainability has not played a big role at either of the two sites, the formality and legitimacy of both models at least empower the general public to include environmental considerations in the urban water framework.
### Table 17 – Performance of Large-Scale, Small-Scale, and Hybrid Utilities

<table>
<thead>
<tr>
<th></th>
<th>LARGE-SCALE OPERATORS</th>
<th>SMALL-SCALE OPERATORS</th>
<th>HYBRID OPERATORS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Efficiency</strong></td>
<td>X</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Effectiveness</strong></td>
<td>✓/ X</td>
<td>✓/ X</td>
<td>✓/ X</td>
</tr>
<tr>
<td><strong>Legitimacy (Political)</strong></td>
<td>X (✓)</td>
<td>X (✗)</td>
<td>X (✓)</td>
</tr>
<tr>
<td><strong>Environmental Sustainability</strong></td>
<td>✓</td>
<td>X</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Scalability / Replicability</strong></td>
<td>X</td>
<td>X</td>
<td>✓</td>
</tr>
</tbody>
</table>
7 Platform-Managed Small-Scale Utilities

I found in Maputo and Parauapebas ideas with potential to improve the status quo of water supply in developing countries. The impact of the condominial design on costs covers exclusively the capital side of assets. Clearly, the case of the FIPAG small-scale networks offers more possibilities to balance both regulation and supply costs; I therefore took the FIPAG project as a basis for the idea of platform-managed small-scale utilities described in this chapter.

7.1 Concept and Costs

To develop a water sector that is effective, legitimate, environmentally sustainable and scalable, urban water planners should consider two perspectives – the operator’s and the regulator’s. Operators face supply costs that must be kept low to be scalable in the developing world. The complexity of water provision increases from a certain number of connections. In regard to complexity, only operators that have gradually built up a set of specific capabilities succeed in keeping operations efficient. Such reasoning clearly differs from an output-centered theory, which emphasizes incentives for the success of operators. Incentives might be useful to a degree, but eventually, the quality of capabilities distinguishes efficient from inefficient large-scale operators.

Large-scale utilities in developing countries should therefore focus on the buildup of the required capabilities in human capital. Yet the buildup of competencies also implies costs that might threaten the scalability of service. In developing countries, small-scale operators have emerged as an alternative that reduces both complexity and costs through a cutback of scale. Instead of increasing their capabilities, small operators balance scale with the low-capability environment of developing countries.

Regulators, on the other hand, are meant to guarantee a legitimate and environmentally sustainable water sector. They face transaction costs that increase with the number of operators under regulation. From a regulatory point of view, it is therefore wise to limit the number of operators, which goes against the establishment of a small-scale provision model.

Both, the supply costs of all operators in a city and the regulation costs add up to the total costs of an urban water sector. This thesis has discussed the evolution of supply costs depending on the number and size of the operators (U-form; cp. Figure 11), but it has not provided detailed information on how the costs of regulation develop along with the number of operators. It has been argued on the basis of the Asunción case that, overall, regulation costs increase with scale, yet without indicating if they rise proportionally, exponentially or in form of a U-curve. Future researchers may tackle this gap. In any case, the total costs of an urban water sector are minimized at the point with the lowest supply and regulation costs combined.
Unfortunately, the operator and regulator perspectives appear to stand in conflict. Whereas the operator perspective posits a high number of small-scale providers, the regulator point of view demands the opposite: a small number of high-scale providers. The challenge is to find a model that adapts operations to the low-capability context of developing countries while keeping the costs of regulation at a low level. The model of platform-managed small-scale operators indicates a possible way out of this conflict.

Figure 17 gives an overview of the different water provision models in relation to regulation and supply costs. The costs for an efficient and legitimate urban water supply increase from the inner corner of the matrix towards the outer circles. The model with the highest costs is self-supply. Under self-supply, every household must invest in and drill a borehole before installing domestic pipes. The regulatory authority needs to individually reach out to all households to protect the common groundwater sources.

The condominial and conventional approach form both parts of the large-scale model, as there is no difference between the two in terms of operations. The condominial approach, however, is positioned closer to the inner corner of the diagram, as it offers some saving potential thanks to lower capital expenditures.

The model of platform-managed small-scale operators pursues the idea of allocating the tasks of the supply chain to the most efficient level by decentralizing the supply-related tasks of providers while centralizing the interactions between operators and the outside world at a platform level (cp. Figure 19). Interfaces with the stakeholders can include, for instance, functional tasks, such as finance, government permissions, PR, regulation (incl. key monitoring figures), or maintenance (group supply of spare parts). The model reduces the complexity of operations, keeping the size of networks small, and eases the task of regulation, keeping the number of managing platforms small.

![Figure 17 – Cost Matrix of Water Provision Models](image-url)
From a cost perspective, the supply costs under such a model split into platform expenses and expenses for the small-scale operators. In order to be financially justified, the combined costs for the platform(s), the small-scale operators, and the regulator must be lower than the total costs of the already discussed provision models. The bottom line result matters, meaning that a cost premium in one line (e.g. regulation) needs to be balanced by a cost surplus in another line (e.g. operation). From a theoretical point of view, it is expected that the model of platform-managed, small-scale operators will have the lowest costs for the following reasons.

First, the costs of regulation should be identical to the regulation costs in a large-scale model as the regulator deals in both models with only one responsible actor. In any case, it would be interesting to also have more cost data available, on how the regulation costs evolve with the number of operators/platforms. If the regulation costs increased, for example, only slightly at a low number of operators, it would be conceivable to consider a set-up with several platforms per city.

Second, the costs of the formalized small-scale operators should theoretically be lower than the ones of the informal small-scale operators, as the formers complete a narrower scope of tasks with some functions being outsourced to the platform level. Figure 16 shows that the FIPAG small-scale systems have in fact the lowest operational costs among the three small-scale suppliers studied (excluding the platform overhead). Still, as a single case, it does not provide sufficient firm empirical evidence and a more careful comparison of the costs between formalized and informal small operators would be required to back the theoretical argument.

Third, another challenge appears to arise with the establishment of a managing platform. The functioning of a managing platform implies a new cost line and new managing capabilities. Combined with costs for small-scale operators, they should be lower than the entire supply costs of a large-scale operator.

Theoretically, the platforms should do nothing different from the large-scale operators in a monopoly context, within, however, a more limited scope of tasks. They may continue, for instance, with the overall monitoring of the networks; they may manage relations with the government, the financial market, and the suppliers; or they may develop a common sewage network. They only leave most of the supply-related tasks in the hands of the small-scale operators. While the decentralization of supply-related tasks creates substantial savings, the costs for the tasks assigned to the platform should remain more or less identical to those managed by a large-scale operator.

The hypothesis of moderate platform costs implies, however, that the breakdown of tasks between platforms and small-scale operators does not cause significantly higher transaction costs. Section 3 of this chapter proposes the implementation of the platform model within a franchise structure. In general, franchisee autonomy may leave some room for opportunistic behavior and thus cause an increase in transaction costs (Cochet, Dormann, & Ehrmann, 2008).
Yet, for the particular case of the water sector, extensive opportunism vis-à-vis the large-scale model can be doubted. The small-scale entrepreneurs personally depend, similar to employees of large-scale operators, on the full-time job offered by the franchisor. In the monopolistic environment of water sectors, it would be very hard for a failing entrepreneur to be reconsidered for similar appointments and without a franchise license, independent individuals would not be allowed to operate on own accounts.29

Moreover, opportunistic behavior is expected to establish most where information gaps between the principal and his agents exist (Schedler, Public Management and Public Governance, 2007, pp. 255-256). The franchise system, as sketched over the following two sections, however, contains a close operation between the platform and the operators. These daily interactions reduce the potential emergence of information asymmetries.

Also, the model of platform-managed small-scale operators is not restricted to the erection of a single platform. As the complexity possibly increases with scale, it is conceivable that the tasks assigned to the central level can be fulfilled by multiple platforms at a lower cost per small-scale system. Each platform would then manage a limited number of operators only, reducing the risk of potential information gaps.

The following example illustrates the multiple choices. A city of 10 million residents chooses between the following supply models. In a large-scale model, the regulator supervises the operations of a single monopoly provider with 2 million connections. The complexity of the network is enormous, and the capabilities required for the efficient functioning of the system demand substantial human capital investments. In an independent small-scale model, one regulator faces 2'000 networks with 1'000 connections each. Whereas here the operational costs remain low, the regulation process demands extensive resources. In a platform-managed small-scale model, the regulator confronts 20 formal platforms that manage 20 systems each. One system consists on average of 5'000 connections. Different from the first two options, in the last model, the complexity and scope of tasks faced by each actor involved have been lowered to a presumably efficient scale. The general idea is to adequately balance the scale of connections, networks, and platforms with the resources and capabilities available at the regulator, the platforms, and the operators.

29 This implies that informal operators are effectively banned from the urban water landscape. Otherwise, operators may see advantages in staying informal because formality has a cost. The promotion of small-scale operators’ legitimacy through the establishment of coordinating platforms implies additional expenses at the platform level that independent small-scale operators do not have to bear. Sometimes, informal operators may be more profitable in the short-run. The example of Maputo shows the difficulty of establishing a formal water sector in an urban landscape that tolerates informality. The model of platform-coordinated small-scale operators has a chance to succeed only where a prohibition of informal water network supply is strictly enforced by authorities.
Empirical data on the average total cost curves faced by the operators, the platforms, and the regulators in a specific, local context would help in coming to an informed decision with respect to the size of all actors. Figure 18 shows, for instance, the total costs per cubic meter in relation to the network size (in terms of house connections) of 156 small-scale providers in Paraguay (ERSSAN, 2012). The data indicates strong economies of scale between 1 and 1'000 connections. Due to a lack of data, it does not indicate, however, at what point the average costs start to rise again along with the costs of complexity. Based on the case study data, ESSAP, the large-scale operator in Asunción, has a total cost per m³ (consumed) of US $0.54. Assuming hypothetical diseconomies of scale from 10’000 connections on, the optimal size of the networks would be between 1’000 and 10’000 users.

Summarized, the model of platform-managed small-scale operators seeks to minimize the costs of supply and regulation. It assumes comparable regulation costs to the ones under a large-scale model. The supply costs split into costs for operations performed by the small-scale operators and into costs for supportive services performed by the managing platform. On the one hand, the decentralization of tasks to the micro utilities should create substantial savings. On the other hand, the tasks and costs performed by the platform should be comparable to the ones of a large-scale operator. The total supply costs of the platform and the operators should be lower as long as the transaction costs between the franchise and the franchisee can be ignored.
In the end, the theoretical arguing in this section needs further back up with empirical figures. Particularly, the costs of the formal small-scale operators and the platform need to be furnished with more detailed information and data. Are the costs of formal small-scale operators really lower than the ones of informal operators and are the transactions costs between platforms and small-scale operators in fact negligible? What would be an efficient size for the operators, the platform and the regulator? The case of Maputo offers still some potential to compare formal with informal operators in the city or to study in detail the tasks and costs as performed by FIPAG’s platform.

7.2 Responsibility Assignment

The particular costs of the platform and of small-scale operators also depend on the allocation of the functional tasks of a supply chain either to the central platform or to the decentralized micro network systems (cp. Figure 19). As urban water sectors have very local characteristics, the actual allocation may vary from one city to another. Nonetheless, certain criteria should guide this decision-making process.

Discourses in literature on state decentralization and the “mergers & acquisitions” industry provide good inputs as to why certain tasks are better fulfilled at a central and others at a decentralized level (Blankart, 2003, pp. 563-566; Ficery, Herd, & Pursche, 2007). Two criteria stand out: First, to satisfy local preferences and particularities, specific tasks can require local know-how and are more effectively performed at a decentralized level, or vice versa. Second, cost synergies can justify the shifting of tasks to the platform level where they are performed more efficiently.

Figure 19 – Decentralization of Operations and Centralization of Transactions
• *Finance*: Due to their semi-formal status and size, it is reportedly very difficult for small-scale operators to gain affordable access to finance markets. Through the bundling of operators, access to finance markets can potentially be channeled more efficiently and with more attractive conditions through a fully formal platform.

• *Regulation*: The integration of small operators under the umbrella of a managing platform eases the task of regulation. Instead of being exposed to hundreds of operators, a regulator can efficiently deal with only one platform as a responsible partner.

• *Procurement*: A common procurement through the managing platform makes sense if the suppliers, for instance, of spare parts, grant discounts on quantity purchases. Otherwise, the procurement may be assumed by each small-scale system individually.

• *Production & treatment*: Both a centralized and a decentralized production may be considered depending on the environmental context of a particular city. In the four cities studied within this thesis, Asunción, Santa Cruz, Parauapebas, and Maputo, groundwater resources were easily accessible and of good quality for the small-scale networks. Small-scale operators can deal with microbiological water contaminants, but chemical contaminants, metals, or salt in the water can only be eliminated through powerful and very expensive treatment plants. In an arid climate, or in an environment of heavily contaminated or brackish water sources, urban water planners may therefore adapt the catchment strategy to a more centralized water sourcing. Due to the high capital costs, the platforms or a special production unit could centrally source the water and then re-sell it in the role of a wholesaler to the small-scale units. Roughly 10% of urban residents live in developing cities with heavily contaminated water sources (de Carvalho, Graf, Kayser, & Vousvouras, 2011, p. 4).

• *Pricing*: On the one hand, prices have a social impact in restricting access to water for those able to pay for it. Therefore, pricing thresholds by governments usually do and should set a limit to the operators’ tariff freedom. On the other hand, operators should enjoy some flexibility regarding prices in order to respond to the local particularities of each water network. The operation of a network in a hilly area (gravity fed energy) can, for instance, be cheaper than the management of a comparable system located on a plain (electric energy required for pressurization).

• *Delivery*: Usually, small-scale operators can efficiently and effectively run the distribution networks, as the case studies have demonstrated.
• **Billing:** In some areas, locally embedded billing agents of small-scale operators may attain higher collection rates than large-utilities with an anonymous, centralized billing apparatus. On the other hand, a centralized billing system may generate cost synergies and prevent fraud at the local level.

• **Public relations:** Public relations can address locally restricted (e.g. service interruptions) or city-wide messages (e.g. social marketing campaigns). The former type of communication might be assumed by the operators themselves and the latter type of communication by a PR department at the platform level.

• **Customer management:** The case studies demonstrate that users can be effectively managed at the local level where the distances between the operators and the customers are short. Customer management in large-scale utilities is, in contrast, complex, requiring advanced capabilities to understand, localize, dispatch, solve, and monitor client issues.

• **Monitoring:** The case studies have shown that small-scale operators can efficiently monitor their networks, benefiting from their local knowledge. Still, in order to prevent opportunistic behavior by the operators and to respond to the regulation authority, platforms must complement the efforts of the operators with monitoring activities.

• **Maintenance:** Similarly, small-scale operators are usually able to perform standard maintenance activities. Only complex maintenance tasks or the procurement of spare parts, as discussed, may be assumed more effectively and efficiently through the platform.

• **Sewage:** The infrastructure of sewage networks is typically more expensive than of water networks – e.g. factor 1.6 higher at SAGUAPAC in Santa Cruz (E. Padilla, Interview, 11 July 2012). In light of economies of scale, it might therefore be more efficient to run the sewage system centrally or to share a common sewage system among several operators (A. Gamarra, Interview, 28 June 2012). Still, alternative sewage systems, such as community-shared bio digesters should be considered as possibly efficient solutions at the local level.

• **Human Resources Management:** Local operators are potentially best suited to select the workforce for local job vacations. The platform may complement these HR activities by hiring the operators and conducting city-wide trainings.

• **Information Management:** Cost synergies and more effective communication may justify the establishment of a central IT platform for all operators and the platform.
Generally, it has been seen that most of the supply-related tasks can be efficiently and effectively fulfilled by small-scale operators, whereas tasks, implying an interaction between the operators and the stakeholder environment, require the support of the platform. In any case, the scope of tasks for the operators and the platform must be defined for each city individually on the basis of the local parameters and the mentioned criteria. Over time, adjustments to the allocation of tasks might become necessary if the fulfillment of synergies or tasks in general does not match with prior expectations (Ficery, Herd, & Pursche, 2007, p. 35).

7.3 Franchise System

Ronald Coase and Oliver E. Williamson have shaped the “new institutional economics” discipline claiming that, depending on transaction costs, either hierarchies or markets regulate processes of social coordination (Coase, 1937; Williamson O. E., 1973). To grasp the potential of a firm, strategy should match the organizational strategy (Yin & Zajac, 2004). But, for the model of platform-managed small-scale operators, neither pure hierarchies nor markets seem to be an adequate form of governance.

The model of platform-managed small-scale operators seeks to leverage the benefits of small-scale systems, including the simplicity and the adaptability of micro operators to the local context. Small-scale utilities should therefore enjoy a certain degree of freedom, which would speak for a market form of organization.

However, the model of platform-managed small-scale operators also demands a standardization of services across the city, the centralization of defined tasks to the platform, a close cooperation between the platform and the operators, and an effective regulatory mechanism within the responsibility of strong platforms. All these requirements rather request a hierarchical form of coordination. The model of platform-managed small-scale operators hence asks for a hybrid form of social coordination.

Such a hybrid alternative can be franchise systems that mix market mediated with hierarchy mediated elements of governance (Norton, 2003, pp. 27-28). By definition, they concede commercial freedom to the franchisees, but under a common name and under the strategic leadership of a franchise platform. The franchisee pays a royalty on revenues in exchange for the know-how, the brand and other services provided by the franchisor (Coughlan, Abdessson, Stern, & El-Ansary, 2001, p. 546).

In recent years, franchise systems have gained, under the term “microfranchising”, a higher profile in the development community (Fairbourne, Gibson, & Dyer, 2007). The term “micro” refers to the relatively low capital investments compared to the investments of franchise branches of large chains headquartered in developed countries. Microfranchising provides opportunities for fast growth and tackles the typical problems of small businesses in developing countries, such as the lack of
access to finance, low educational skills, weak links to suppliers, or problematic legal aspects (Henriques & Herr, 2007, pp. 46-47). “Microfranchisees don’t have to set up from scratch their financial, supply chain, IT and communication systems. They don’t have to deal with legal issues, licensing, real estate and other things required to start up a business. Microfranchisees are established companies with proven operating systems and powerful brands. Microfranchisees purchase the right to use the name and benefit from the rich support net their microfranchise offers.” (Microfranchise Ventures, 2010).

A franchise governance scheme would therefore set up a good basis for exploiting the varying advantages of the model of platform-managed small-scale operators. On the one hand, it allows the small-scale operators to commercially adapt to the local context of business (Yin & Zajac, 2004, p. 379). On the other hand, it establishes the platforms as the strategic center of leadership, linking the operators to important stakeholders and guaranteeing city-wide high service quality.

Examples of franchise companies in the development and particularly in the WASH sector already exist. In India, Sarvajal, a social enterprise, manages around 120 community water filtration plants, operated by local franchisees. The franchise model has allowed the franchisees to benefit from quick access to state-of-the-art infrastructure and know-how, whereas the franchisor’s success has built upon the entrepreneurial spirit and the local embedment of the operators. Sarvajal systems deliver high quality drinking water to more than 66’000 people (de Carvalho, Graf, Kayser, & Vousvouras, 2011, pp. 171-177).

However, the use of a franchise system is bound to certain risks and limitations, particularly in terms of transaction costs. After all, it would not make any sense to switch to a platform model if the advantages of small-scale operations would be outweighed by even higher transaction costs. Franchise platforms must therefore keep transaction costs low, but still avoid actions of fraud or any other type of opportunistic behavior by the franchisees.

Cochet, Dormann, and Ehrmann (2008) have empirically studied agency problems in franchise companies. On the basis of 208 observations, they conclude, as one of the findings, that the threat of termination or nonrenewal of a relationship reduces the risk of opportunism (Cochet, Dormann, & Ehrmann, 2008, p. 56).

In the case of small-scale water operators, as discussed in the first section of this chapter, this threat is particularly imminent as the operators rely with a full-time job on the good-will of the franchise platform. The prevalence of opportunistic behavior and the necessity to control the operators may therefore be “in casu” relatively low. Still, further research is necessary to back this hypothesis with empirical figures.
7.4 Implementation

Up to this point, urban water management has been discussed in this chapter from a conceptual perspective, balancing the advantages and disadvantages of the different models. It has been shown that the model of platform-managed small-scale providers offers good potential to improve overall performance. However, that some models might have persisted over years due to particular interests of individual stakeholder groups has only been peripherally mentioned. In line with public choice theory (cp. Chapter 2), short-sighted politicians may have an incentive to bundle operations to ensure their influence over the water sector.

In Brazil, the introduction of the condominial approach has caused strong internal resistance from employees. The condominial model requires employees to change their mindsets from a focus on technology to an emphasis on demand. It also exposes employees to customers and criticism. Employees have therefore often resisted carrying out the necessary modification of the working routine. In other places, legal regulations have slowed down or completely blocked the implementation of new provision models. In Nicaragua, for instance, the small-diameter pipes used in condominial projects were illegal under the given legal water framework (C. Rissoli, Interview, 8 October 2012). Thus, prior to project implementation, the local legislation had to be amended.

This anecdote shows that even if one model appears rationally superior to another, it does not automatically mean that the superior model will establish itself as the dominant paradigm (cp. Figure 20). Particularly in the water industry, where for decades experts have taken monopoly provision for granted, a careful transition strategy may be necessary to shift to a new paradigm.
A detailed analysis of such processes would go beyond the scope of this study, but a mix of internal drivers and conditions in the context of a water sector to favor industry transformation has been found. Examining the issue again from a capability perspective, for example, explains how Brasilia’s public utility, the “Companhia de Saneamento Ambiental do Distrito Federal” [CAESB], transferred its entire sewage network in the early 1990s from a conventional to a condominial model.

At the time, politicians in Brazil’s capital had decided to build new satellite cities around the original center, called “plan piloto”. Politicians and local water experts realized that with business as usual, the utility would face serious difficulties in connecting the growing population base with water and sanitation. Progressive politicians from Brasilia’s ruling workers’ party (“Partido dos Trabalhadores”) encouraged the utility to study the condominial model.

At the same time, within the utility a new team of young and idealistic co-workers had taken positions in the sewage department of the utility. Convinced by José Carlos Melo’s first positive experiences with the condominial model in other cities of Brazil, they felt enthusiastic about trying something new to scale up sewage in the capital. The condominial approach quickly became the dominant model for sewage in Brasilia’s utility. The difference between the two departments - water and sanitation - is striking. It is only in the latter, where a young and dynamic team took initiative, that the condominial approach has been implemented. Curiously, water continues to be delivered through a conventional pipe system (K. Neder, Interview, 8 October 2012).

7.5 Scope and Limitations

In Chapter 1, I argued that differing starting conditions in developed and developing countries may justify the creation of separate urban water delivery models for the two contexts. The field results confirmed this hypothesis, particularly grounded on differing capability levels. There remains, however, the question of at what point developing countries indeed become developed countries; or more generally, I would like to frame the model of platform-managed small-scale utilities in terms of scope and depth. To which countries does the model apply? What happens when countries develop over time and up to which point does the model contribute to an alleviation of urban water problems in the developing world? A profound analysis of these issues would go beyond the extent of this thesis. Still, it is possible to sketch some possible entry points for future researchers.

- **Adapting to development over time**: This study applies to the context of developing countries. On the basis of enormous gaps in wealth, water access, and educational standards, it has been argued that a modularization of water delivery would better fit to the context of these countries. Still, as the term “developing” already indicates, the countries targeted are expected at some point to reach the status of a “developed” country. Over time, as the levels of income and education rise or differences slightly disappear, adjustments to the
model might become necessary. With rising educational standards in a country, higher degrees of complexity become more manageable. In any case, the modular design of the model allows for mid-/long-term changes as technology and concession contracts have a limited shelf life.

- *Reaching down to the very bottom of the pyramid:* The proposed shift toward small-scale supply can contribute to an extension of household water access worldwide. However, water offered by small-scale utilities is still too expensive for people living in extreme poverty. In the cases of Asunción and Santa Cruz, the small-scale operators were able to reduce the entry barrier for low-income residents by around US $400 from US $1’775 to US $1’375 annual household revenues (cp. Figure 21).\(^{30}\) Households with an annual income lower than US $1’375 continue to depend on subsidies.

At present, around 1.6 billion people in cities of the developing world have an annual household income higher than US $1’775. Approximately, 150 million people enjoy annual household incomes of between US $1’375-$1’775; and, about 550 million urban residents fall below the US $1’375 threshold. Still, these figures do not limit the impact of small-scale supply to 150 million people. Households that are already served benefit from savings of up to US $20 every year and subsidies on piped-in water supply for the poorest can be reduced by the same amount.

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**Figure 21 – Affordability of Piped-In Household Water**

![Graph showing the affordability of piped-in household water](image)

Source: Based on data from Hammond, Kramer, Katz, Tran, & Walker, 2007

\(^{30}\) Under the assumption that 5% of the household income can be used to cover a monthly consumption volume of 15m\(^3\).
8 Conclusions

The importance of cities is growing. Since 2010, for the first time in human history, more people on this planet live in cities than in rural areas. By 2050, the proportion of urban residents is expected to account for 70% of the global population. (WHO, 2010). Even today 70% of the world’s mega cities are situated in developing countries. With population size in urban centers increasing, urban infrastructure, including water supply, must keep pace. Unfortunately, around 30% of the urban population in developing countries does not have access to urban water supply networks.

In the light of these numbers, urban water planners can continue with business-as-usual, slowly expanding giant utility monopolies at the cost of heavy subsidies, or they can switch to an alternative, innovative water provision model, with several operators supplying a city with water. The results of this study demonstrate that the latter option has a greater chance of extending water networks to the ones living without access to water in a city of the developing world.

Large-scale network operators have become the dominant supply model in cities because of two theoretical arguments. First, the enormous upfront costs of infrastructure are traditionally considered too high to leave space for a second operator in the city. Second, to reduce regulatory transaction costs, experts suggest keeping the number of operators small.

However, traditional large-scale supply leaves an enormous supply gap, filled, to a large extent, by small-scale suppliers. Around 50% of the urban population in Africa and 25% in Latin America are served by a small-scale operator. In Latin America, small-scale supply most often takes the form of micro networks, which typically serve some hundreds of households. Clusters of these micro networks have emerged in and around the cities of Asunción, Santa Cruz, and Guatemala City.

While many researchers over the past twenty years have emphasized with public-private partnerships an incentive-based discourse, this thesis took off from another point. It challenged the universal applicability of economies of scale in urban water sectors of the developing world. A comparison between large-scale and small-scale utilities aimed at analyzing how scale of urban water operators in developing countries influences their performance as to five dimensions. Eventually, the size of operators in general and mixed supply forms between large-scale and small-scale are variables and options that policy makers should have more in mind than they used to.

Concretely, I analyzed two large-scale and two small-scale operators in the cities of Asunción and Santa Cruz. Results show that large-scale and small-scale operators

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31 Mega cities are commonly defined as metropolitan areas with a population in excess of 10 million people.
face different obstacles to scale and replication. Large-scale systems have issues with financial viability and efficiency. Small-scale operators fail to put the networks under democratic control of the public. As a result, small-scale providers often operate in a status of legal ambiguity and have problems to access credit markets.

The case studies also indicate that the traditional image of water networks as natural monopolies requires some modification. Aricio Gamarra, a small-scale water entrepreneur in Asunción, for example, established his initial network of 150 connections with only US $30,000. Contrary to expectations, only a minor portion (between 20%-30%) of total costs come in the case studies from capital expenditures. In the long run, a large share of both operational and capital costs is variable.

Operations thus matter most for determining the cost structure, and these case studies indicate that the efficient running of a large-scale system is much more demanding than the running of a small-scale system. Large-scale operators are in charge of sophisticated production facilities, they control and maintain complex distribution networks – partly situated in informal areas – and they manage hundreds of employees – often in a context of corruption. Small-scale operators, in contrast, run basic production and distribution equipment; they typically have a clear perception of the extension and status quo of the network and they only supervise a few employees.

In consideration of these findings, I propose a shift to a “capability perspective”. Large-scale water supply has high capability requirements, and only operators who systematically invest in human capital may be able to deal with the complexity of business efficiently. Small-scale water supply, in comparison, has low capability requirements. Such systems are perfectly adapted to the environment of developing countries, where a bulk of the working population has a low skill set. To run a small-scale system efficiently, it is not necessary to attract highly qualified workers from top universities. A small-scale operator can tap its potential with lower human capital and lower overall operational costs compared to a large-scale operator.

However, the operational gains of small-scale suppliers do put a strain on the regulator. The regulation of hundreds of operators in a dynamic and partly informal urban environment is demanding. A regulator would need to build a resource-devouring regulation apparatus to effectively fulfill this extensive mandate. Such a scenario can lead to an explosion of regulation costs.

The case study in Maputo, where the public asset owner FIPAG has established and coordinated small-scale water networks, indicates a way to overcome this conflict between high supply and regulation costs. This model fosters the decentralization of all supply-related tasks to small-scale franchisees and the centralization of all stakeholder transactions (including with governments, financial markets, etc.) under the umbrella of coordinating franchise platforms. It suggests restricting the size of water networks to balance the scale of operations with the low capability context of
developing countries and simultaneously reducing the number of providers regulated through the creation of coordinating platforms. Based on the results in this research, urban water planners may therefore choose between alternative strategic options, which differ in terms of radicalism and potential impact on growth:

- **Strategy option 1 – Platform-managed, small-scale operators**: Urban water planners can create a limited number of franchise platforms that are responsible for the establishment and coordination of a defined number of small-scale water networks. According to the findings, it is the model with the biggest potential for growth provided that the described efficiency gains can be realized.

  It introduces ideas to radically re-organize urban water supply and might therefore provoke substantial resistance, for instance from governments fearing a loss of power. Before realizing the model, policy makers may develop an implementation plan and strategies to involve or act against critics.

  Urban water planners can then create or establish a partnership with one or several managing platforms. To define the number and size of platforms, decision makers must evaluate how many operators a platform can efficiently manage and how the number of platforms affects the regulation costs in the broader urban context.

  As a next step, the franchisor platforms can construct a series of small-scale systems. The appropriate size of these systems may vary depending on the context (geographical, educational, and other parameters) and the average supply costs (cp. Figure 18).

  Thereafter, the platforms can contract the operations of the networks out to franchisees. In this process, they can conduct an analysis that shall enable an informed allocation of the service tasks along the supply chain either to the platform or to the franchisees (cp. Section 2 of chapter 7).

  Eventually, the franchise platform and the operators conclude a franchise agreement. This structure of the water sector can be adapted over time, as policy makers gain experience and know-how over things that work or do not work.

Alternatively, policy makers have two more options to choose from, which, according to the results in this study, have a limited potential for growth, but might be preferred if option 1 for instance faces too heavy resistance or fails to provide the expected positive results in implementation:

- **Strategy option 2 – Condominial, large-scale operator**: A large-scale utility continues to be responsible for water provision in the entire city but switches
from a conventional to a condominial distribution structure, reducing the costs of capital. The operator emphasizes the importance of human capital, allocating financial resources to the attraction and continuous development of a highly skilled work force. This option may create some organizational resistance.

- **Strategy option 3 – Independent, small-scale operators**: Urban water planners contract operations out to dozens or hundreds of small-scale systems. The government and legislators create and strengthen an independent regulatory mechanism with substantial investments towards a bigger regulatory body. This option may also provoke some resistance from politicians, representatives of the previous monopoly operator, and other interest groups.

One of the biggest challenges of this thesis project concerned the general validity of and the extrapolation of the results to other cities in the developing world outside or even within Latin America. I tried to tackle this issue through a deliberate selection of the case studies (one large- and one small-scale operator per city), through the careful development of theoretical claims, and by providing extensive information on the context the cases are embedded in.

Still, some doubts persist to which degree factors other than capabilities and complexity have influenced the performance of the cases selected. In this context, I see capabilities and complexity as important factors that should help decision makers to rethink the size and the structure of a water sector: But, experts should have some flexibility to adapt the results of this study to different urban contexts and to add other variables into the analysis.

More specifically, I see four particular areas that require a refurbishment with more empirical data. First, this study has placed water operators into the center of attention of investigations. This managerial perspective neglects to some extent the importance of the regulation body within a broader political context. In particular, the thesis has not fully clarified how the regulation tasks and costs evolve dependent on the size of the operators.

Second, the concept of platform-coordinated small-scale operators has been sketched theoretically. Now, the claims discussed would need to be backed with more empirical data. How do costs and tasks of operator franchisees differ from the ones of informal operators? How do the tasks and costs of platforms split? How do transactions between platforms and franchisees look alike and how much do they cost?

Third, the implementation of and the change management toward a new model require high consideration. The formation of large-scale monopolies has been documented as the result of a process of political lobbying in the early decades of the 20th century. Any shift to a new supply model may cause substantial internal and
external resistance, as the introduction of the condominial model in Brazil has illustrated. Now, these internal and external factors would need to be identified and further elaborated.

Fourth, the idea of platform-managed small-scale operators may only apply to developing countries and benefit in the first place top tier segments of the BoP. Future researchers may draw clear borders to distinguish developed from developing cases and to assess the number and extent of people truly benefiting from the model.

Those investigators could for instance start by positioning regulators as the center of analysis and analyze how the scale of operators impacts the regulators’ performance. They could also choose again Maputo’s water sector, studying how FIPAG operators compare with informal suppliers, how the FIPAG platform performs its tasks, and how the platform and operators interact.

Despite some unresolved issues, eventually, one should keep in mind that 700 million people in cities with restricted water access may expect researchers to challenge the actual theoretical paradigms. The mentioned restrictions do not question the findings of the thesis in general but rather highlight areas with a potential for a continuous improvements. Cities in development countries have specific characteristics, such as huge disparities in income, living environments, and education. A new model with more but smaller networks which take developing cities’ many variables into account has the promising potential to contribute to the delivery of piped household water to more than 20% of today’s 700 million underserved.
ANNEX: CASE STUDIES
Asunción

A.1 ESSAP

Governance Analysis

**Problem**

**Main goals:**
Providing water and sanitation to urban citizens all over Paraguay in the most effective, efficient, and sustainable way possible.

**Main challenges:**
- The infrastructure is heavily outdated. In earlier decades, CORPOSANA paid little attention to the maintenance to the network. Today, the renewal of the pipes costs enormous amounts of money.
- Paraguay is one of the most corrupt states in Latin America, only topped by Venezuela and Haiti (Transparency International, 2011). Corruption in ESSAP is believed to be widespread.

**Geographical focus:**
ESSAP has the mandate to cover cities in Paraguay with more than 10’000 residents. ESSAP serves Gran Asunción and 21 other cities in the country.

**Actors**

**External:**
- Various ministers form the council of public companies. The council supervises all state enterprises (electricity, railway, telecommunications, gas etc.). It is supported by the monitoring unit of public companies within the Ministry of Finance. The council and ESSAP signed in 2009 a contract that defines the basic operational objectives and standards for the company. These objectives have served as an evaluation tool. The details of the contract are not open to the general public.
- ERSSAN is the national water and sanitation regulator, entitled to regulate and revise all operators in the country. ERSSAN is formally independent as it finances its activities through a 2% regulation commission on all operators’ revenues. In practice, only ESSAP and a dozen of other water providers pay this fee (O. L. Sarubbi, Interview, 20 June 2013). The President of ERSSAN is appointed by the President of the Republic. The bill 1614 determines that each operator must conclude a concession or permission contract with ERSSAN.
However, due to the resistance from the operators and the institutional weakness of ERSSAN, no contract has been signed yet. Despite its formal independence, ERSSAN needs for important decisions the backing of political authorities. An increase of ESSAP’s tariff requires support by the President of the Republic. The fact that both institutions ESSAP and ERSSAN depend to some extent on politicians may lead to biases in the regulation process.

- There is a lack of political leadership in the WASH sector. For this purpose, the Directorate for Water and Sanitation, DAPSAN, was created in 2009. However, its position within the government is still weak and its organizational structure in construction.
- Any investment over US $25’000 must be channeled through the national procurement office. This office is understaffed with the result that investment processes can stretch over a long time.

**Internal:**

Figure 22 – Organizational Chart ESSAP

- ESSAP is a limited company under private law but in public ownership. The shareholders’ assembly is composed to 99% by the Presidency of Paraguay and to 1% by the national railway association. The shareholders, here the President of the Republic, appoint the president of the company and approve the annual budget. The President of ESSAP was known to be a good friend of former President of Paraguay Fernando Lugo.
- The governing body consists of the president, and two vice-presidents. A representative of the shareholders takes parts in the meetings of the body but has no voting rights. The governing body is supported by the advisory offices
for strategy and operation. They monitor key performance indicators and can propose specific measures. The advisory offices for strategy and operation are in constant interaction with the monitoring unit for public companies.

- ESSAP’s organizational structure is flat with nine area managers. In addition to the traditional finance, general administration, commercial, and technical areas, the structure includes areas for “water losses”, for the water production in the capital and for three sub-regional areas. The management areas are divided into multiple unities. Beside the nine management areas, there are eight advisory offices to the president. They have a similar status as the management areas. The advisory offices include strategy and operations, IT, PR, risk management, internal audit, and legal support. The fragmented structure complicates the development of a coherent strategy.

**Processes**

**Information:**

- The sub-management areas and the advisory offices inform the governing body in monthly reports.
- The governing body and the advisory offices for strategy and operation regularly report to the shareholders (in fact the Presidency of Paraguay) and to the council and to the monitoring unit for public companies.
- Most information is confidential. For the general public, it is therefore hardly possible to exercise control over the company.

**Decision-making:**

As a result of the flat organizational structure, the different sub-management areas and advisory offices overlap. All important decisions are taken either by the President himself or by the entire governing body. The president’s duty, to manage the 16 sub-management areas is completely overloaded. Due to the lack of transparency, it is unclear to which degree the president coordinates the decisions with his political supporters in the government.

**Nodal points**

- ESSAP is as centralized as the Paraguayan state has been over decades. All important strategic decisions are taken at ESSAP’s headquarter office in Asunción’s historic center.
- ESSAP manages sub-office buildings for operations and customer support in the cities of Gran Asunción and the rest of the country. Together with the service hotline, they are often the first link to the customer.
### Norms

**Explicit:**

The basic rules on decision making are determined in ESSAP’s internal, organizational charter.

**Inexplicit:**

The power and responsibility of the sub-managers is relatively low. The general perception in the company is that any important decision needs to be backed by the president. The president on the other hand needs to find support for any important decisions in politics.

### Modes

**Between legislator/regulator and utility:**

At the end of the 1990s, foreign creditors and Paraguayan lawmakers planned to transfer urban water provision to the free market. However, as political enthusiasm for the free market diminished, ESSAP was set up as a quasi-private, financially independent entity, but of public ownership. Yet, political influence in ESSAP is still big. Certain elements of a hierarchical, bureaucratic order have therefore prevailed.

### Vertical Forms of Organization

**Regulation:**

The national regulator ERSSAN is entitled to regulate and revise ESSAP’s operations. However, a concession contract with detailed provisions has not been signed yet.

**Operation:**

ESSAP is a public company, entitled to provide water and sanitation services to cities in Paraguay with more than 10’000 residents. ESSAP’s regional sub-offices are only involved in operational, but never in strategic matters. All important decisions are taken at headquarters in the capital.

### Supply Chain Analysis

**Finance**

ESSAP has to finance itself independently and does not receive any direct subsidies from the state. Any potential losses increase the debt. ESSAP can only apply through the government for a loan. This mechanism increases ESSAP’s dependency from politics. At the moment, ESSAP implements a US $50.5 million loan from the World Bank directed towards the renewal and the expansion of the water and sanitation
network. Beside that loan, ESSAP has to repay the debt from its predecessor, CORPOSANA. This debt amounts to around US $89 million (US $100 million including interests) and belongs to a large extent to the Interamerican Development Bank. In order to fulfill its mandate of delivering water and sanitation to urban Paraguay, a report estimated that ESSAP would need to invest US $1’500 million.

Institutional Context
ESSAP manages an area of operation as allocated by the national regulator ERSSAN. Over the past years, ERSSAN and ESSAP have been in negotiation for a 30-years concession. However, it is only this or in the next year that an according contract is expected to be signed. The area of operation corresponds to the effective coverage and does not set the boundaries of a potential service area. Each time that ESSAP wants to connect a new neighborhood, it must seek for approval from the regulator. 10% of ESSAP’s concession area overlaps with other networks. New potential users need to present their identity, a title of property, a municipal confirmation of residency and a map, identifying the position of the plot of land to be connected.

Procurement
ESSAP uses water from the nearby Paraguay river as the demand from more than one million users would potentially overstress the groundwater resources under the city. In theory, the water from this river would have a sweet, pleasant taste. However, due to the lack of a treatment plant in Asunción, sewage and industrial waste have polluted the river over time.

ESSAP receives electricity from the state enterprise, ANDE, spending around US $-Cents 4.4 on energy per cubic meter produced. The energy consumption has been reduced in recent years thanks to the introduction of capacitor banks.

Production
There is one central plant that produces around 320’000 m$^3$ of water from the Paraguay river per day. In addition, ESSAP manages around 15 boreholes in the suburbs of Asunción with a total capacity of around 30’000 m$^3$ per day (7% of total production). This means that ESSAP produces in Gran Asunción around 126 million m$^3$ of water every year. ESSAP overstrains the production facilities, using polymers to speed up the treatment process. As a consequence, the production filters congest faster, the quality of the water reduces and the filters need more flushing and more maintenance.

Treatment
The water from the Paraguay river is heavily polluted. ESSAP flocculates the dirt and filters the water from microbiological pollutants. It finally adds sodium hypochlorite to disinfect and protect the water from contamination during distribution. However, the overproduction and the use of polymers decrease the quality of water.
**Pricing**

In order to connect, users pay a fee of US $150 for a 0.75 inch connection and US $200 for a 1 inch connection. The fee is payable in 10 installments over 10 months. Cash payments receive a 20% discount. The fee just covers the connection cost (the last meters to the house). A third party conducts the installation of new house connections. The process is very slow. It is suspected that some employees slow down the process on purpose to receive bribes from users with a willingness to pay for being faster connected to the water network.

ESSAP’s tariff structure has a fixed part, independent from the consumption, and a variable part. Within the variable part, the prices per cubic meter increase with volume. Non-resident customers fall into a more expensive tariff category. Customers from marginal areas benefit from lower tariffs. Around 10% of all connections pay a reduced price on water. However, these marginal areas have sometimes a heterogeneous socio-demographic structure. Therefore, it can happen that people who would not have any difficulty to afford the regular prices benefit from the reduced tariff category. The average price per cubic meter sold amounts to US $-Cents 49.5 and an average user consumes around 24.2m³ of water per month. Users with a connection to the sewage system pay a 50% surcharge on their monthly water consumption. The tariffs presented in the table have been effective since mid-2012. This increase was the first in ten years.

### Table 18 – Tariffs ESSAP

<table>
<thead>
<tr>
<th>Volume</th>
<th>Residential (reduced)</th>
<th>Residential (regular)</th>
<th>Not residential</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fixed</strong></td>
<td>US $ 0.88</td>
<td>US $ 1.54</td>
<td>US $ 4.39</td>
</tr>
<tr>
<td>0-15 m³</td>
<td>US $0.26</td>
<td>US $0.37</td>
<td>US $0.52</td>
</tr>
<tr>
<td>15-40 m³</td>
<td>US $0.37</td>
<td>US $0.43</td>
<td>US $0.53</td>
</tr>
<tr>
<td>&gt; 40 m³</td>
<td>US $0.40</td>
<td>US $0.50</td>
<td>US $0.62</td>
</tr>
</tbody>
</table>

*Source: M. Banti, Interview, 29 June 2012*

**Delivery**

The main factory pumps the water into eight distribution centers. However, ESSAP has connected some neighborhoods between the factory and the distribution centers. As a result, fatal incidents of leakages occur from time to time before the water even reaches the distribution centers. Frequently, the pumps in the factory overheat and break down. From the distribution centers, the water flows through about 3’500 kms of pipes. This length corresponds to around 15.2 meters of pipes per connection. The diameter of pipes ranges between 3 and 14 inches for the secondary network and around 16 inches for the primary network. Most pipes are made of PVC. Some water reaches the households through gravity, but most water needs to be pressed into the network with electric energy. ESSAP aims at a network pressure of between 1.5 and 4 bar. Due to high upfront costs, ESSAP uses only one elevated water tank. 46.8% of the water produced cannot be brought to account: 21.9% of the losses
emerge from leakages in the system; 4.5% result from illegal connections; 12.1% trace back to measurement errors; 4.4% of the water is used internally, and 3.9% goes to users for which the company does not emit any invoices. The percentage of water lost has remained constant over the past four years. High physical water losses create a vicious circle. The leakages require the producer to increment the network pressure. The high pressure on the other hand increases the stress on the pipe system, leading eventually to a further increase in leakages.

**Billing**

68% of the house connections are equipped with a micro meter. However, only around 25% of the micro meters have been installed over the last seven years. The typical shelf life of a micro meter is around seven years. The maturity of the micro meters installed contributes to 12% water losses from measurement errors. An investment in around 175’000 micro meters would be needed to close the measurement gap.

ESSAP conducts monthly billing cycles. The employees use mobile handhelds to save the users’ consumption data. At the headquarters, they connect the devices to a computer and copy the information to the central billing system. The staff distributes the printed bills in the next billing round. In order to avoid fraud, the employees cover each month a different area. ESSAP has outsourced the payment transactions to a third party provider. Users can pay their bills at pharmacies, supermarkets and other popular sights around Asunción. Around 8.5% of all invoices are not successfully billed in. Usually, the customers with the lowest payment discipline are public institutions. User in default can be blocked after three expired invoices (four months of non-payment). Connections that fall into the reduced tariff regime cannot be cut by law.

**Customer Management**

ESSAP has a customer hotline and customer service offices in each of the cities of Gran Asunción. However, the customer service is poor. Some customer complaints require weeks or months until they are solved. However, over the past years, ESSAP has made efforts to professionalize the customer service. The call centers work now with a mapping software. This software is able to identify the locality of a technical problem on a map and automatically orders a maintenance mission to the next available technician. Every day, around 100 customer reports on leakages reach the customer service. The high number of leakages and the slow customer service have contributed to ESSAP’s inglorious image in the general public.

**Monitoring**

**Internal:**

- The customer feedback is one of the key sources to revise the proper functioning of the network on a daily basis. All technicians have a radio set to
exchange information on the status of the network at different sights.

- Computer software automatically collects technical data from the network, such as the level of production or the network pressure.
- All sub-management areas present each month a report to the governing body, containing the key performance indicators.
- ESSAP has an internal lab for water quality testing. As required by law, the lab tests each hour a sample from the production plant on chemical, physical, and microbiological quality.

**External:**

- The council for state enterprises and ESSAP signed in 2009 a contract that defines the basic objectives and standards for the company. These objectives serve as a benchmarking tool. From 2009 to 2011, ESSAP has fulfilled the goals set and was ranked among the best-performing public companies.
- ERSSAN is meant to regulate and monitor ESSAP’s activities. However, both institutions, ESSAP and ERSSAN depend to some extent on the President of the country. This interdependence may create biases in the regulation process.

**Maintenance**

ESSAP has teams of technicians based at the eight distribution centers. They react upon customer requests forwarded by the call center agents. After the solution of a problem, the technicians report back to the distribution center. The report describes the time and the spare parts spent on an operation. However, the professional skills of the technicians are often low so that some problems reappear after a short period of time. ESSAP assumes all maintenance costs, both inside and outside the users’ property.

**Sewage**

107’000 users or around 46.5% of all customers have a connection to the sewage system. However, only 5% of the sewage receives full treatment. The lack of a large-scale treatment plant heavily stresses the quality of the Paraguay river and the top tiers of Asunción’s groundwater resources (F. B. Villar, Interview, 2. July 2013). The 53.5% of users without a connection to the sewage system have almost always a sewage pit under their land.

**HR**

ESSAP employs around 1’500 persons. Usually, the staff composition, particularly at the management level, changes after the election of a new President in Paraguay. This means that a good amount of personnel is selected on the basis of political favors and not on technocratic merits. The professional skills of many employees are thus low. Furthermore, little incentive is given to employees who perform well. The
salaries are fixed and the career opportunities often link to political favors. Employees who reach a certain rank usually keep that rank even if they are downgraded at a later stage. Higher ranks imply more privileges and higher salaries. The average human capital spending amounts to US $720 per month and employee.

**IT**

10 years ago, the internal IT system was heavily outdated. Therefore, a number of innovations have been introduced over the last years. The billing personnel have been equipped with mobile handhelds to transfer and process data more efficiently and securely; the call centers work now with modern mapping software for a quicker identification and resolution of problems; and, computer software monitors the production and distribution processes.
Financial Analysis

Cost-Revenue-Analysis

<table>
<thead>
<tr>
<th></th>
<th>Amount/Year</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Revenues</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>+ Revenues through water sales</td>
<td>US $30.4 million</td>
<td></td>
</tr>
<tr>
<td>+ Revenues through sewage</td>
<td>US $ 7.6 million</td>
<td></td>
</tr>
<tr>
<td>+ other revenues</td>
<td>US $4.5 million</td>
<td></td>
</tr>
<tr>
<td><strong>Total revenues</strong></td>
<td><strong>US $42.5 million</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Operational costs</strong></td>
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<td></td>
</tr>
<tr>
<td>Electricity</td>
<td>US $5.5 million</td>
<td></td>
</tr>
<tr>
<td>Chemicals</td>
<td>US $3.5 million</td>
<td></td>
</tr>
<tr>
<td>Maintenance</td>
<td>US $1.5 million</td>
<td>(estimated sanitation $0.6 million)</td>
</tr>
<tr>
<td>Salaries</td>
<td>US $10.5 million</td>
<td>(estimated sanitation $1.8 million)</td>
</tr>
<tr>
<td>Taxes</td>
<td>US $2.7 million</td>
<td>(estimated sanitation $0.5 million)</td>
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<tr>
<td>Other costs</td>
<td>US $3 million</td>
<td>(estimated sanitation $0.5 million)</td>
</tr>
<tr>
<td><strong>Total operational costs</strong></td>
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<td>(estimated sanitation $3.4 million)</td>
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<tr>
<td><strong>Total capital costs</strong></td>
<td><strong>US $16.1 million</strong></td>
<td>(estimated sanitation $6.4 million)</td>
</tr>
</tbody>
</table>

Includes expansions and catch up of missed investments in earlier decades

*Based on 2011 results. Exchange rate used: 1 USD = 4'400 PYG*
### Unit-Cost-Analysis

<table>
<thead>
<tr>
<th>Item</th>
<th>US $-Cents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>9</td>
</tr>
<tr>
<td>Chemicals</td>
<td>5.7</td>
</tr>
<tr>
<td>Surcharge for water losses</td>
<td>7.5</td>
</tr>
<tr>
<td>Maintenance</td>
<td>1.5</td>
</tr>
<tr>
<td>Salaries</td>
<td>14.2</td>
</tr>
<tr>
<td>Other</td>
<td>4.1</td>
</tr>
<tr>
<td><strong>Total operational costs per m³ billed in</strong></td>
<td><strong>34.5</strong></td>
</tr>
<tr>
<td>Taxes</td>
<td>3.6</td>
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<tr>
<td><strong>Total operational costs per m³ billed in (incl. taxes)</strong></td>
<td><strong>38.1</strong></td>
</tr>
<tr>
<td>Capital</td>
<td>15.8</td>
</tr>
<tr>
<td><strong>Total cost per m³ billed in</strong></td>
<td><strong>53.9</strong></td>
</tr>
</tbody>
</table>

### Performance Analysis

**Effectiveness**

**Service continuity:**
24 hours per day

**Water quality:**
Some people in Asunción drink water from the tap. However, most interview partners (incl. ESSAP managers) strongly question the quality of tap water.

**Efficiency**

**Operational costs per m³ of water:**
US $0.35

**Capital costs per m³ of water:**
US $0.16 *(including expansions and catch up of missed investments in earlier decades)*

**Capital Cost / Total Cost**
31.5% *(including expansions and catch up of missed investments in earlier decades)*

**Infrastructure cost per connection:**
US $1’800-$2’800 in 1997 *(Solo, 2003, p. 15)*
Affordability - Total cost for 15m³ / 5% monthly household income:
The cost-covering price for 15m³ of water is around US $7.55. Applying the 5% rule, ESSAP’s water can be afforded by households with an annual income higher than US $1’800. In Paraguay, around 465’000 urban residents or around 12% of the people living in cities fall below the BoP1800 threshold (Hammond, Kramer, Katz, Tran, & Walker, 2007).

Employees/100 connections:
3.5

Water losses (Water produced / Water successfully billed in):
51.3% of the water produced cannot be successfully billed in. 46.8% is physically lost and 4.5% represent bills that are written off. These losses cause the cost per cubic meter to increase by around US $-Cents 7.5/m³.

Legitimacy

Public interest:
Democratic influence is exercised through the President of the Republic, the minister council for public companies and the new Directorate for Water and Sanitation.

Users’ interest:
Customers have no direct leverage on decision-making in ESSAP. They can only accept the service offered or switch to self-supply with the construction of a private borehole. Many businesses and hotels in Gran Asunción have a private borehole.

Accountability:
- ERSSAN as Paraguay’s regulation body is meant to oversee ESSAP’s activities. However, the fact that both the President of ERSSAN and ESSAP are appointed by the President of the Republic dilutes to a certain extent the impartiality of the regulatory process.
- ESSAP’s organizational set up and the results are to a large extent not public. It is thus very hard to understand for an outsider how the company works.

Equality of output:
All city residents are supposed to receive the same service. Discrimination exists only in terms of pricing. Low-income users from defined living areas benefit from reduced tariffs.
**Scalability / Replicability**

**Current scale:**
230'000 connections for around 1.15 million people.

**% of households covered in area of operation:**
100%

**% of households covered in potential area of operation:**
55% ESSAP, 19% “aguaterias”, 18% community groups, 8% self supply

**Growth rates since establishment:**
Average: 4'750 (+2.1% – basis year 2011)
2011: n/a (n/a % – basis year 2011)

**Favourable conditions and obstacles to scale:**
- The expansion and the renewal of the network require additional upfront finance. A current World Bank loan amounts to US $50.5 million. It is estimated that ESSAP would need to invest 30 times more, US $1’500 million, to cover all Paraguayan cities with water and sanitation.
- ESSAP’s potential area of growth is limited by other providers. Many urban areas are blocked today by community groups or “aguateros”. Parts of the networks overlap.
- Low-income residents that fall into the lowest tariff category cannot be served viably at the current cost structure. Moreover, customers of the lowest category who do not pay their debt cannot be blocked. ESSAP has therefore little reasons but political ones to expand the network towards low-income areas.

**Favourable conditions and obstacles to replication:**
- The model is preferably replicable in BoP 1800 markets.
- The separation of the revenues of the company from the global state budget has been a key incentive for ESSAP to improve its cost structure. ESSAP has professionalized the customer service, it has updated the IT system, and it has increased the degree of automation of production and distribution.
- Overall prices for water and sanitation have been set at a level that (almost) allows the recovery of all operational and capital costs.
- The high volume of unaccounted water would threaten the long-term sustainability of water resources in regions dryer than Asunción.
Environmental Sustainability

% of HH connected to the sewage:
Around 48% of ESSAP’s customers have a connection to the sewage system.

% of sewage treated:
Only 5% of the sewage receives full treatment.

Sustainability of water resources:
More than 90% of the water that ESSAP provides is sustainably extracted from the local Paraguay river. Estimations show that the superficial water resources around Gran Asunción tend to grow by 26.5 hecto cubic meters each year. This number is expected to grow to 106.5 hecto m$^3$ in 2035. However, the water quality is a constant source of concern as hardly any sewage is treated in Paraguay’s capital.
### A.2 YBU

#### Governance Analysis

**Problem**

**Main goals:**

Aricio Gamarra’s overall goal is the achievement of profits that allow him and his family to make a good living. Unlike some other “aguateros”, Aricio Gamarra considerably invests into the quality and long-term sustainability of his network. He is convinced that the fortune of his business depends on the satisfaction of his customers and of the regulation authority.

**Main challenges:**

Under Paraguayan law, the water operators are expected to sign a contract with the national regulator ERSSAN. However, the law has only partly been enforced and no contracts have been signed yet. In this legal limbo, investments into the sector run the risk of being confiscated at some point by the government. The planning horizon for Aricio Gamarra is therefore limited and full of ambiguity.

**Geographical focus:**

YBU is based in a quiet neighborhood of San Lorenzo, a city that forms part of Gran Asunción. Between two and three residential blocks overlap with ESSAP’s network.

**Actors**

**External:**

- The head of the national water and sanitation regulator ERSSAN is appointed by the President of the Republic and has the mandate to monitor and regulate the water operators in the country. However, due to the fragmentation of the sector and the limited resources, ERSSAN has difficulties to effectively fulfill its task. It depends to some degree on the operators’ disposition to cooperate. Aricio Gamarra tries to avoid any conflict and implements ERSSAN’s regulations. He adds chlorine to the water, as legally required, and submits any tariff increase to the regulator for approval. By law, ERSSAN charges operators a 2% regulation commission. In practice, only ESSAP and a few other operators (e.g. Aricio Gamarra) pay this fee.

- By request of international donors and creditors, the Paraguayan government established in 2009 within the Ministry of Public Works the Directorate for Water and Sanitation, DAPSAN. The DAPSAN is meant to bundle any efforts for the development of a coherent, legal framework. So far, the Directorate is still understaffed and other areas in the government such as SENASA (the
rural water and sanitation development agency) fight with DAPSAN for competences and most notably finance (R. Monte Domeq, Interview, 25 June 2012). There is no direct link between DAPSAN and the aguateros.

- Following the highly discussed bill 1614, the private operators in the country formed the “Cámara Paraguaya del Agua” [CAPA]. The CAPA is a lobbying group, representing the interests of the small-scale private operators in politics. The group is financed by its members and meets regularly on a monthly basis (J. Candia, Interview, 25 June 2012).

Internal:

Aricio Gamarra is an old-school entrepreneur who understands and controls any aspect of his business. He takes all decisions and does not face any opponents within the organizational structure of YBU.

Processes

Aricio Gamarra typically takes informed decisions on the basis of the data collected in the IT system, and upon feedback from his customers and employees. He faces boundaries set by ERSSAN in the implementation of Paraguayan law.

Nodal points

- YBU’s key nodal point is Aricia Gamarra’s property, where both the production facilities and the office are located. This is the place where customers can approach the operator with problems, where information comes together, and where the most important decisions are taken.
- For customers, the AQUI PAGO billing points are often the first link to the operator. In case of operational problems, the customers can contact Aricio Gamarra via mobile phone or directly visit his office.

Norms

As the exclusive owner and manager of the company, Aricio Gamarra can take all decisions by himself and does not have to respect any governance rules in decision-making.

Modes

Between legislator/regulator and utility:

At the moment, the state tolerates private property in the water sector and the market-based operation of small-scale networks. Due to the unstable political conditions in the country, it is not clear how the legal sector framework will develop over the next years.
**Vertical Forms of Organization**

**Regulation:**
ERSSAN, the national regulator based in Asunción, specifies and monitors YBU’s activities. However, the lack of financial and human resources make an effective regulation process difficult. Even worse; no operator, not even ESSAP, has signed a binding agreement with ERSSAN so far.

**Operation:**
YBU is a private small-scale operator, entitled to cover a small neighborhood of the city San Lorenzo, part of Gran Asunción.

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**Supply Chain Analysis**

**Finance**
Aricio Gamarra financed his first US $30’000 investment for a borehole, a water tank, a pump and 150 connections from his own savings. In order to finance the first extension of the primary network, he sold a second house where he had lived before becoming an aguatero. Since the second up-front investment, further extensions have been financed either through the revenues generated by the business or through loans from private banks. However, bank loans are very expensive at 30% annual interest rates or even more.

**Institutional Context**
Aricio Gamarra built the borehole and the production facilities on his own property of 840 square meters where he lives and from where he manages the company. Until the year 2000, Paraguay’s water sector was unregulated. Operators could build their networks wherever they wanted and as consequence a lot of areas are served until today by multiple providers. YBU has only a small area that overlaps with ESSAP’s network. In the year 2000, lawmakers passed the bill 1614, creating ERSSAN and transforming CORPOSANA into ESSAP. Within the law, it is also determined that all operators shall conclude a contract with ERSSAN. For small-scale operators, this contract expires after ten years. ERSSAN can then decide to renew the agreement or to nationalize all goods and to transfer the service to another operator. The law has been highly controversial and so far not a single operator in Paraguay has signed an agreement with ERSSAN (ABC Digital, 2009). However, since the introduction of the bill, operators, and so did YBU, have been able to register with the advantage that ERSSAN would grant them a “operational permission” for an exclusive area of operation.
**Procurement**

YBU uses three boreholes. They have a profundity of 112, 130, and 152 meters and a diameter of five inches each. The three boreholes together extract around 560m$^3$ of water per day or 201'850m$^3$ per year. YBU uses around 171'500 kWh energy per year from the biggest national provider, ANDE. One kWh has a prize of around US $-Cents 5. For each cubic meter of water produced, YBU pays around US $-Cents 4.2 on electricity.

**Production**

From the three boreholes, three pumps pressure the water with 7.5-10 horsepower [HP] into an elevated tank of 80m$^3$ capacity. The tank is connected to the boreholes and once it empties out, the tank automatically emits a signal to the pumps to produce more water. The production is equipped with a macro meter and an automatic frequency control gear, regulating the use of the pumps according to the actual demand in the network.

**Treatment**

The quality of the water extracted is perfectly drinkable, according to Aricio Gamarra. However, to prevent potential risks and to comply with the law, automatic dosing feeders add sodium hypochlorite to the water prior to distribution.

**Pricing**

Upon connection, new clients pay a fee of around US $225, including the house connection, a micro meter, and simple tap. This connection fee includes a margin of around 50% on the real cost of connection (including accessories and manpower). If users prefer, they can pay the connection fee in six installments over six months.

YBU charges for a minimum consumption of 10m$^3$ US $7.13, including taxes. The consumption that goes beyond 10m$^3$ is priced at US $0.84 per cubic meter. The average consumption per connection and month amounts to 14.5m$^3$ or US $10.91 revenues per customer and month. Each increase in tariffs has to be justified toward and approved by the national regulator ERSSAN. The last price increase in YBU dates back to 2008.

<table>
<thead>
<tr>
<th>Volume</th>
<th>Domestic</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-10 m$^3$</td>
<td>US $0.71 (min 10 m$^3$)</td>
</tr>
<tr>
<td>&gt;10 m$^3$</td>
<td>US $0.84</td>
</tr>
</tbody>
</table>

**Delivery**

From the tanks, the water is pushed through gravity and pressure from five pumps (3-7.5 HP) into the distribution network, consisting of 33.5 kms of PVC pipes. The network length per household is comparatively large; but, the biggest pipes have only
a diameter of 4.3 inches. The smallest ones have a diameter of 1.6 inches. At the beginnings, Aricio Gamarra used polyethylene pipes. But after some time, he felt that PVC has a longer shelf life and switched. Around 13.5% of the water produced is physically lost in the network. The network pressure fluctuates between 2-2.5 bar.

**Billing**

Since the beginnings, all bills were issued on the basis of micro meters. The billing agents cover the entire area of operation monthly. They use mobile billing handelds to save the users’ consumption data. Upon return to the office, they transfer the information contained on the devices to the central server. The computer software processes the information, controls the data and issues the invoices. The software also emits a warning signal against unusual consumption levels of specific users. In such event, Aricio Gamarra personally checks the connections of the affected users.

The payment transactions have been outsourced. “AQUI PAGO” manages a wide network of billing partners, such as pharmacies, gas stations, and supermarkets all over Paraguay. AQUI PAGO charges YBU a 3% commission fee on revenues. For Aricio Gamarra, the main benefits of this cooperation are “security” as he does not want to keep large amounts of money in his house and improved “accessibility” of the company to customers. In case of non-payment, the connections are cut, in accordance with law, after three expired invoices or four months. 97.5% of all households pay their debts within the four months period. Customers that manipulate the micro meter must bear the cost of replacement. In cases of repeated fraud, YBU may inform the police.

**Customer Management**

The customer management is limited to problem solving. Users with problems can contact the provider via telephone or they come directly to the office. Usually, Aricio Gamarra awaits between 15 and 20 phone calls a month. YBU does not conduct any marketing activities.

**Monitoring**

**Internal:**

- The tank is equipped with an automatic alarm. When the water level sinks below 80 centimeters, an alarm is emitted to Aricio Gamarra’s mobile device, informing that a pump or some other part in the system has broken.
- The computer software helps Aricio Gamarra to analyze the key technical, commercial, and financial performance indicators on a monthly basis.

**External:**

- An external laboratory tests the water quality four times a year. YBU submits the results to ERSSAN.
- YBU hast to justify any tariff increase toward the regulator, presenting detailed financial data.
**Maintenance**

Aricio Gamarra himself conducts any task that requires the skills of an electronic engineer. Construction works, on the other hand, are carried out by the three employees or a specialized third party. Around ten leakages per month in the network are the most frequent origin of maintenance activities.

**Sewage**

There is no sewage system in the area. The people usually build sewage pits (depth of 4 meters and diameter of 1.5 meters) under their land. The sewage infiltrates into the soil, stressing the quality of Asunción’s ground waters. Aricio Gamarra would be interested to invest in cooperation with other small-scale operators into a sewage system. However, such an investment would require more planning security which is not given under the current legal limbo.

**HR**

Aricio Gamarra has delegated most operational tasks out, employing three people full time. Their job includes the maintenance of the infrastructure, the monthly meter reading, and the distribution of bills. An employee earns around US $450/month. To compensate the entrepreneur’s workload and business risks, I added a 12.5% profit margin on total costs. This profit margin would provide the entrepreneur with a decent salary of US $8'000/year, 1.5 times as high as the salary of his employees, respectively three times as high, assuming that the “aguateria” accounts only for 50% of the entrepreneur’s work time. It is Aricio’s wish that in the future his son, who has recently started to study electromechanic engineering at the university, will carry on the company.

**IT**

YBU uses tailored content management software. Aricio Gamarra ordered this software from an IT specialist according to the requirements of the company. The software synchronizes information with the mobile billing handhelds that YBU uses. Each mobile handheld was purchased for US $600 and the software was acquired for US $1’200. AQUI PAGO has access to YBU’s data server in order to collect and process the payments.
## Financial Analysis

### Cost-/Revenue-Analysis

<table>
<thead>
<tr>
<th></th>
<th>Amount</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Revenues</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>+ Revenues through water sales</td>
<td>US $131’000</td>
<td></td>
</tr>
<tr>
<td>+ Other revenues</td>
<td>US $1’500</td>
<td>Margin on household connections</td>
</tr>
<tr>
<td><strong>Total revenues</strong></td>
<td><strong>US $132’500</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Operational costs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electricity</td>
<td>US $8’500</td>
<td></td>
</tr>
<tr>
<td>Chemicals</td>
<td>US $2’000</td>
<td></td>
</tr>
<tr>
<td>Maintenance</td>
<td>US $9’500</td>
<td></td>
</tr>
<tr>
<td>Salaries</td>
<td>US $16’000</td>
<td>Including 10% VAT and 2% regulation fee (for ERSSAN)</td>
</tr>
<tr>
<td>Taxes</td>
<td>US $13’500</td>
<td></td>
</tr>
<tr>
<td>Other costs</td>
<td>US $5’500</td>
<td></td>
</tr>
<tr>
<td><strong>Total operational costs</strong></td>
<td><strong>US $55’000</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total capital costs</strong></td>
<td><strong>US $18’500</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Profit margin 12.5% on total costs</strong></td>
<td><strong>US $8’000</strong></td>
<td>Based on 2011 results. Exchange rate used: 1 USD = 4’400 PYG</td>
</tr>
</tbody>
</table>

Based on 2011 results. Exchange rate used: 1 USD = 4’400 PYG
Unit-Cost-Analysis

<table>
<thead>
<tr>
<th>Item</th>
<th>US $-Cents</th>
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<tbody>
<tr>
<td>Electricity</td>
<td>5.1</td>
</tr>
<tr>
<td>Chemicals</td>
<td>1.3</td>
</tr>
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<td><strong>Surcharge for water losses</strong></td>
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<td>Maintenance</td>
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<td>Salaries</td>
<td>9.4</td>
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<tr>
<td>Interests</td>
<td>0</td>
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<tr>
<td>Other</td>
<td>3.2</td>
</tr>
<tr>
<td><strong>Total operational costs per m³ billed in</strong></td>
<td><strong>24.6</strong></td>
</tr>
<tr>
<td>Taxes</td>
<td>8</td>
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<tr>
<td><strong>Total operational costs per m³ billed in (incl. taxes)</strong></td>
<td><strong>32.6</strong></td>
</tr>
<tr>
<td>Capital</td>
<td>10.7</td>
</tr>
<tr>
<td><strong>Total Cost per m³ billed in</strong></td>
<td><strong>43.3</strong></td>
</tr>
<tr>
<td>12.5% Profit Margin</td>
<td>4.7</td>
</tr>
<tr>
<td><strong>Total cost per m³ billed in (incl. profit margin)</strong></td>
<td><strong>48</strong></td>
</tr>
</tbody>
</table>

Performance Analysis

**Effectiveness**

Service continuity:
24 hours

Water quality:
According to operator information, the water is potable at the point-of-use. An external laboratory tests the water four times a year. YBU submits the results to the national regulator.

**Efficiency**

Operational costs per m³ of water (excl. taxes):
US $0.25 without profit margin / US $0.29 incl. 12.5% profit margin

Capital costs per m³ of water:
US $0.11

Capital Costs / Total Costs:
26.75%
Infrastructure cost per connection:
> US $200

Affordability - Total cost for 15m$^3$ / 5% monthly household income:
The cost-covering price for 15m$^3$ of water is around US $6. Applying the 5% rule, YBU’s water can be afforded by households with an annual income higher than US $1’450. In Paraguay, around 275’000 urban residents or around 7% of the people living in cities fall below the BoP1500 threshold (Hammond, Kramer, Katz, Tran, & Walker, 2007).

Employees/1’000 connections:
3.5

Water losses (Water produced / Water successfully billed in):
15.5% of the water produced cannot be successfully billed in. 13.5% is physically lost and 2% represent bills that are written off. These losses cause the cost per cubic meter to increase by at least US $-Cent 1/m$^3$.

Legitimacy

Public interest:
The public system has no direct control over the private, small-scale operators.

Users' interest:
As YPU has a monopoly in its area of service, consumers have little power to influence, but to complain to the operator or to ERSSAN.

Accountability:
The public interest is represented through ERSSAN that regulates all water operators around the country. YPU must announce and justify any increase in tariffs to the regulator for approval. However, while Aricio Gamarra tries to comply very carefully with basic standards set in the Paraguayan law (he respects tariffs, he adds chlorine to the water, he submits water quality test results), there seems to be a considerable amount of cheating and incompetence among other small-scale operators. Due to the limited resources and the large number of operators (over 400), ERSSAN finds it very hard to track these black sheeps. In fact, no operator in the country has even signed a legally binding contract with ERSSAN so far.

Equality of output:
Within YBU’s service area, all residents are supposed to receive the same service. However, the model of multiple, independent operators ine one city has led to varying service standards from one operator to another.
Scalability / Replicability

Current scale:
1’000 connections for around 5’000 people.

% of households covered in area of operation:
100%

% of households covered in potential area of operation
55% ESSAP, 19% “aguaterías” (0.25% YBU), 18% community groups, 8% self supply

Growth rates since establishment:
Average: 39 (+3.9% – basis year 2011)
2011: 40 (+4% – basis year 2011)

Favourable conditions and obstacles to scale:
- Today, almost 100% of Asunción, including the suburbs are covered through water operators. New immigrants usually settle down in already existing living areas, close to relatives that had come to the city before. Therefore, Aricio Gamarra does not see any opportunity for growth in the city.
- 20 years ago, when people in many areas of Asunción still did not have household access to water, Aricio Gamarra lacked access to finance to expand his company within the city.

Favourable conditions and obstacles to replication:
- The model is preferably replicable in BoP 1450 markets.
- In Asunción, groundwater is easily accessible few meters below the surface. The accessibility of the water has favoured the growth of small-scale businesses who have been able to start with a small investment, selling water in a small network.
- Paraguay did not have any legal water framework until the year 2000 and therefore no ban on private property and private operations in the water sector. Any replication would require a comparably flexible legal framework.
- The growth has been mostly driven by entrepreneurs who – before becoming “aguatero” – had already saved some money and possessed some basic engineering skills. The savings are important because the access to finance for SMEs is in Paraguay limited and expensive.
Environmental Sustainability

% of HH connected to the sewage:
0%

% of sewage treated:
0%

Sustainability of water resources:
YBU extracts water from Gran Asunción’s Patiño aquifer. However, estimations show that the groundwater resources under Gran Asunción tend to decrease by 111.5 hecto cubic meters each year. This number is expected to grow to 305.5 hecto m$^3$ in 2035. As the water quantity decreases, problems might emerge for aguaterias to supply water (ABC Digital, 2012). In addition, the water quality is a constant source of concern as hardly any sewage is treated in Paraguay’s capital. Among small-scale operators, there is little awareness for the sustainability of water resources.
Santa Cruz de la Sierra

B.1 SAGUAPAC

Governance Analysis

Problem

Main goals:
SAGUAPAC’s all-embracing goal, reflected already through the name (SAGUAPAC = Servicios de agua potable y alcantarillado), is the provision of water and sewage services to the population of Santa Cruz. As an independent cooperative, SAGUAPAC strives for financial viability and environmental sustainability.

Main challenges:
- Due to high upfront costs, sanitation coverage in SAGUAPAC’s area of license is still well below water coverage with 62% compared to 100%.
- The continuous influx of immigrants requires the city network to expand steadily.
- The population growth, the urbanization and the deforestation in the surroundings of the city threaten the environmental sustainability of the local water resources. Experts believe that the exploitation of the aquifer could exceed the natural rechargeable level from the year 2020 on. In the light of the decreasing aquifer level, water operators have to invest in alternative water sources.

Geographical focus:
The city of Santa Cruz has grown around 12 circles. SAGUAPAC’s water operations reach the outer circles of the city while the sanitation network currently stops at the inner, wealthier circles. The total area of license covers around 1.2 million people or 182’500 connections. The area of license has grown continuously with new residents and neighborhoods asking SAGUAPAC to connect. The national regulator has to approve any expansion of the area of license.

Actors

External:
- MMAyA (Ministry of Environment and Water): The Vice-Ministry for Water and Sanitation helps to develop and implement a coherent legal framework for Bolivia’s WASH sector. The Vice-Ministry in La Paz only sporadically interacts with SAGUAPAC.
- AAPS, the national regulator, has specified SAGUAPAC’s license, including
regulations on the area covered, maximum tariffs, and minimum service requirements.\textsuperscript{32} SAGUAPAC regularly submits lab results on water quality to the regulator. SAGUAPAC contributes to the finance of AAPS with 1.5\% of its revenues.

- VIPFE: The Vice-Ministry for Public Investments channels public and external finance into the sector.
- The municipal and the departmental government play only a minor role in urban water provision. They sometimes propose and finance infrastructure expansions, conducted in cooperation with SAGUAPAC or another cooperative in the city (G. J. Ferrufino, Interview, 4 July 2012).

\textbf{Internal:}

\textbf{Figure 23 – Organizational Chart SAGUAPAC}

\begin{itemize}
\item SAGUAPAC’s area of concession divides into nine districts. Each district assembly elects every two years a president, a vice-president, a secretary, three board members and three delegates. The district boards organize once a month user forums to inform about new developments and discuss problems. The district boards further meet with the administration board and the management every month to share information and to discuss problems in the districts.
\item Three delegates per district form the delegate assembly that elects nine
\end{itemize}

\textsuperscript{32} The board of AAPS is composed of members from the government, the operators, and the general public.
people into the administration and six persons into the supervisory board for a term of six years. Board members are compensated with around US $5’000/year. Direct re-elections are not possible. The assembly also approves at its annual meeting financial and board reports. Moreover, it has the power to change the formal statutes of the cooperative.

- The administration board defines in 24 annual meetings the main policies, approves budgets (and expenses exceeding US $10’000), sets salary scales, and oversees the bidding processes. Decisions are usually taken with majority vote. The board members hire a general manager and four area managers. The general manager participates in and informs during the board meetings.
- The administration board reports to the supervisory board. The supervisory board can approve in its monthly meetings the administration board’s decisions or call for an extraordinary delegate assembly. SAGUAPAC’s general manager participates and informs the supervisory board during these meetings.
- The cooperative is organizationally split into four areas, led by four area managers. The commercial branch is the interface to the customer for marketing and billing activities. The finance branch revises and budgets the financial resources. The construction branch elaborates and executes new projects. Finally, the operational and maintenance branch manages the technical operations. The four area managers and the general manager work in close contact, coming together at least once a week.
- Each area is hierarchically divided into different (usually four) departments. The departments consist of different sections (usually two or three), the lowest organizational sub-element in SAGUAPAC.

**Processes**

**Information:**

The information stream in SAGUAPAC has the form of a cascade: The head of a section informs the head of the department. The head of a department informs the head of the area. The head of an area informs the general manager. The general manager informs both the administration and the supervisory board. The administration and the supervisory board inform the delegate assembly and the district boards. The district delegates and the district boards eventually inform the users/proprietaries.

**Decision-making**

- Board members play a very important role in decision-making. The members of the administration board meet at least twice a month and are involved in any important decision (investments > US $ 10’000). Its members are sometimes criticized for allegedly being part of Santa Cruz’ elite circles, the
so-called “logias de Santa Cruz” (R. Ferreira, Interview, 13 July 2012). The members of the “logias” are accused of pursuing personal interests through representation in the city’s powerful cooperatives (CRE for electricity, COTAS for telecommunication, SAGUAPAC for water). Those critics claim that a culture of nepotism is responsible for SAGUAPAC’s high tariffs - among the highest in urban Bolivia. Advocates of SAGUAPAC claim that the organizational stability has been one of the key factors for SAGUAPAC’s success and those prices are higher than elsewhere because SAGUAPAC is one of the few fully self-sustainable, urban operators in Bolivia (B. Costas, Interview, 17 July 2012).

- The role of the shareholders is small. Formally, they are the highest, legitimate decision unit of SAGUAPAC, but in practice, only 2.5% of the shareholders participate in delegate meetings. User interests are defended indirectly by the district boards and district delegates. Critics therefore claim that SAGUAPAC is in fact in hands of a small group of people, who can take decisions against the users’ interests. Supporters of the cooperative in contrast explain the low level of participation with a high level of user satisfaction and efficiently working institutions.

**Nodal points**

- The district offices organize district assemblies once a month as a communication channel between the cooperative and the shareholders/users.
- The monthly meetings between the district representatives and SAGUAPAC’s board members serve as an interface between the user representatives and representatives of SAGUAPAC.
- The meetings between the general manager and the board of administration twice a month facilitate the communication between the organizational and the strategic units of SAGUAPAC.
- The monthly meetings between the general manager and the supervisory board contribute to an independent monitoring mechanism.
- The weekly meetings between the general and the four area managers serve as an important link between the management and the daily operations.
- The headquarter building has an open and transparent architecture, meant to stimulate the daily exchange between the staff members and visitors.

**Norms**

**Explicit:**

Cooperatives in Bolivia determine its organizational rules in the statutes. To become legally accepted, these statutes must be approved by the agency for cooperatives within the Ministry of Labor. Only the delegate assembly can amend SAGUAPAC’s statutes.
**Inexplicit:**

- Every office room shows on the wall a famous poem from Ruy Barbosa:

  "De tanto ver triunfar las insignificancias, de tanto ver prosperar la deshonra, de tanto ver crecer la injusticia, de tanto ver agigantarse los poderes en las manos de los malos, el hombre llega a desanimarse de la virtud, a reírse de la honra, a tener vergüenza de ser honesto"

- The meritocratic principles are not an explicit part of the statutes, but hard-working employees can expect to grow within the company. An average employee works roughly 15 years for SAGUAPAC.

**Modes**

**Between legislator/regulator and utility:**

Bolivian law entitles municipalities to transfer water operations to cooperatives. Being neither fully private nor public, SAGUAPAC has traditionally been exposed to pressure from both angles.

**Vertical Forms of Organization**

**Regulation:**

AAPS, the national water and sanitation regulator based in La Paz, specifies and monitors SAGUAPAC’s license.

**Operation:**

SAGUAPAC is legally entitled to cover the water supply of major parts (70%) of the city of Santa Cruz.

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**Supply Chain Analysis**

**Finance**

SAGUAPAC is financed through a mix of equity and debt. Upon connection, each user becomes a shareholder of the company in buying shares worth US $300 for water and US $1’000 for sanitation. However, as US $1’300 are a high upfront investment for Bolivian households, SAGUAPAC gradually recovers the amount through a 20% surcharge on water consumption. An average associate repays the full amount over a period of 30 years. SAGUAPAC’s balance sheet values these contributions at US $113.5 million. Moreover, the equity increases with profits added to the reserves. The reserves are currently valued at around 57.6 million.

At the establishment of SAGUAPAC as a cooperative, the user contributions and reserves were still marginal. Since the early 1980s, SAGUAPAC has therefore applied for external finance, mostly from international finance organizations, starting with a US $8 million loan from the World Bank in 1983. Today, the financial debt...
amounts to US $34.7 million, with contributions from the World Bank (~US $ 10 million), the Interamerican Development Bank (~US $ 15 million) and the Andean Promotion Corporation (~US $ 10 million). The soft loan is repaid over 15-25 years with interest rates of between 1%-5%/year. Around 70% of these assets are directed to expansions of the sanitation network and 30% to the expansion and renewal of the water network. SAGUAPAC’s debt-to-capital ratio is 24%.

The central government must guarantee and approve any credit from international finance organizations. The process depends on “political games” and can take up to 10 years to reach approval. For further loans, SAGUAPAC therefore evaluates the possibility of accessing private credit markets with more flexibility but less favorable interest rates.

**Institutional Context**

In 1999, SAGUAPAC was granted a concession for the period of 40 years. The agreement was called concession even though the capital assets were fully in hands of the cooperative. The contract determined the area of operation; it approved the tariff system; and, it defined the service requirements.

With political winds turning left in Bolivia, a new regulatory body, the AAPS, was established in 2005. The authority transformed the concession into a license. The substantial difference between the concession and the license is that the former had a time limit whereas the latter has been issued for an indefinite amount of time.

SAGUAPAC’s area of operation grows alongside the expansion of the city. In the context of the “legal right to water” discussion, there is political pressure on water operators to connect peri-urban settlers. Community groups often approach SAGUAPAC and ask for a connection to the network. SAGUAPAC develops a project and asks the AAPS for an expansion of the area of license.

**Procurement**

SAGUAPAC sources water from 350 meters deep aquifers, using 67 boreholes. Each borehole extracts roughly 2'634 m³ of water every day, leading to a total annual production of 64'437'000 m³. The boreholes are deeper than the ones used by other cooperatives. The characteristics of the water source (higher quantity, high quality, better flow rate, sustainability) improve with depth. SAGUAPAC evaluates the possibility of tapping even deeper aquifer tiers as some experts have warned from an over-exploitation of current tiers of the aquifer by 2025.

SAGUAPAC receives electricity from the cooperative CRE. Despite the traditional linkage of board members from both cooperatives, SAGUAPAC claims to pay a standard rate. The annual bill for 37 million kWh amounts to US $3.2 million in total and to $3 million only for the water production. This means that SAGUAPAC transfers around US $-Cents 8.6 per kWh to CRE. Each cubic meter of water produced has an electricity cost of around US $-Cents 4.7. SAGUAPAC tests modern
sewage facilities that transform foul water gases into electricity. In the future, it aspires to auto-generate around 30% of its energy supply.

**Production**

The water from the 67 boreholes is collected in eight half-buried, storage tanks with a capacity of 37’000 m³ each. With a total daily production of 176’500m³, the tanks are completely refilled every 40 hours. From the storage tanks, the water runs then into one of the five pumping stations.

**Treatment**

The quality of water from the aquifer before treatment is excellent. The water is only treated with a diluted chlorine solution in order to protect it from contamination between the production facilities and the household tap. SAGUAPAC uses 24’525 kilos of chlorine gas/year or 0.38g/m³. It spends around US $100’000 per year on chemicals. In Santa Cruz, it is common and not risky at all to drink water from the tap.

**Pricing**

SAGUAPAC has four different tariff levels. Domestic users consume 76.73% of the water, commercial users 17.79%, special users (NGOs, hospitals) 4.26%, and industrial users 1.12%. A typical water bill consists of three items: The price for the water consumption, the price for the use of the sewage system - which corresponds to 80% of the water consumption -, and a 20% surcharge on water consumption as a contribution to equity. This last item falls away at the point users reach an accumulated contribution of US $300 for water and US $1’000 for sewage. SAGUAPAC uses an increasing block tariff system, meaning that the per cubic meter price increases with consumption. SAGUAPAC chose this tariff structure to cross-subsidize the consumption of the poorest and to incentivize the practice of saving water.

An average household consumes 20.65m³ per month, an average commercial user 36.62m³, an average industrial user 103.5m³, and an average special user 95.01m³. An average household pays US $8.15/month on water, an average commercial user US $21.96, an average industrial user US $86.60, and an average special user US $40.85. Assuming operational costs of US $0.43/m³, it is likely that SAGUAPAC cross-subsidizes the consumption of any domestic user with US $0.70/month. Commercial users in contrast generate a margin of US $6.48 and industrial users a margin of US $42.31 per month. Special users just cover the operational costs. While household connections lead to a total deficit of around US $111’500 every month, commercial and industrial users compensate these losses with a surplus of US $154’500. The remaining US $43’000 however cover only slightly more than 13% of the estimated capital costs for water. 87% of the capital costs on water are covered through revenues from the sewage system. According to the license, tariffs can be adjusted every five years, but only if SAGUAPAC can justify and convince the regulator of the necessity for an increase. Since 10 years, tariffs have not changed.
Table 20 – Tariffs SAGUAPAC

<table>
<thead>
<tr>
<th>Volume</th>
<th>Domestic</th>
<th>Commercial</th>
<th>Industrial</th>
<th>Special</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-10 m³</td>
<td>US $0.36 (min 10 m³)</td>
<td>US $0.53 (min 15 m³)</td>
<td>US $0.53 (min 15 m³)</td>
<td>US $0.43</td>
</tr>
<tr>
<td>-15 m³</td>
<td>US $0.43</td>
<td>US $0.63</td>
<td>US $0.63</td>
<td></td>
</tr>
<tr>
<td>-30 m³</td>
<td>US $0.48</td>
<td>US $0.63</td>
<td>US $0.63</td>
<td></td>
</tr>
<tr>
<td>-45 m³</td>
<td>US $0.56</td>
<td>US $0.76</td>
<td>US $0.75</td>
<td></td>
</tr>
<tr>
<td>&gt; 45 m³</td>
<td>US $0.62-$1.07</td>
<td>US $0.90-$1.53</td>
<td>US $0.85-1.48</td>
<td></td>
</tr>
</tbody>
</table>

Source: C. Flores, Interview, 11 July 2012

Delivery

Five pumping stations press the water into the network. The annual energy consumption for this activity amounts to almost 35 million kWh, or 0.54 kWh per cubic meter of water processed. Santa Cruz is geographically located on a plain which makes the use of gravity systems difficult. Water towers are not used, due to the enormous upfront costs. The 182’497 users are connected with 3’371 kms of PVC pipes. An additional connection requires an average extension of 18.5 meters of pipes. The pipe diameters range between 8 and 12 inches for the primary network and between 3 and 6 inches for the secondary extensions. The pressure in the network ranges typically between 1.2 and 1.5 bar, reaching heights at certain points up to 2.5 bar. In 2011, SAGUAPAC added 276 kms of pipes to the system. Around 20% of the water produced is physically lost, due to leakages or illegal connections.

Billing

SAGUAPAC conducts monthly billing cycles. Since establishment of the cooperative, SAGUAPAC installed micrometers at 100% of the connections. Most meters are easily accessible outside the building, visible for everyone above the sidewalk level. Each staff member in the billing area has an electronic handheld to type in and save users’ consumption data. At headquarters, the staff syncs the devices with the central IT system. Both, the handheld and the system have filters that emit a warning signal against unusual consumption levels. The signal allows staff members to react on the ground and to assess immediately whether a leakage or a manipulation may be the reason of an irregularity. With the handheld, the personnel can in addition print the bill at the time of reading. This measure increases the transparency of the billing process; it reduces the number of complaints and strengthens the users’ willingness to pay.

Customers can pay the bills at banks, pharmacies and many other payment points around the city. Most banks offer the service free of charge (as a marketing activity to attract customers). Other businesses charge a 1% commission fee. SAGUAPAC does not operate its own payment points in order to avoid internal fraud. Connections can be blocked theoretically within 60 days of non-payment. However, the “legal right for water” discussion has created political and social resistance against the practice...
of blocking water supply. In this mine field, SAGUAPAC does not want to fall into political disgrace. It therefore offers users a lot of flexibility. Users who are not able to pay their bills on time can contact SAGUAPAC’s commercial staff to negotiate a payment plan. Usually, the users are asked to make a first installment for 20% of the debt and to pay the resting amount over 24 months. Thanks to or despite the flexibility offered to users, SAGUAPAC eventually bills in 95% of the invoices emitted.

**Customer Management**

There are several interfaces between the customer and SAGUAPAC. The quickest link for the customer to SAGUAPAC is the hotline “Aló 178”, operating 24 hours, 7 days a week. The monthly district assemblies are another, though slower problem solving mechanism, organized by SAGUAPAC’s district representatives. In the event of payment problems, defaulting customers can come to the headquarter building to convene a new payment plan.

SAGUAPAC positions itself as a socially responsible institution, anticipating possible pressure from the public sector. For educational campaigns and CSR activities, SAGUAPAC spends around US $750,000 or 2% of its total expenditures a year. The products and activities presented are manifold. SAGUAPAC produces brochures on water savings, it publishes a glossy, annual social responsibility report, it conducts workshops on how to prepare delicious Bolivian food, it invites school classes to visit the waste water lagoons, or it is present at the biggest water conference in the world.  

33 The range and amount of activities has called for critics who question the sense of marketing activities for a monopoly provider. SAGUAPAC argues that its education campaigns have a positive impact on users’ willingness to pay and on water saving behavior. Similar to other cooperatives, SAGUAPAC offers scholarships to the shareholders’ most talented sons and daughters.

**Monitoring**

SAGUAPAC monitors its processes and products both, internally and externally. The external evaluation helps SAGUAPAC to demonstrate transparency and good performance. It is also a tool to balance political pressure:

**Internal:**

- Each year an operating program is drafted, setting a list of goals for the following year.
- For water quality monitoring, SAGUAPAC operates a private testing lab.
- The general manager reviews key financial indicators at least once a month.
- The technical operations are monitored from several control centers. Manpower has checked for a long time pressure in the pipes, as an indicator for leakages. A recently constructed control center has increased the degree

33 World Water Forum in Marseille, March 2012
of automation of network monitoring. Today, computers check and regulate the network pressure.

- The HR department works with target indicators as a basis to assess the performance of its employees.
- A recently conducted study has produced a hydrologic balance of Santa Cruz’ aquifers.

External:

- SAGUAPAC sends the lab results on water quality once a month to the regulatory body, AAPS. AAPS representatives additionally conduct unannounced visits to the cooperative, monitoring the service quality.
- The financial statement from 2011 was audited by Pricewaterhouse Coopers Bolivia.
- The internal processes and safety standards have been accredited by TÜV Rheinland (ISO 9001:2008).

Maintenance

SAGUAPAC spends around US $2.4 million in maintaining the water and sewage network. SAGUAPAC mainly drives a reactive maintenance approach. This means that the technicians circulating in the city react upon messages from the customer service, from the meter readers, from the technical centers or any other units or persons related to SAGUAPAC.

Sewage

62% of the users have access to the sewage system (58% domestic, 93% commercial, 74% industrial, 47% special). 71% of all accounted water flows into the sewage system. The sewage network counts 1,706 kms of pipes for 113,604 connections which represents 15 meters of pipes per connection. SAGUAPAC registered 8,799 new connections in 2011. The collecting pipes lead the sewage through gravity to one of the four elevating stations. The effluents receive a pre-treatment and are finally directed to one of the three treatment plants. 100% of the sewage is treated, before being ejected to the local river. The treatment systems consist of four lagoons with a total surface of 158 hectares. SAGUAPAC tests a technology to recycle foul gases as electricity. The system is planned to cover around 30% of SAGUAPAC's energy needs. Originally, the project was meant to be financed through sales of carbon emission bonds. However, President Morales’ opposition to carbon emission trade has blocked the process.

In order to access sewage, users have to buy shares for US $1’000. These shares are gradually discounted through the monthly water bill. Customers with a sewage connection pay an 80% surcharge on the water consumption. Users without access to the sewage system have usually a sewage pit under their houses. But, these sewage pits negatively affect the water quality of Santa Cruz’ aquifers.
HR

SAGUAPAC is extremely proud of its human resource management. 575 or 72% employees work directly for SAGUAPAC and 225 or 28% people have an external contract and conduct support services. From direct staff, 10% serve the general management, 10% the administration and finance area, 10% the project area, 30% the technical area, and 40% the commercial area. The admission process is competitive and current employees have worked on average 15 years for the organization. The previous general manager was in office for 18 years. The stability is remarkable in the context of developing countries where utility staff often depends on political rather than career merits. The constancy traces back to a variety of reasons. First, with an average of US $1’500/month (incl. all human capital expenditures), salaries are extremely rewarding. Second, employees can grow within the company. The company offers trainings and preferably fills vacancies with good-performing, internal candidates. Third, SAGUAPAC monitors the staff on the basis of performance indicators. The indicators help SAGUAPAC to identify over- and underperforming employees. High performing employees have a bright future in the company. Fourth, an architecturally attractive and transparent office building creates a pleasant and open working environment.

IT

The introduction of the electronic billing handhelds with printing function has been one of the key technological innovations over the past years. The handheld makes the processing of data more efficient and contributes to the detection of leakages and other irregularities. The printing function increases the transparency of the billing process. Other innovations include the inauguration of a new technical operations center, automatizing the control of pressure in the network and other functions.
## Financial Analysis

### Cost-/Revenue-Analysis

<table>
<thead>
<tr>
<th></th>
<th>Amount/Year</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Revenues</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>+ Revenues through water sales</td>
<td>US $ 25.1 million</td>
<td>US $0.49-$0.51 average price/m3</td>
</tr>
<tr>
<td>+ Revenues through sanitation</td>
<td>US $17.5 million</td>
<td></td>
</tr>
<tr>
<td>+ Other revenues</td>
<td>US $4.1 million</td>
<td></td>
</tr>
<tr>
<td><strong>Total revenues</strong></td>
<td>US $46.7 million</td>
<td></td>
</tr>
</tbody>
</table>

|                         |                      |                                   |
| **Operational costs**   |                      |                                   |
| Electricity             | US $3.2 million      | US $ 0.086/kWh                   |
|                         | (sanitation: $0.16 million) |                                   |
| Chemicals              | US $0.1 million      |                                   |
| Maintenance            | US $2.4 million      |                                   |
|                         | (sanitation $1 million) |                                   |
| Salaries               | US $14.4 million     |                                   |
|                         | (sanitation: $4.91 million) |                                   |
| Taxes                   | US $3.9 million      |                                   |
|                         | (sanitation $1.75 million) |                                   |
| Interests               | US $0.9 million      |                                   |
|                         | (sanitation US $0.46 million) |                                   |
| Other costs             | US $7 million        |                                   |
|                         | (sanitation: $ 2.1 million) |                                   |
| **Total operational costs** | US $31.9 million     |                                   |
|                         | (sanitation $10.4 million) |                                   |

|                         |                      |                                   |
| **Total capital costs** | US $8 million        |                                   |
|                         | (sanitation $4.1 million) |                                   |

*Based on 2011 results. Exchange rate used 1 USD = 7 BOB*
Unit-Cost-Analysis

<table>
<thead>
<tr>
<th>Item</th>
<th>US $-Cents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>6.3</td>
</tr>
<tr>
<td>Chemicals</td>
<td>0.2</td>
</tr>
<tr>
<td>Surcharge for water losses</td>
<td>1.6</td>
</tr>
<tr>
<td>Maintenance</td>
<td>2.9</td>
</tr>
<tr>
<td>Salaries</td>
<td>19.6</td>
</tr>
<tr>
<td>Other</td>
<td>10.1</td>
</tr>
<tr>
<td><strong>Total operational costs per m3 billed in</strong></td>
<td><strong>39.1</strong></td>
</tr>
<tr>
<td>Taxes</td>
<td>4.5</td>
</tr>
<tr>
<td><strong>Total operational costs per m3 billed in (incl. taxes)</strong></td>
<td><strong>43.6</strong></td>
</tr>
<tr>
<td>Capital</td>
<td>8.1</td>
</tr>
<tr>
<td>Interests</td>
<td>1.8</td>
</tr>
<tr>
<td><strong>Total cost per m3 billed in</strong></td>
<td><strong>53.5</strong></td>
</tr>
</tbody>
</table>

Performance Analysis

**Effectiveness**

**Service continuity:**
The water flux is generally reliable during 24 hours.

**Water quality**
Very good quality both at the source and at the household tap. All interview partners confirmed to drink water from the tap.

**Efficiency**

**Operational costs per m³ of water:**
Around US $0.39

**Capital costs per m³ of water:**
Around US $0.1

**Capital Costs / Total Costs:**
20.25%

**Infrastructure cost per connection:**
≥ US $550
### Affordability - Total cost for 15m³ / 5% monthly household income:

The cost-covering price for 15m³ of water is around US $7.35. Applying the 5% rule, SAGUAPAC’s water can be afforded by households with an annual income higher than US $1’750. In Bolivia, around 2.6 million urban residents or around 41% of the people living in cities fall below the BoP1750 threshold (Hammond, Kramer, Katz, Tran, & Walker, 2007).

### Employees/1’000 connections:

Around 2.75 employees

### Water losses (Water produced / Water successfully billed in)

25% of the water produced cannot be successfully billed in. 20% is physically lost and 5% of the bills are written off. These losses cause the cost per cubic meter to increase by around US $-Cents 1.6.

### Legitimacy

**Public interest:**

The public has no direct influence on the utility. However, the perceived pressure from politics on SAGUAPAC is currently high. There are opinions in Bolivia, arguing that water should be free and exclusively public. These critics make no distinction between cooperatives and private for-profit companies. In this sense, they describe SAGUAPAC as the playing field of Santa Cruz’ liberal elite. SAGUAPAC’s membership in the civic committee Pro Santa Cruz is brought forward as an evidence for this position.³⁴ SAGUAPAC defines itself in this difficult context as a socially responsible institution. It offers, for instance, flexible payment conditions to users or constantly expands its network towards marginalized neighborhoods of the city. In a nutshell, institutional pressure within SAGUAPAC seems to be rather low whereas political pressure in the Bolivian context appears to be very high.

**Users’ interest:**

Existing users/shareholders can influence the activities of the cooperative through elected representatives. Only around 2.5% of the cooperative shareholders participate at meetings.

### Accountability:

The general public is represented through the national regulator, AAPS. The agency is subordinated directly to the President’s office. It specifies and monitors with a local

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³⁴ Left-wing views make the civic committee responsible for separatist tendencies and the 2008 riots in the region.
representation in Santa Cruz SAGUAPAC’s compliance with the requirements of the license.

Equality of output:
All users are supposed to receive the same service.

Scalability / Replicability

Current scale:
Around 1.2 million people or 182,000 household connections - 23,500 commercial/industrial connections (SAGUAPAC, 2011)

% of households covered in area of operation:
100%

% of households covered in potential area of operation:
100% (70% by SAGUAPAC, 30% by other other cooperatives)

Growth rates since establishment:
Average: +5,500/year (3%/year – basis year 2011)
2011: +11,300 (6% - basis year 2011)

Favourable conditions and obstacles to scale:

- Any expansion requires external finance to afford the heavy upfront investments. Loans from multilateral finance organization have favourable conditions but are difficult to obtain. A critical bottle neck is the government which has to approve and guarantee every loan. Finance from the private market is in contrast more flexible, but also much more expensive.

- At the current pricing scheme, SAGUAPAC only covers the operational costs of domestic users with a connection to the sanitation network or of water users with an exceptionally high consumption level. Selling water to domestic customers only would drive SAGUAPAC into losses. The problem is that the sanitation network has still a considerably lower extension than the water network. Users from the outer circles of Santa Cruz are therefore connected more for political/social considerations and in expectation of linking them at a later stage to the profitable sewage network.

- Low-income households are sometimes reluctant to pay for water in general or US $1’300 to become a member of SAGUAPAC. Therefore, it can happen that low-income users prefer to form their own water cooperative or to connect to a smaller cooperative with lower tariffs.
Favourable conditions and obstacles to replication:

- The model is preferably replicable in BoP 1750 markets.
- The high quality and easy access to water resources reduces both, the capital and the operational costs.
- The political pressure seems to have a positive impact on SAGUAPAC’s performance. The cooperative needs to demonstrate efficiency and social responsibility in order to survive in the difficult Bolivian political context.
- Santa Cruz’ historic isolation from political power in La Paz has led to the conclusion among residents that no one and certainly not the central government will ever provide good basic services, if not the citizens themselves. This entrepreneurial spirit has probably contributed to SAGUAPAC’s establishment as a fully self-sufficient entity.
- A replication would require heavy upfront investments and therefore good access to finance

Environmental Sustainability

% of HH connected to the sewage:
62% of all connections in the area of license.

% of sewage treated:
100%

Sustainability of water resources:
An internal study by SAGUAPAC predicts that water demand will exceed the naturally rechargeable supply of the current aquifer by 2020. SAGUAPAC therefore assesses the possibility of tapping alternative water sources. It considers the exploitation of an aquifer 200 m below the actual tier tapped.
B.2 COOPLAN

### Governance Analysis

#### Problem

**Main goals:**

In 1986, the local population founded the cooperative COOPLAN to fill a water supply gap in the Plan 3000 district. Recently, COOPLAN has added to water a sewage network.

**Main challenges:**

- A typical household in Plan 3000 with 7 members has a daily budget of US $8.60. Being part of Santa Cruz' lower socio-demographic segments, the population is highly sensitive to any increase in tariffs.
- This lack of financial resources affects the ability of the cooperative to conduct major investments. For large-scale projects, COOPLAN depends on third-party contributions.

#### Geographical focus:

COOPLAN's operational license is restricted to an area in the south-east of the city, commonly denominated as Andres Ibañez or Plan 3000. Around 175'000 persons live in the area of license. COOPLAN roughly serves 145'000 from the 175’000. Other groups in the area have created private self-supply systems.

#### Actors

**External:**

- MMAyA (Ministry of Environment and Water): The Vice-Ministry for Water and Sanitation develops and implements a legal framework for the WASH sector. COOPLAN is keen to maintain good relations as the Ministry approves and channels important grants from third parties to the cooperative.
- AAPS, the national regulator, has specified COOPLAN’s license, including regulations that define an operating area, and set up the maximum tariffs, minimum service requirements. COOPLAN regularly submits lab results on water quality to the regulator. AAPS is financed through the operators, Operator render 1.5% of total revenues to AAPS. However, COOPLAN has reached an agreement with the government to be exempt from this fee.
- The municipal and the departmental governments play an important role in co-financing many of COOPLAN’s infrastructure projects (R. M. Roca, Interview, 17 July 2012).
The members’ assembly is the highest authority and meets regularly at least once a year. Extraordinary assemblies can be convened by one of the two boards or by 25% of the members’ base. The assembly discusses problems and upcoming investments; it approves the annual report (incl. financial statements) or establishes an investigation committee in case of disapproval. The assembly furthermore elects members into the administration and supervisory board for the term of three years. Candidates are typically local non-professionals without prior experience. Direct re-elections are only possible for the administration board. Usually, around 2’500 or 10% of all active members participate at the assembly.

The administration board consists of five members, including a president, a vice-president, a secretary, and a treasurer. The five board members meet at least four times a month to direct and supervise the day-to-day business. The board must approve tariff changes and any decision related to investments higher than US $21’500. It further leads discussions with external institutions and selects a general manager for the cooperative.

The supervisory board is composed of three members. It controls in at least four meetings per month the administration board’s and the management’s activities. In the case of disagreement, the supervisory board can order the establishment of an investigation committee.

The general manager meets on a regular basis with members of both boards. He also leads a team of three sub-managers. The sub-managers supervise the three areas, administration and finance, technics, and commercial. Each area consists of three sub-divisions. The general manager and the three sub-managers constitute the so-called “strategy committee”, meeting on a weekly basis.
Processes

Information:
Information is collected in the three areas, financial, commercial and technical. The strategy committee discusses in its weekly meetings and on the basis of detailed monthly reports the development of the cooperative. These data are shared with the administration and the supervisory board four times a month. COOPLAN’s shareholders are informed only once a year in the scope of the general assembly.

Decision-making:
- The management in form of the “strategy committee” takes key strategic decisions. Board members play an important role in strategic planning and operations. However, in contrast to SAGUAPAC, board members are usually non-professionals. On that account, there seems to be an information and capacity gap in favor of the management.
- The impact of the shareholders on operations is small. The involvement of the assembly is however key in strategic investments, affecting the costs and tariffs. Water provision in Bolivia is a controversial topic. COOPLAN’s board or management could not push through a tariff change without gaining acceptance among the members’ base.

Nodal points
- In the event of problems, customer can call the help line or directly approach COOPLAN’s staff at the headquarter building in Plan 3000.
- The general manager’s meetings with the administration and the supervisory board, four times a month, create an internal monitoring mechanism.
- The “strategy committee” takes major strategic and operational decisions in a weekly meeting each Friday afternoon.
- During the general assembly, conducted at least once a year (usually in March), the shareholders can overview the board members’ and the management’s activities.

Norms

Explicit:
- Cooperatives in Bolivia determine the organizational rules in the statutes. To become legally accepted, these statutes must be approved by the agency for cooperatives within the Ministry of Labor. Amendments require a majority of two thirds of the votes of the general assembly. Regular decisions by the assembly are taken with “half of the votes plus one” among the members present. The last amendment of COOPLAN’s statutes dates back to 2006. It defines in four titles:
1. The basic characteristics and objectives
2. The members’ rights and obligations
3. The management of the assets
4. The organizational structure

- Decisions within the boards are taken with simple majority.
- Corporate governance rules – as defined in the statutes – set basic boundaries for board members. Candidates are not allowed to be member of a political party. They shall not have any direct links to the family of former board members. COOPLAN’s employees cannot run for a board seat.

**Modes**

**Between legislator/regulator and utility:**
Bolivian law entitles municipalities to transfer water operations to cooperatives such as COOPLAN. COOPLAN is a middle-sized cooperative, providing water to around 10% of the urban population

**Vertical Forms of Organization:**

**Regulation:**
AAPS, the national water and sanitation regulator based in La Paz, specifies and monitors COOPLAN’s license.

**Operation:**
SAGUAPAC is a locally restricted water and sanitation operator, entitled to cover the Plan 3000 district in Santa Cruz.

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**Supply Chain Analysis**

**Finance**
The cooperative at its current size claims to be fully self-sustainable. However, in order to grow faster and to offer a sewage network, COOPLAN has depended over the last 7 years on donations from the Spanish Development Agency, the Interamerican Development Bank [IDB] and the local municipality of Santa Cruz. Between 2005 and 2013, around US $25.5 will have been invested. US $18 million cover the construction of a sewage network for around 10’000 connections. US $1.5 million was the prize for the installation of 15’000 brand-new micro-meters back in 2005 and US $6 million are currently invested into the renewal and improvement of the water network. The Spanish Development Agency and the IDB have contributed most with around US $21.5 million. This money is part of a US $100 million donation by the Spanish government (US $80 million) and the IDB (US $20 million) to the Bolivian people. The local government of Santa Cruz has contributed with US $4
million as a local counterpart. Discounted over the entire term, COOPLAN benefits each year from donations worth US $3.18 million for water and sanitation, or US $0.94 million only for water. This is much more than the cooperative could afford with members’ contributions to equity. With a growth rate of 1’000 new members per year, the cooperative could only generate US $171’000 as a contribution to equity.

**Institutional Context**

COOPLAN was originally granted a concession for 15 years. In 2005, the new regulatory body AAPS transformed the concession into a temporally unlimited license. The AAPS has to approve any expansions of the area of license.

In order to connect, a new member needs to present a title of property and an according location plan. A legal confirmation of residency from the municipality is not required. If a potential user cannot present any title of property, COOPLAN asks the local neighbors’ association to confirm the residency. This flexibility traces back to the right to water, guaranteed by the Bolivian constitution.

**Procurement**

COOPLAN produces with 11 boreholes (between 250 and 300 meters deep) 6’068’577m$^3$ of water every year. Each borehole extracts around 1’511m$^3$ every day. The quality of the water extracted is excellent. For the production and distribution process, COOPLAN uses energy from the cooperative CRE, Santa Cruz’ main provider. The total energy consumption amounts to 2’582’296kWh per year. As a member of the federation of Santa Cruz’ water cooperatives, COOPLAN benefits from a special rate. The total costs per year is US $191’000, meaning that COOPLAN pays around US $-Cents 7.4 for every kWh. Each cubic meter of water produced has an electricity cost of around US $-Cents 3.2.

**Production**

Two half-buried, storage tanks with a capacity of 1’500 m$^3$ each collect the water produced. At a total daily production of 16’626m$^3$, the tanks refill every 4 hours and 20 minutes. From the storage tanks, the water is pumped into the network.

**Treatment**

According to COOPLAN, the quality of the water extracted is very high and would not require any treatment. Yet, in order to comply with Bolivian law and to protect the water from contamination between the source and the household tap, COOPLAN adds between 0.2 and 1 gram calcium hypochlorite per cubic meter prior to distribution. The calcium hypochlorite added has a cost of US $65’000 a year or US $-Cent 1.1 per cubic meter produced. Microbiological tests show a sufficient quality of water for 100% of the samples taken. However, test results also indicate that in 36% of the water samples, the residual chlorine was insufficient. An insufficient level of residual chlorine is a potential health risk when water becomes exposed to contaminants.
Pricing

In order to become a member of the cooperative, new members contribute with US $171 to equity. From the US $171, users have to pay at least US $14 upfront. For the resting amount, credit plans can be arranged up to the duration of 36 months. COOPLAN uses the equity to finance part of the network expansions. In addition to the contributions to equity, new users have to pay around US $121, covering the infrastructure cost of their own connection to the network.

COOPLAN manages two customer segments, domestic and commercial users. 92.63% (20749) of the customers are domestic and 7.08% (1586) are commercial. COOPLAN uses an increasing block tariff system, meaning that the per cubic meter price increases with consumption. Commercial users pay around 10% more than domestic users. An average consumer uses about 19m$^3$ per month, paying about US $5.97 as a domestic user or US $6.45 as a commercial user. COOPLAN subsidizes domestic consumption up to 20m$^3$ and commercial consumption up to 10m$^3$. In order to cover the total cost through water consumption, the current average price of US $0.32/m$^3$ would require to increase by US $0.07m^3$. The national regulator AAPS must approve any tariff increase. The last change dates back to 2010. For 2013, at the introduction of the sewage network, COOPLAN plans to raise the tariffs for water by 15%. In addition to the price for water, each user pays a flat fee of US $0.21, directed to COOPLAN’s medical center.

<table>
<thead>
<tr>
<th>Volume</th>
<th>Domestic</th>
<th>Commercial</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-12 m$^3$</td>
<td>US $0.3$</td>
<td>US $0.33$</td>
</tr>
<tr>
<td>(minimum consumption)</td>
<td>(minimum consumption)</td>
<td></td>
</tr>
<tr>
<td>-20 m$^3$</td>
<td>US $0.33$</td>
<td>US $0.35$</td>
</tr>
<tr>
<td>-30 m$^3$</td>
<td>US $0.35$</td>
<td>US $0.37$</td>
</tr>
<tr>
<td>-40 m$^3$</td>
<td>US $0.37$</td>
<td>US $0.40$</td>
</tr>
<tr>
<td>&gt; 40 m$^3$</td>
<td>US $0.40$</td>
<td>US $0.43$</td>
</tr>
</tbody>
</table>

Source: J. Ibarra, Interview, 4 July 2012

Delivery

The water is pumped from two water tanks/pumping stations into the network. The annual energy consumption for this activity amounts to almost 2.6 million kWh, or 0.43 kWh per cubic meter of water pressed into the network. Each pump disposes of automatic frequency control gears, adjusting the energy used to the actual water demand. Santa Cruz is geographically located on a plain which makes the use of gravity systems impossible. COOPLAN does not have any water storage towers.

The 22400 active users are connected with 350 kms of pipes, made of PVC. An additional connection requires an average extension of 15.5 meters of pipes. In 2011, COOPLAN added 25 kms to the system. The network consists of pipes with diameters ranging between 2 and 10 inches. The pressure within the network ranges
between 1.7 and 2 bar. Around 15% of the water produced is physically lost due to leakages or illegal connections. This figure has shrunken from 49% in 2006.

Billing

COOPLAN divides the service area into five billing zones. It serves the five zones on a monthly basis, but in different cycles. The billing staff is equipped with electronic handhelds. The staff can save the users’ consumption levels on the devices and synchronize this data at headquarters with the central IT system. The system controls the consumption levels against irregularities. Finally, the billing staff distributes the printed invoices with the next billing loop. In order to avoid internal fraud, the billing personnel covers each month a different area.

Before 2005, most households did not have any micro meters. Facing heavy opposition, COOPLAN started to promote the advantages of micro-measurement among the members’ base. It contracted community leaders and conducted a large number of members' assemblies. With a donation of 15’000 micro-meters by the Spanish Development Corporation, the project was finally realized. COOPLAN granted users a transition period of three months to adapt and to assess potential problems. During this duration, users could control their monthly consumption but continued to pay the flat tariff. In 2011, almost 100% of the consumption was measured.

Users can pay the invoices at 18 billing points of seven financial cooperatives in Plan 3000. These cooperatives charge a commission fee of 1% on the bill. COOPLAN does not collect any money itself. It can cut connections after two months of non-payment. To re-connect, users must pay a fine of around US $2.80. In 2011, around 12% of the invoices issued were not successfully billed in.

Customer Management

On a day to day basis, customers have two channels to report problems or other issues. They can either come to COOPLAN’s main building during office hours (MO-FR 8AM-6PM; SA 8AM-12) or call a hotline that works 24 hours 7 days a week. Depending on the seriousness of the problem, COOPLAN has set a general target to solve problems within four working days. Members can bring in strategic issues at the annual assembly. In urgent matters, 25% of the members can call for the convention of an extraordinary assembly.

Due to the lack of basic services in peri-urban Santa Cruz, COOPLAN’s shareholders asked the cooperative to establish a medical center. The center employs five practitioners, including a gynecologist, a pediatrician, and a dentist. For this service, each user pays a monthly flat fee of US $0.215, resulting in a total annual budget of US $57'600. The cooperative also offers funeral support for deceased persons who had been members of the cooperative for more than five years. COOPLAN supports about five funerals each month.
**Monitoring**

**Internal:**
- For water quality monitoring, COOPLAN operates a private testing lab. Bacteriiological tests are drawn with samples from water taps while physical and chemical tests are conducted with samples from the water source. 324 samples were taken in 2011. The microbiological results were satisfactory for all samples, but 36% indicated an insufficient level of residual chlorine in the water. The lab sells as well water quality tests to 11 smaller cooperatives.
- COOPLAN’s processes and results are analyzed every month internally on the basis of a defined set of technical, commercial, and financial indicators. This data is presented once a year in an annual memorandum to the members of the cooperative.
- Macrometers at all boreholes control the level of production. A comparison with the monthly level of consumption indicates potential losses and other irregularities in the network.

**External:**
- COOPLAN sends monthly water quality results to the regulatory body, AAPS. The national regulator conducts in addition irregular test visits to the operators.
- The financial statement from 2011 was audited by a local audit company (D&A Auditores y Consultores).
- COOPLAN aspires to optimize its processes for an ISO certification by 2014.

**Maintenance**

COOPLAN’s technical department solves technical problems upon user request within four days. At the moment, COOPLAN renews with funds from the Spanish Development Agency, IDB and the municipality its primary network. These construction works have been outsourced to a third party.

**Sewage**

At the moment, COOPLAN does not have any sewage network, meaning that the wastewater is directed usually to a sewage pit under the people’s house. However in 2011, constructions have begun for a sewage system. The first phase, to be concluded in 2013 comprises the establishment of a waste water plant with 10’000 connections. The network will connect in a first phase around 40% of the members of the cooperative. From the total cost of US $24 million, US $20 million have been financed by the Spanish development cooperation and the Interamerican Development Bank. The municipality of Santa Cruz has contributed with US $4 million as a local counterpart. The external funds were channeled through the Ministry of Water and Environment in La Paz.
HR
COOPLAN employs around 100 people. 33% work for the commercial area, 25% for administration and finance, 35% in technics and 7% in the medical center. Expansion works and billing points have been outsourced to third-parties. The board members select a general manager. This manager can then form his/her own managing team. The current general manager, Julián Ibarra, has been working for more than 15 years in the sector and appears to be highly qualified. For the small cooperatives, it is a big challenge to find skilled workforce as the smartest people in town prefer employers with a “bigger name”. Moreover, the management has to defend itself against influences from political parties who have repeatedly tried to position party members within the staff of the cooperative. An average employee works at COOPLAN for 8.5 years. The average salary amounts to US $400 per month, ranging from US $225 for a meter reader to US $1’050 for the general manager. Board members receive attendance fees of around US $780 per month.

IT
The billing staff has electronic handhelds to digitally process users’ consumption data. The devices easily connect to a computer, releasing data to the central billing system. The information is then saved on one of COOPLAN’s four servers.
## Financial Analysis

### Cost-/Revenue-Analysis

<table>
<thead>
<tr>
<th></th>
<th>Amount</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Revenues</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Revenues through water sales</td>
<td>US $1'450'000</td>
<td>US $0.32 average price/m³</td>
</tr>
<tr>
<td>Other water-related operational revenues</td>
<td>US $322'000</td>
<td></td>
</tr>
<tr>
<td><strong>Total revenues</strong></td>
<td>US $1'772'000</td>
<td></td>
</tr>
<tr>
<td><strong>Operational costs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electricity</td>
<td>US $191'000</td>
<td>US $0.074/kWh</td>
</tr>
<tr>
<td>Chemicals</td>
<td>US $65'000</td>
<td></td>
</tr>
<tr>
<td>Maintenance</td>
<td>US $47'000</td>
<td></td>
</tr>
<tr>
<td>Salaries</td>
<td>US $550'000</td>
<td>US $475'000 salaries + US $75'000 board fees</td>
</tr>
<tr>
<td>Taxes</td>
<td>US $150'000</td>
<td>US $60'000 transaction tax + US $90'000 VAT</td>
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<tr>
<td>Other costs</td>
<td>US $456'000</td>
<td>estimated</td>
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<tr>
<td><strong>Total operational costs</strong></td>
<td>US $1'459'000</td>
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<tr>
<td><strong>Depreciation</strong></td>
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<tr>
<td><strong>Interests</strong></td>
<td>US $94'000</td>
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<tr>
<td><strong>Total capital costs</strong></td>
<td>US $314'000</td>
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*Based on 2011 results. Exchange rate used 1 USD = 7 BOB*
**Unit-Cost-Analysis**

<table>
<thead>
<tr>
<th>Item</th>
<th>US $-Cents</th>
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<tbody>
<tr>
<td>Electricity</td>
<td>4.2</td>
</tr>
<tr>
<td>Chemicals</td>
<td>1.4</td>
</tr>
<tr>
<td>Surcharge for water losses</td>
<td>1.4</td>
</tr>
<tr>
<td>Maintenance</td>
<td>1.0</td>
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<tr>
<td>Salaries</td>
<td>12.1</td>
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<tr>
<td>Other</td>
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<tr>
<td><strong>Total operational costs per m³ billed in</strong></td>
<td><strong>28.7</strong></td>
</tr>
<tr>
<td>Taxes</td>
<td>3.3</td>
</tr>
<tr>
<td><strong>Total operational costs per m³ billed in (incl. taxes)</strong></td>
<td><strong>32.0</strong></td>
</tr>
<tr>
<td>Capital</td>
<td>4.8</td>
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<tr>
<td>Interests</td>
<td>2.1</td>
</tr>
<tr>
<td><strong>Total cost per m³ billed in</strong></td>
<td><strong>38.9</strong></td>
</tr>
</tbody>
</table>

**Performance Analysis**

*Effectiveness*

**Service continuity:**
24 hours/day

**Water quality:**
- **Effective:** Water quality seems to be very reliable. 100% of the 324 samples indicate a satisfactory, microbiological quality.
- **Potential:** However, 36% of the samples had an insufficient level of residual chlorine which is a potential threat should water become exposed throughout distribution to some contaminant.

*Efficiency*

**Operational costs per m³ of water:**
US $0.29

**Capital costs per m³ of water:**
US $0.07

**Capital Costs/Total Costs:**
≥19.5%
Infrastructure cost per connection:
n/a

Affordability - Total cost for 15m³ / 5% monthly household income:
The cost-covering price for 15m³ of water is around US $5.35. Applying the 5% rule, COOPLAN’s water can be afforded by households with an annual income higher than US $1’300. In Bolivia, around 1.75 million urban residents or around 28% of the people living in cities fall below the BoP1300 threshold (Hammond, Kramer, Katz, Tran, & Walker, 2007).

Employees/1’000 connections:
Around 4.5 employees

Water losses:
25% of the water produced cannot be successfully billed in. 15% is physically lost in the network and 10% represent bills that are written off. These losses cause the cost per cubic meter to increase by around US $-Cents 1.4.

Legitimacy

Public interest:
The public system has no direct control over the cooperatives. The lack of direct public control can sometimes lead to unpleasant developments. COOPLAN was in fact managed for a long time rather poorly. As the members of the cooperative did not want to pay cost-adequate prices, COOPLAN was running the risk of long-term deficits. As a result, it did not have the money to expand the network to people without access. Investments into a sewage network were unthinkable with the consequence that the aquifers under Santa Cruz would step by step contaminate, and pose a risk on the water supply of future generations. COOPLAN’s experience shows that the strong internal legitimacy of cooperatives can sometimes go at the expense of a weak legitimacy towards non-members.

Users’ interest:
Existing users/shareholders can control the activities of the cooperative within the general assembly, organized once a year. 25% of the members can convene an extraordinary assembly. They approve the annual report, including the financial report, and elect the board members. The impact on day-to-day business is rather small. But, important strategic decisions require the backing from the population. Around 10% of the shareholders participate at the general assembly. In the late 1990s, the German Development Cooperation proposed smaller operators to merge with SAGUAPAC. Members of these cooperatives were heavily opposed because they did not want to lose control over what they consider to be theirs.
Accountability:
The general public is represented indirectly through the national regulator, AAPS. The agency is subordinated directly to the President’s office. It specifies and monitors with a local representation in Santa Cruz COOPLAN’s compliance with the requirements of the license.

Equality of output:
Within COOPLAN’s service area, all users are supposed to receive the same service. However, the model of multiple, independent operators in one city might lead to varying service standards from one operator to another.

Scalability / Replicability

Current scale:
22’500 connections for around 145’000 people (COOPLAN, 2011)

% of households covered in area of operation:
83%

% of households covered in potential area of operation:
100% (70% by SAGUAPAC, 8% by COOPLAN, 22% by other other cooperatives)

Growth rates since establishment:
Average: 875 (+4.1% – basis year 2011)
2011: 1’330 (+5.9% – basis year 2011)

Favourable conditions and obstacles to scale:
- Any expansion requires external finance to afford the heavy upfront investments. The cooperative has successfully managed to attract grants worth US26.5 million over the last 7-8 years. However, the Spanish state as the main source has fallen into an economic crisis. Further investments will therefore require the search for new funding.
- At the current pricing scheme, COOPLAN only covers the operational costs of domestic users that have a consumption level exceeding 20m³/month. COOPLAN needs to adapt its pricing scheme, reduce the costs, or find more high-revenue users in order to compensate for potential losses from low-income members. Otherwise, there is little interest for COOPLAN, but social responsibility to involve new, low-income user groups.
Favourable conditions and obstacles to replication:

- The model is preferably replicable in BoP 1300 markets.
- The high quality and easy disposability of water resources has reduced both capital and operational costs.
- COOPLAN’s success partly traces back to the professionalism and qualifications of the management and the work force. COOPLAN only made a turnaround with the creation of rigid institutions and the engagement of professionals who pushed for the installation of micro meters over the entire network. The resulting savings from reduced water losses were reinvested into the cooperative and step by step, COOPLAN became a story of success. Cooperatives without professional workforce and institutions have typically a weaker performance.
- In Bolivia, the legal restrictions to establish a water cooperative and attract new users are low. The low legal hurdles have contributed to the rapid growth and replication of water cooperatives in Santa Cruz.
- Many small cooperatives have obtained at its beginnings a financial grant from the public sector in order to stem the heavy upfront costs. Whether grants or loans, good access to finance seems to be a key enabling factor for replication.

Environmental Sustainability

- % of HH connected to the sewage:
  0% of all connections in the area of operation. This number is expected to increase to 40% by 2013.

- % of sewage treated:
  0% because there is no sewage network yet. Once in operation, 100% of the waste water will be treated.

Sustainability of water resources:

SAGUAPAC’s boreholes reach deeper than COOPLAN’s boreholes do. COOPLAN therefore runs a higher risk that the current sources tapped contaminate at some point in the future. More than half of the city’s waste water is still not treated and infiltrates into the ground. A study on the development of Santa Cruz’ water resources shows that the current tiers of the aquifer may become overexploited by 2020. In contrast to SAGUAPAC, COOPLAN has not developed a plan B on how to ensure water availability for future generations.
Parauapebas

C.1 SAEEP

<table>
<thead>
<tr>
<th>Governance Analysis</th>
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</thead>
<tbody>
<tr>
<td><strong>Problem</strong></td>
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<tr>
<td><strong>Main goals:</strong></td>
</tr>
</tbody>
</table>
The main goal of the operator is to provide water and sewerage services to the population of Parauapebas.
| **Main challenges:**|
In the 1990s, as one of the quickest growing cities in Brazil, Parauapebas had to build a cost-effective water and sanitation infrastructure in order to keep pace with the quick economic and socio-demographic development. However, today’s inefficient cost structure outweighs the gains from the innovative condominial network design. There is each year more people without formal access to the water network and the sewage coverage is restricted to only 7% of the population.

| **Geographical Focus:** |
The “Municipal Water and Sewerage Service” has the mandate to cover all areas of the city of Parauapebas with water and sanitation. 90% of the residents live in an area, denominated as urban.

<table>
<thead>
<tr>
<th><strong>Actors</strong></th>
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</table>
- The Municipal Water Sewerage Service is the key actor, regulating and operating Parauapebas’ water and sewerage system. It is part of the hierarchical structure within the local administration. It is structured into four departments, administration, accounting & finance, operations & maintenance, and planning & infrastructure. An executive and a vice-executive director manage the utility. The directors are directly appointed by the prefect of the municipality.
- An administration council supervises the operations of the utility. It consists of seven members, two representatives of the civil society, two representatives of the legislative branch, two representatives of the prefecture, plus the director of SAEEP. An external regulator does not exist. In Brazil, water operation and regulation falls into the responsibility of municipalities. Parauapebas has not created a fully independent institution for the supervision of the water and sanitation sector.
Processes

Decision-making:
- Even though denominated as “Serviço Autônomo”, important decisions such as the appointment of the management, the specification of a tariff system, or the blocking of connections continue to be taken top-down by politicians.
- The administrative council specifies if necessary municipal laws and decrees.

Nodal Points
- The main building of the municipality is the place where major strategic decisions on the water and sewage service are taken.
- At the headquarter building, the Municipal Water and Sewerage Service takes operational decisions on a daily basis. The locality moreover serves as the main point of contact between the utility and the customers.

Norms

Explicit:
The Municipal Water Service is constituted upon the municipal legislation about public services (“Estatuto do Servidor Publico Municipal” 4.231/02), in particular about water and sanitation (“Cria o Serviço Autônomo de Água e Esgoto do Município de Parauapebas”), including Decree Nº 619/09 on the readjustment of tariffs.

Inexplicit:
The decision authority of staff is restricted to technical matters of little importance. Important decisions on expenditures, tariffs, or the blocking of connections are purely political.
**Modes**
The operating Municipal Water and Sewerage Service is hierarchically integrated into the local government. There is no separation between the functions of legislation, regulation, and operation.

**Vertical Forms of Organization**

**Regulation:**
The water service is regulated at the local level by the municipality.

**Operation:**
The water service is provided by the Municipal Water and Sewerage Service for the entire city of Parauapebas.

---

**Supply Chain Analysis**

**Finance**
The initial water and sanitation network from 1997 was financed through a US $14.5 million World Bank loan guaranteed by VALE (former Companhia do Vale do Rio Doce). The municipality amortized this loan, investing 25% of the royalties each year - received from VALE for the exploitation of the Carajás mine on the land of the municipality.

However, the current tariff system does only cover half of the operational costs of the water and sewage system. The municipality subsidizes the public service through its global budget with around US $4 million every year – this number does not even include the depreciation of the capital assets or investments in further extensions of the network.

Over the next years, the municipality will focus on expanding and improving the sewage network with a US $22.5 million grant from the federal infrastructure program “Programa de Aceleração de Crescimento”, plus around US $1 million from the municipal treasure.

**Institutional Framework**

Until 2005, the municipality contracted operations of the water and sewage system out to the private company “Condominium Empreendimentos Ambientais” – the same company which had previously built the system. The service was regulated by the Municipal Water and Sewerage Service. In 2005, after the election of a new administration, the service was transferred to the Municipality who had little expertise in water and sanitation. As a result, little priority has been given by the new operator to the importance of metering and the prices have not been adjusted to the costs of the service. Since 2005, the performance of the water utility service has deteriorated.
**Procurement**

SAEEP extracts the water from two sources, the local Parauapebas river and local groundwater. The original, main production plant at the riverbed catches around 30'000m$^3$ per day. 31 boreholes additionally deliver roughly 10’000m$^3$ of water every day. In October 2012, SAEEP inaugurated a new surface water plant, raising the production potential by approximately 20'000m$^3$/day.

**Production**

From the river intake, the water is directed in pipes of 20 inches 1’500 meters up to a reservoir with a capacity of 6’000 m$^3$. The water leaves the production facilities with gravity-fed pressure to an elevating station. From the elevating station, two pumps press with 4.5 bar each the water up into a distribution tower.

**Treatment**

The influx of water from the local river is contaminated. In the production plant, the river water therefore runs through a variety of treatment processes, including coagulation, flocculation, filtration, and chlorination. The coagulation process implies the use of around 1’100 kilos of aluminium-sulphate per year. The treated water is potable prior to distribution.

**Pricing**

Upon connection, users pay a fee of between US $24 and $28.50 for a simple connection, plus US $57.85 if they wish to install a micro meter. Among the total client base, 95.5% of the connections correspond to residential users, 4.4% to commercial users and a very small share to industrial users. Residential and commercial users face a minimum consumption level of 10m$^3$ respectively 15m$^3$. For residential users with a minimum consumption of 10m$^3$, each cubic meter is slightly more expensive (US $0.78) than it is for customers with a monthly usage of 15m$^3$ (US $0.76). After 15m$^3$, tariffs increase alongside consumption volume up to US $1.09/m$^3$. A social tariffs applies to residential customers who fall under the federal “bolsa familia” program (28% of Parauapebas’ population). Eligible users pay US $0.1 less per cubic meter at a 15m$^3$ monthly consumption. The consumption of commercial users is on the first 15m$^3$ cheaper (US $0.62/m^3) than the one of residential users. After 15m$^3$, the tariffs for commercial connections however increase proportionally more than they do for residential usage. Residential users without micro meters pay a flat rate of US $15.5 per month, social users US $12.5, and commercial users US $18.6. At 40% water losses, the average revenue per cubic meter received by the utility amounts to US $0.47. The flat rates for users without micro meter are far away from covering the real cost of usage. Some users with a flat connection are engaged in re-selling the water to neighbors. Based on the production and revenue structure, 40% water losses, as officially reported by SAEEP, are probably an underestimation. I estimate water losses of roughly 60%.
Table 22 – Tariffs SAEEP

<table>
<thead>
<tr>
<th>Volume</th>
<th>Residential</th>
<th>Social</th>
<th>Commercial</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-10 m³</td>
<td>US $0.78 (min 10 m³)</td>
<td>US $0.63 (min 10 m³)</td>
<td>US $0.62 (min 15 m³)</td>
</tr>
<tr>
<td>&gt;-15 m³</td>
<td>US $0.76</td>
<td>US $0.66</td>
<td></td>
</tr>
<tr>
<td>&gt;-30 m³</td>
<td>US $0.79</td>
<td>US $0.74</td>
<td>US $0.82</td>
</tr>
<tr>
<td>&gt;-45 m³</td>
<td>US $0.87</td>
<td>US $0.83</td>
<td>US $0.98</td>
</tr>
<tr>
<td>&gt; 45 m³</td>
<td>US $0.87-$1.09</td>
<td>US $0.84-$1.09</td>
<td>US $0.99-$1.09</td>
</tr>
</tbody>
</table>

Source: F. de Almeida Sierua, Interview, 3 October 2012

Delivery

The water is directed from the water tower in two water reservoirs with a capacity of 10’000 cubic meters. The water from the boreholes is collected in five reservoirs with a total capacity of 420 cubic meters. From the reservoirs the water is delivered through a condominial network to the households.

In the 1990s, the World Bank, Vale and the Municipality of Parauapebas chose a condominial design to reduce the capital costs compared to a conventional design system by US $123 per connection (Melo, 2005). 44% of the savings traced back to less and cheaper infrastructure and 56% to a reduction in the excavation costs. However, the presented calculations did neither include the costs of social intermediation nor the opportunity costs for the families’ time spent in project planning and constructions. In a replication of the condominial water network in El Alto (Bolivia), these costs were estimated at US $28 per connection (L. Corridor, Interview, 25 September 2012). The application of this number to the case of Parauapebas indicates that at establishment of the network in the 1990s, the total cost per connection amounted to approximately US $72, with savings of 57% or US $95 per connection compared with a conventional system (without micro meter). Today, users pay around US $81-$85 for a connection with micro meter. Today’s price obviously covers only part of the real connection cost.

A condominial branch in Parauapebas typically consists of around 15 connections. Thanks to the condominial design, the length of the main network in Parauapebas was reduced by 85% from 287 kilometers to 44 kilometers. The pipes of the main network typically range between 10 and 24 inches. The pipes within the condominium have a diameter of typically between 1.3 and 2.4 inches and are located along the sidewalk at around 0.40 meters below the surface.

Over time, the operators have expanded the network, but without upgrading the according infrastructure (pumps, tanks, etc.). The system is today overloaded and SAEEP regularly interrupts the service during 12 hours a day. Around 40% of the water produced is officially lost. However, the production volume and the revenue structure suggest around 60% water losses. In this context, SAEEP estimates that approximately 15’000 clandestine connections free-ride on the water system.
Billing
SAEEP conducts monthly billing cycles, with billing staff manually registering the users’ consumption levels. Around 46% of the connections have an installed micro meter. Unfortunately, this number has been decreasing from 77% in the year 2000 due to a lack of political will and resistance towards micro meters among users. Users can pay their bills directly at SAEEP’s office building or in a local bank at a commission of US $1.25.
SAEEP can block defaulting users’ connections. On average, SAEEP cuts around 18.5% of the connections each month. However, the blocking policy is not very strict, particularly prior to elections. Therefore, the payment moral fluctuates alongside election periods. Before the regional elections in October 2012, the revenues of the utility fed by user payments dropped to under 30% of the invoices.

Customer Management
In order to convince the population of the condominial approach, the former private operator initiated in the 1990s a sound social marketing campaign and successfully launched a pilot project (J. C. Melo, Interview, 2 October 2012). It explained to the population that condominial systems were not inferior in terms of quality or service, but cheaper. The members of each condominium started to organize themselves, selecting a leader as representative toward the provider. Company staff then coordinated with the population the technical specifications of the network for each condominium. The housing block representatives organized the collection of contributions for the purchase of construction materials. In coordination with utility experts, the residents finally helped in completing the construction of the network within each housing block.
Over the years and with the transfer of operations to the municipality, the operator has reduced the strong social element to a minimum. Today, the company staff or contractors build the system, without community participation. This development corresponds to a general trend that sees little interest from the population to actively participate in the construction and operation of the systems. In Brasilia, where the main operator CAESB runs a condominial sewage network, community participation is restricted to project planning. Most households prefer that the condominial branches are placed outside their property. Today, in Parauapebas, the interaction between SAEEP and users proceeds as in other conventional systems bilaterally without involvement of a condominium representative. Upon technical or other problems, customers directly contact the municipal water service via telephone line.

Monitoring
SAEEP solves technical problems upon users’ request. The project plan initially included the installation of macro meters at the entrances to each condominium. Unfortunately, over time, the macro meters were sacrificed for the sake of a lower budget. This lack of macro meters has partly been made responsible for a large portion of the water losses.
The plant managers test the water at the production facilities every hour on physical, chemical, and bacteriological quality. An external company additionally conducts monthly quality controls at the production facilities. SAEEP prints the test results every month on the users' bills. However, the factory quality of the water has limited value as recontamination frequently occurs during transport between the plant and the users' tap. Due to the frequent network intermittences, the quality of the water at the tap is considered as not potable.

Overall, the monitoring process suffers from a lack of neutrality as both tasks, operation and regulation are carried out by the municipality. Brazil does not have a national regulation body and the responsibility for the regulation of the water and sanitation sector rests upon the municipalities. As a losses-driving operator, the water service of Parauapebas directly depends on the annual global budget of the municipality.

**Maintenance**

In Brasilia and Parauapebas, the responsibility for any problem, occurring within the users land plot falls into the hand of the property owner. The operator only assumes responsibility for incidents emerging outside the users' plots. Brasilia’s operator grants households who decide to place the sewage condominial branch within the boundaries of their property a discount for assuming a higher degree of responsibility (K. Neder, Interview, 8 October 2012). In Parauapebas, the condominial branches have been placed outside the yards in order to ensure meter-reading of the water consumption.

For multiple reasons, amongst them the modular network structure and the easy accessibility of the pipes (implying less excavations), CAESB, the operator of the sewerage network in Brazil’s capital, found that the maintenance of its condominial sewerage connections was three times more cost-efficient than the maintenance was of its conventional connections. However, other studies have pointed out that condominial sewerage systems require more maintenance, but at a lower cost per intervention. Facing the ambiguity of results, it is difficult to come to a final conclusion.

**Sewerage**

Only 7% of the households have at the moment access to the sewage network of Parauapebas. From these households, the effluents run into a condominial sewage system and eventually into five decentralized waste stabilization ponds. Under the federal infrastructure program “Programa de Aceleração de Crescimento”, around US $23.5 million will be invested into the sewage sector Parauapebas over the next years.
**HR**

SAEEP employs more than 300 people for 36,000 connections (32,000 for water and 4,000 for sanitation). With more than 8 employees per 1,000 connections, the organization is inefficiently staffed. Employees receive an average remuneration of US $100 per month. In the light of the low salaries, it can be expected that only low-skilled workforce without other job opportunities is motivated to work for the Municipal Water and Sewage Service.

The switch from a conventional to a condominial sewage network can come with resistance from employees (A. Dionísio, Interview, 8 October 2012). A conventional model implies that the employees emphasize first the technology and with second priority, the users; in a condominial model in contrast, the technology always adapts to the interests and demands of the users. Therefore, the condominial approach exposes employees to the praise and criticism of the population. Such exposure demands from employees social skills in addition to the technological know-how.

**IT**

In Parauapebas, an exclusively developed software program, fed with a defined set of parameters, such as the condominium size, the client structure, or the income of residents, determines the required diameters of pipes and other technical specifications for each condominium separately.
Financial Analysis

Cost-/Revenue-Analysis

<table>
<thead>
<tr>
<th>Revenues</th>
<th>US $ / Month</th>
</tr>
</thead>
<tbody>
<tr>
<td>+ Revenues through water sales</td>
<td>US $341'000</td>
</tr>
<tr>
<td>+ Revenues through sewage</td>
<td>US $22'500</td>
</tr>
<tr>
<td><strong>Total revenues</strong></td>
<td><strong>US $363'500</strong></td>
</tr>
</tbody>
</table>

**Operational costs**

<table>
<thead>
<tr>
<th>Cost Category</th>
<th>US $ / Month</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>US $104'000</td>
</tr>
<tr>
<td>Chemicals</td>
<td>US $183'000</td>
</tr>
<tr>
<td>Maintenance</td>
<td>(estimated costs for sewage incl.: $18'000)</td>
</tr>
<tr>
<td>Salaries</td>
<td>US $366'000</td>
</tr>
<tr>
<td>(estimated costs for sewage incl.: $36'000)</td>
<td></td>
</tr>
<tr>
<td>Taxes</td>
<td>n/a</td>
</tr>
<tr>
<td>Other costs</td>
<td>US $52'000</td>
</tr>
<tr>
<td>(estimated costs for sewage incl.: $5'000)</td>
<td></td>
</tr>
<tr>
<td><strong>Total operational costs</strong></td>
<td><strong>US $705'000</strong></td>
</tr>
<tr>
<td></td>
<td>(estimated costs for sewage incl.: $59'000)</td>
</tr>
</tbody>
</table>

**Total capital costs**

n/a

*Based on 2011 results. Exchange rate used 1 USD = 2 BRL*
Unit-Cost-Analysis

<table>
<thead>
<tr>
<th>Item</th>
<th>US $-Cents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>16</td>
</tr>
<tr>
<td>Chemicals</td>
<td>5</td>
</tr>
<tr>
<td>Surcharge for water losses</td>
<td>12.5</td>
</tr>
<tr>
<td>Maintenance</td>
<td>34</td>
</tr>
<tr>
<td>Salaries</td>
<td>68</td>
</tr>
<tr>
<td>Other</td>
<td>10</td>
</tr>
<tr>
<td><strong>Total operational costs per m3 billed</strong></td>
<td><strong>133</strong></td>
</tr>
<tr>
<td>Taxes</td>
<td>n/a</td>
</tr>
<tr>
<td><strong>Total operational costs per m3 billed (incl. taxes)</strong></td>
<td><strong>133</strong></td>
</tr>
<tr>
<td>Capital</td>
<td>n/a</td>
</tr>
<tr>
<td><strong>Total cost per m3 billed in</strong></td>
<td>n/a</td>
</tr>
</tbody>
</table>

Performance Analysis

**Effectiveness**

**Service continuity:**
12h/day

**Water quality:**
The water is considered by both, utility officials and the population to be not drinkable at the point-of-use.

**Efficiency**

**Operational costs per m3 of water:**
US $1.33

**Capital costs per m3 of water:**
n/a

**Capital costs / Total Costs:**
n/a

**Infrastructure cost per connection:**
US $72 *(only pipe system without micrometers – CAPEX for production facilities not available)*
## Affordability - Total cost for 15m³ / 5% monthly household income:

To cover the operational costs for 15m³ of water, households would need to spend around US $20.25. Applying the 5% rule, SAEEP’s water can therefore be afforded by households with an annual income higher than US $4,800. In Brazil, around 88 million urban residents or around 52% of the people living in cities fall already below the BoP3000 threshold (Hammond, Kramer, Katz, Tran, & Walker, 2007).

## Employees/1’000 connections:

8

## Water losses (Water produced / Water billed):

Around 60% (officially 40%) of the water produced is physically lost. Theses physical losses cause the cost per cubic meter to increase by around US $-Cents 11.5.

### Legitimacy

#### Public interest:

The water operator depends on the political goodwill of municipal authorities. Major decisions require the support of political institutions. The municipal government appoints the management. Six out of seven members within the administrative council represent public institutions.

#### Users’ interest:

The users have no direct role in decision-making. They can only indirectly influence the water service through participation in local politics.

#### Accountability:

Brazil’s federal constitution yields the responsibility for the water and sanitation sector to the municipalities. A countrywide regulator does not exist. The legal water framework of Parauapebas does not establish an independent regulatory agency. The municipality owns, operates, and regulates the water network.

#### Equality of output

All city residents are supposed to receive the same service. Discrimination exists only in terms of pricing. Low-income users who apply for the federal “bolsa familia” program benefit from reduced tariffs.
**Scalability / Replicability**

**Current scale:**
32'000 connections for around 165'000 people (55'000 households)

**% of households covered in area of operation:**
58%

**% of households covered in potential area of operation:**
58%

**Growth rates since establishment:**
Average: 2’125 (+6.66% – basis year 2012)
2011: n/a (n/a – basis year 2011)

**Favourable conditions and obstacles to scale:**
The condominial model as implemented in Parauapebas reduces in the first place the capital expenditures. The operational expenditures in constrast are not significantly affected by the switch from a conventional to a condominial system. Today’s utility service suffers from a lack of operational efficiency (high water losses, overstaffing), linked to an unsustainable tariff policy. Generating constant losses, the network is not able to keep pace with the fast population growth. Any house connection added to the system aggravates the delicate financial situation.

**Favourable conditions and obstacles to replication:**
The set up of the condominial network in the 1990s as a greenfield project has favored the acceptance of the model within organizational structure of the municipality and among the population. In other projects around Latin America, the switch from an already working conventional to a condominial model has caused serious resistance from the population (L. Mindreau, Interview, 25 September 2012), the state, and employees. Users tend to perceive the condominium design as a service of inferior quality; national legislation on water systems is typically restrictive toward the introduction of new standards; and, operating staff find it often awkward to build up all of a sudden social in addition to technical skills.

**Environmental Sustainability**

**% of HH connected to the sewage**
7%
% of sewage treated
100%

Sustainability of water resources
The catchment of water from the Parauapebas river is sustainable and does not stress local groundwater resources. SAEEP sources 25% of the water produced from local groundwater basins. This number is likely to decrease after the recent inauguration of a second river water production plant.
Maputo

D.1 FIPAG Small-Scale Systems

<table>
<thead>
<tr>
<th>Governance Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Problem</strong></td>
</tr>
<tr>
<td><strong>Main goals:</strong></td>
</tr>
<tr>
<td>Improving the access to and the affordability of water in Maputo’s low-income suburbs through formal, small-scale network systems.</td>
</tr>
<tr>
<td><strong>Main challenges:</strong></td>
</tr>
<tr>
<td>Independent, small-scale operators serve already many areas of Maputo’s suburbs. Some of them are highly profitable businesses. FIPAG has to set attractive incentives (and cover initial losses) in order to win capable entrepreneurs over to the formal sector.</td>
</tr>
<tr>
<td><strong>Geographical focus:</strong></td>
</tr>
<tr>
<td>The project targets Maputo’s low-income suburbs, comprising a population of around 600’000-700’000 people.</td>
</tr>
</tbody>
</table>

**Actors**

**External:**
- The National Directorate of Water, organizationally hosted within the Ministry of Infrastructure and Housing leads the development of a legal framework for the WASH sector.
- The Ministry of Health monitors the water quality.
- The “Conselho de Regulação do Abastecimento de Água” [CRA] is Mozambique’s national regulation authority for the water sector. It regulates and monitors the economic sustainability (incl. tariffs) and the rights of the consumer. An administration board, consisting of three members, selected by Mozambique’s government, overviews CRA’s activities. The water operators finance the regulator with a tax paid on revenues. However, the regulation body suffers from some institutional weaknesses. Around 450 informal, water networks largely operate beyond the control of the regulator.

**Internal:**
- The “Fundo de Investimento e Patrimônio do Abastecimento de Água” [FIPAG] is the main asset holder of public infrastructure in Mozambique’s
urban water sector. Hosted within the Ministry of Infrastructure and Housing, FIPAG is formally independent in administrative and financial terms. An Executive Director leads the agency, under supervision of an Administration Board, consisting of five members. International organizations, and in particular the World Bank and the African Development Bank cover the majority of FIPAG’s expenses. FIPAG is also the majority owner (73% of the shares) of Maputo’s new water and sanitation company, Aguas de Região de Maputo (formerly Aguas de Moçambique owned by Aguas de Portugal).

Recently, FIPAG has started to construct 16 small-scale water systems as an attempt to increase coverage of the formal water sector in Maputo’s low-income areas. FIPAG supervises and supports the small-scale operators and receives in exchange a royalty of around 15% on all revenues. Between 1 (in project implementation) and 4 (in project planning) persons in FIPAG manage the small-scale operators project.

- 16 formal, small-scale entrepreneurs independently operate within the framework of a five year concession contract with the asset owner FIPAG.
- Hydroconseil, a French consultancy firm with a focus on the water and sanitation industry, supports FIPAG in setting up and implementing the small-scale operator project.

**Processes**

**Information:**

The entrepreneurs share important key performance indicators, such as the production volume, every quarter with FIPAG. FIPAG shares data on water quality with the Ministry of Health.

**Decision-making:**

Overall supervision and management is exercised through FIPAG. The entrepreneurs have decision authority within the boundaries of the concession contract. The regulator CRA should act as a mediator between FIPAG and the operator. However, it has not assumed any active role so far.

**Nodal points**

n/a

**Norms**

The operators are free to define the internal decision structure and procedures. However, the minimum service requirements, the water quality standards, and the maximum tariffs are defined in the concession contract between FIPAG and the operator.
**Modes**

**Between legislator/regulator and platform:**
FIPAG is a quasi-independent institution under public ownership, entitled by the government to operate water and sanitation systems in Mozambique.

**Between platform and operators:**
The small-scale networks are governed under a public-private concession framework. All assets remain public under the management of the asset owner FIPAG. The private SMEs compete upfront for five year concessions. The offers with the lowest price and the highest credibility win the bidding process.

**Vertical Forms of Organization**

**Regulation:**
CRA is the national regulation body entitled to monitor all water operators in the country. However, it has not assumed any active role so far.

**Operation:**
The small-scale networks serve small neighborhoods of up to 5’000 connections in Maputo’s low-income suburbs. The cooperation between the platform and the small-scale entrepreneurs represents a form of multi-level governance. The small-scale systems fulfill supply-related tasks independently and the platform (FIPAG) assumes external affairs, such as the organization of finance for the build-up of the networks and the embedment of the small-scale systems in a formal context.

**Supply Chain Analysis**

**Finance**
In a first phase, it is planned to construct 16 systems for around US $3.84 million. FIPAG as the national asset holder in the water and sanitation sector organizes the construction of the small-scale plants and the primary networks for a potential 3’000 to 5’000 house connections per system. This initial step has a cost of around US $240’000 per system. The private operators organize and pre-finance the extensions of the secondary and tertiary network to the households. Upon putting into service, they receive a subsidy from FIPAG of around US $115 per connection. The users contribute with US $34.

At the current average size of 750 connections per network, FIPAG only amortizes a small share of its US $326’250 investment over a 15 years depreciation period. 92.75% of the capital assets are borne by FIPAG and 7.25% by the users. Currently, the operators pay around US $7’600 royalties per year to the asset holder. After
the deduction of the platform operational costs valued at US $4’400 per system, US $3’200 only cover 15% of US $21’750/year – required for full capital cost recovery. Even at maximum capacity with 5’000 connections, the operators would cover through the royalties transferred only around 85% of FIPAG’s first contribution to the capital assets. At the current size and 8 plants, FIPAG loses around US $148’400 each year. At full capacity and 16 plants, this amount could be brought down to around US $128’000 per year. Over 15 years, these losses could accumulate to US $1.92 million. The losses are currently covered through donations by the French Agency for Development, the Dutch Government, the European Union and the European Investment Bank.

Institutional Context

Around 350 water operators are tolerated under precarious commercial city licenses today. As a response, FIPAG, the public asset holder of infrastructure in Mozambique’s water sector, establishes in a first phase 16 formal small-scale systems. FIPAG tenders the systems for operation to candidates with a good track record and with the lowest tariff proposal. The systems are leased for five year terms in exchange for a 15% royalty on the water produced. FIPAG planned to set up the systems in areas where no other operator had established before. However, when FIPAG finally started to construct the facilities, new informal, independent operators had in the meanwhile penetrated some of the target areas. In order to connect, new customers must prove legal residency. According to FIPAG, this requirement does not cause any serious problems, as most inhabitants in Maputo’s suburbs have formally registered.

Procurement

Maputo has easily available groundwater resources. 30 to 60 meters deep boreholes pump the water from the underground to the surface. At the actual load, around 54’000 m³ of water are produced every year per system, corresponding to a daily production of 150 m³.

Production

The water extracted is pumped into an elevated polyethylene tank of between 5 and 10 m³ capacity. The private operator has a meter that measures the volume of production and according to which he is obliged to pay royalties to the asset holder FIPAG. The construction of the entire system (production, primary network and consulting fees) costs about US $240k. With capital costs of US $417 per connection at the current size (excl. consulting fees), the system seems to be expensive. However, the installations are designed to be expanded to around 3’000-5’000 customers. In that case, the capital expenses per user could be reduced to under US $200. In any case, the FIPAG networks are pricey in comparison with some informal providers in the city whose infrastructure costs are less than US $100 per connection.
**Treatment**

The operators treat the water with chlorine prior to distribution. But, people are used to drink raw water from the ground and the awareness for safe water is generally low. Users often complain about the chlorine taste in the water. FIPAG’s operators have therefore started to chlorinate the water with a concentration below WHO standards. The plan is to slowly raise the concentration of chlorine in the water once the households accustom to the taste.

**Pricing**

In order to connect, users pay around US $34. At the current network size (750 connections), this contribution however covers only a small share (7.2%) of the total initial investment. The tariffs are for all users identical and do not vary from one geographical location to another. The average monthly consumption per connection amounts to 6m$^3$. Users pay in addition to the per-cubic meter price a monthly connection fee of US $0.69. A typical household (6m$^3$) pays around US $-$-Cents 94.5 per cubic meter of water. Independent micro operators usually charge around US $1 for the same water volume.

<table>
<thead>
<tr>
<th>Volume</th>
<th>Tariffs</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^3$</td>
<td>US $0.69</td>
</tr>
<tr>
<td>m$^3$</td>
<td>US $0.83</td>
</tr>
</tbody>
</table>

**Delivery**

From the elevated tanks, the water is pressed with gravity into the pipe system. Therefore, the energy consumption is comparably low. The operators spend only 3.7 cents on electricity and chemicals combined per cubic meter of water billed in. FIPAG constructs the primary network and the entrepreneurs add the secondary and tertiary branches. They receive for each new connection installed a subsidy from FIPAG of US $115. The water is distributed through so-called “spaghetti” pipes, made of “High Density Polyethylene”. These pipes have a very small diameter of 2 inches for the primary network and 0.75 inches for the household connections. The flexibility of “spaghetti” pipes makes the construction process easier and less cost-intensive. However, the lightness of the pipes also increases their vulnerability against potential theft.

First results show that the operators lose 46.5% of the water produced. 38% account for physical losses and 8.5% for failures in the billing process (Chaponniere & Collignon, 2011, pp. 7-8). These losses are unexpectedly high, but compared to the main utility (64.5% water losses) still considerably lower. The fact that the operators use only little energy in distribution may have reduced the operators’ incentive to put an emphasis on water losses control.
**Billing**

All households are billed on the basis of individual micro meters. Employees check users’ consumption levels on a monthly basis. Users must pay the invoices in cash as the operators do not offer any micro-finance schemes. The operators typically write off 14.5% of the invoices.

**Customer Management**

The operators fully rely on their local knowledge and conduct house-to-house visits in order to attract new customers. Often, word-by-mouth advertising causes the networks to grow. FIPAG’s networks aspire to offer to clients a superior service at a lower price than its competitors do. Customers with operational problems can contact the entrepreneur or the employees.

**Monitoring**

The operators regularly inform FIPAG with performance indicators, such as the number of clients, the billing recovery rate, water losses, and water quality. FIPAG additionally supervises the operations of the operators through regular visits. The production facilities and the households are equipped with macro- and micro meters. In theory, breaches of regulations can lead to the rupture of the contract. However in practice, FIPAG has only given recommendations to the private operators and has not imposed any fines so far.

**Maintenance**

The operators are fully responsible for the maintenance of the networks. FIPAG is convinced that the entrepreneurs have an incentive to maintain the network in good shape in order to prevent any losses of water from technical problems or illegal activities.

**Sewage**

The project has no direct links to efforts related to the expansion of the urban sewage network. In Maputo, only between 40’000 and 75’000 households (10%-20%) have access to the sewage system, operated by Águas de Região de Maputo. Half of the sewage is treated at the Infulene treatment plant. The other half is directed into rivers that flow into Maputo Bay. Low-income households in Maputo’s suburbs usually discharge the wastewater and other sewage to a self-made pit under the house. The lack of sewage treatment poses a risk on Maputo’s groundwater resources.

**HR**

FIPAG organizes public bids to award the operating concessions. As existing, independent operators make a good living out of their business, FIPAG has to subsidize the franchisees. At the current size and cost structure, FIPAG would need to charge royalties that are 6.8 times higher. However, in such scenario, the franchisee would earn “only” US $3’250/year instead of US $17’400/year. A
comparable, independent entrepreneur earns around US $14'500 in profits a year (Blanc A., 2008, p. 13). FIPAG has deployed between one (in project implementation) and four (in project planning) persons to the project.

An operator employs around six people. His employees typically earn US $100 per month. The number of employees is proportionally high compared to the small-size of 750 connections. However, once the network approximates full capacity load (3’000-5’000 connections), economies of scale might balance the actual over-employment.

Financial Analysis

Cost-/Revenue-Analysis per System

<table>
<thead>
<tr>
<th>Amount/Year</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Revenues</strong></td>
<td></td>
</tr>
<tr>
<td>Revenues through water sales</td>
<td>US $51’200</td>
</tr>
<tr>
<td><strong>Total revenues</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Operational costs</strong></td>
<td>US $24’500</td>
</tr>
<tr>
<td>Electricity</td>
<td>US $3’000</td>
</tr>
<tr>
<td>Chemicals</td>
<td>US $1’000</td>
</tr>
<tr>
<td>Maintenance</td>
<td>US $7’200</td>
</tr>
<tr>
<td>Salaries</td>
<td>US $6’500</td>
</tr>
<tr>
<td>Taxes</td>
<td>US $2’400</td>
</tr>
<tr>
<td>Other costs</td>
<td>US $4’400</td>
</tr>
<tr>
<td>Overhead/system</td>
<td></td>
</tr>
<tr>
<td><strong>Total capital costs</strong></td>
<td>US $23’450</td>
</tr>
<tr>
<td>Capital costs (operator)</td>
<td>US $1’700</td>
</tr>
<tr>
<td>Capital costs (platform)</td>
<td>US $21’750</td>
</tr>
</tbody>
</table>

US $351’750 as an investment for 750 connections amortized over 15 years.

Based on 2010 results. Exchange rate used: 1 USD = 25 MZN
Unit-Cost Analysis

<table>
<thead>
<tr>
<th>Item</th>
<th>US $-Cents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>5.5</td>
</tr>
<tr>
<td>Chemicals</td>
<td></td>
</tr>
<tr>
<td>Surcharge for water losses</td>
<td>1.8</td>
</tr>
<tr>
<td>Maintenance</td>
<td>1.9</td>
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<tr>
<td>Salaries</td>
<td>13.3</td>
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<tr>
<td>Other</td>
<td>4.4</td>
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<tr>
<td>Overhead</td>
<td>8.2</td>
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<tr>
<td><strong>Total operational costs per m³ billed in</strong></td>
<td><strong>33.3</strong></td>
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<tr>
<td>Taxes</td>
<td>12</td>
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<tr>
<td><strong>Total operational costs per m³ billed in (incl. taxes)</strong></td>
<td><strong>45.3</strong></td>
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<tr>
<td>Capital</td>
<td>38.6</td>
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<tr>
<td><strong>Total cost per m³ billed in</strong></td>
<td><strong>83.9</strong></td>
</tr>
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</table>

Performance Analysis

Effectiveness

Service continuity:
24 hours a day

Water quality:
The operators generally provide water of reliable quality. But, after customer complaints about the chemical taste of the water, some operators have reduced the volume of sodium hypochlorite added below WHO standards. This is a potential health threat, should water recontaminate between the source and the point-of-use.

Efficiency

Operational costs per m³ of water:
US $0.32 (excl. taxes)

Capital costs per m³ of water:
US $0.39
(at the current load; however, the systems are designed for a capacity of between 3’000 and 5’000 connections)
Capital costs / Total Costs:
55%
(at the current load; however, the systems are designed for a capacity of between 3'000 and 5'000 connections)

Infrastructure cost per connection:
Around US $470
(at the current load; however, the systems are designed for a capacity of between 3'000 and 5'000 connections; at full capacity the connection costs could be reduced to around US $200)

Affordability - Total cost for 15m3 / 5% monthly household income:
At the current size of the networks, the cost-covering price for 15m\(^3\) of water is around US $10.52 (excl. taxes). Applying the 5% rule, water from FIPAG’s small-scale networks can be afforded by households with an annual income higher than US $2’600. In Mozambique, an estimated 6 million urban residents or around 73% of the people living in cities fall below the BoP2700 threshold (WHO / UNICEF, 2003-2010; Hammond, Kramer, Katz, Tran, & Walker, 2007).

Employees/1’000 connections:
8.5

Water losses (Water produced / Water successfully billed in
46.5% of the water produced cannot be successfully billed in. 38% is physically lost and 8.5% represent bills that are written off. These losses cause the cost per cubic meter to increase by around US $-Cents 1.8.

Legitimacy

Public interest:
Between 350 and 400 informal entrepreneurs have operated small-scale networks in Maputo’s suburbs, to a large extend beyond the radar of the national regulator. The operators have been accused by critics to offer an inferior service at high prices. The independent water operators on the other hand claim that competition works in favour of the customers as some of the networks overlap. FIPAG in contrast, as the public asset holder, sets up small-scale networks that respect the prices and service standards - as defined by law. This model ensures that small-scale operators subordinate to the democratic control of the general public.

Users’ interest:
The users have no direct role in decision-making, neither for the independent nor for the platform managed small-scale model.
Accountability:
In the past, the national regulator, CRA, had troubles to regulate the hundreds of small-scale operators in Maputo’s periphery. The model of platform managed small-scale systems in contrast provides CRA now with FIPAG a key partner who can ensure the implementation of CRA’s regulatory activities among the small-scale operators. However, CRA has not taken any active role so far.

Equality of output:
The duality of the system with Aguas de Região de Maputo being responsible to supply the wealthier parts of the city and FIPAG’s small-scale operators to serve the low-income areas creates two different service standards based on a socio-economic criterion. In the context of the implementation of a condominial system for low-income populations in Lima, the same duality created resistance among the population, leading to an eventual end of the project.

Scalability / Replicability

Current scale:
Per operator: 750
System-wide: 6'000

% of households covered in area of operation:
FIPAG small-scale operators: 18.75%
Other operators: n/a

% of households covered in potential area of operation:\nFIPAG small-scale operators: 4.25%
Other operators: Around 30%

Growth rates since establishment:
Per operator: +500/year (first year)
System-wide: +4’000/year (first year)

Favourable conditions and obstacles to scale:
- Small-scale entrepreneurs have a financial incentive to remain independent unless FIPAG subsidizes part of the capital expenses.

---

35 The potential area is defined as 700’000 people who live in Maputo’s low-income suburbs.
Currently, FIPAG subsidizes 85% of the capital costs, with potential losses of around US $1.9 million over a project time of 15 years. The entrepreneurs have to pre-finance the secondary and tertiary extensions of the network, before they receive a US $115 contribution per connection from FIPAG. Operators without savings or access to finance markets might therefore expand their network only at a slow pace.

Favourable conditions and obstacles to replication:

- At the current cost structure and capacity load, the model is preferably replicable in BoP 2600 markets.
- In order to replicate, the project must attain a higher capacity load or reduce the costs of infrastructure which, at the moment, with US $470/connection are far too high for a low-income context.
- The question if developing cities should be supplied with water by a single utility or rather by multiple small-scale networks under the umbrella of managing platforms relates to the operational expenses for the platform overhead. It should be carefully evaluated from case to case, if the savings expected from small-scale operations (in particular lower production costs and lower HR costs) exceed the operational costs for the platform.
- The technological and organizational set-up might vary in areas without easy access to groundwater resources. In dry areas, it could make sense to apply a centralized water catchment strategy with the platform or a specialized production unit acting as wholesaler for the small-scale networks.
- It is probably more difficult to replicate the model in areas where alternative private small-scale networks already exist than it is in cities where private property in the water sector has been strictly banned. In presence of a vital informal sector, the incentives to formalize must be attractive enough. Otherwise informal entrepreneurs will not take shelter under the umbrella of a formal platform.
- The water sector is often perceived as conservative. Important stakeholders (government, employees, users, etc.) may block the implementation of a radically new distribution model – as presented here.

**Environmental sustainability**

% of HH connected to the sewage:

0%

The existing small-scale networks have been too small to construct sewage and treatment facilities for the customers. The platform umbrella offers an opportunity to benefit from economies of scale with a common sewage system.
% of sewage treated
0%

Sustainability of water resources
So far, the estimated 350-450 independent water operators have tapped as much groundwater resources as they needed, usually without taking the sustainability of the source into consideration. The formalization of the small-scale sector under a common platform, as envisioned by the project, improves this situation as the level of production is now under public control – represented by FIPAG.
### Key Contacts

The information contained in the case studies was retrieved and combined, unless otherwise stated, from the following key contacts:

<table>
<thead>
<tr>
<th>Key Contact</th>
<th>Organization</th>
<th>Date</th>
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<tbody>
<tr>
<td>Marcelo Banti</td>
<td>ESSAP</td>
<td>June 29 2012</td>
</tr>
<tr>
<td>Jorge Pusineri</td>
<td>Ministry of Public Infrastructure and Communications / Ex-ESSAP</td>
<td>June 25/28 2012</td>
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<td>Aricio Gamarra</td>
<td>Aguateria „YBU“</td>
<td>June 26 2012</td>
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<td>César Flores</td>
<td>SAGUAPAC</td>
<td>July 11 2012</td>
</tr>
<tr>
<td>Erwin Padilla Franco</td>
<td>SAGUAPAC</td>
<td>July 12/16 2012</td>
</tr>
<tr>
<td>Julian Ibarra</td>
<td>COOPLAN / COSPHUL</td>
<td>July 4 2012</td>
</tr>
<tr>
<td>João Miranda</td>
<td>Constructora Miranda / Ex-Condominium Empreendimentos Ambientais</td>
<td>October 3-5 2012</td>
</tr>
<tr>
<td>Francisca de Almeida</td>
<td>Serviço de agua e esgotamento de Parauapebas</td>
<td>October 3-4 2012</td>
</tr>
<tr>
<td>Emmanuel Chaponnière</td>
<td>Hydroconseil / FIPAG</td>
<td>January 24 2011</td>
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Interview Guidelines

Guidelines for Interviews with Operators

Basic Data

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<tr>
<th>City</th>
<th>Operator</th>
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<td>Population:</td>
<td>Population reached:</td>
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<tr>
<td>Population growth:</td>
<td>Growth of new customers:</td>
</tr>
<tr>
<td>Water coverage within city:</td>
<td>Water coverage within area of concession:</td>
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<tr>
<td>Market shares:</td>
<td>Legal status:</td>
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Historical Analysis

<table>
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<tr>
<th>N° of users</th>
<th>Features</th>
<th>Features</th>
<th>Features</th>
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<tr>
<td></td>
<td>Drivers</td>
<td>Obstacles</td>
<td>Growth</td>
<td>Others…</td>
<td>Drivers</td>
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<td>Antecedents</td>
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<td>Phase I</td>
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<tr>
<td>Phase II</td>
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<td>Phase III</td>
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<tr>
<td>Phase IV</td>
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</tbody>
</table>

Drivers
Obstacles
Growth
Others…
# Governance Analysis

## Problem:
- Which are the main problems tackled?
- Which are the main goals of the water utility?
- Which is the geographical focus of the utility?

## Actors:
- Which actors are sought advice from in decision making and which actors take decisions? – Areas:
  - Governance structure and process
  - Finance
  - Infrastructure used and expansions
  - Water and electricity procurement
  - Production and treatment technology
  - Pricing
  - Payment (payment means, conditions, disconnections)
  - HR (hire/fire staff; salaries)
  - Maintenance operations

## Processes:
- Which standard processes are followed in decision-making? – Areas:
  - Legislation
  - Regulation
  - Investigation
  - Integration of different opinions
  - Project design
  - Negotiation / consultation
  - Decision-making
- Are decisions taken unanimously or by majority?

## Nodal points:
- For which tasks do different actors come together?
- Do they meet physically or virtually?
- When and how often do they interact?

## Norms:
- Who defines and amends the rules?
- Which explicit rules exist on decision making?
- Which implicit rules exist on decision making?

## Modes:
- Between legislator/regulator and utility (platform)
  - Hierarchy
  - PPP or market
  - SOE
  - Community
- Between platform and operator
  - Internal
  - External
  - Community

## Vertical forms of organization:
- Regulation
  - Centralized
  - Local
- Operation
  - National level
  - Local level
  - Community level
- Multilevel Governance
## Supply Chain Analysis

**Finance:**
- How is the utility financed? (self-sustainable/debt/subsidized)
- Which are the finance partners?

**Land and other institutional arrangements:**
- Whom does the land belong to the utility operates on?
- Does the utility dispose of property and operational rights?
- How is the area of operation of the utility legally defined? What prerequisites do you users need to present in order to connect to the water network?

**Procurement:**
- From where and under what conditions does the utility procure water?
- From where and under what conditions does the utility procure electricity?

**Production:**
- What kind of production equipment is being used?
- How many liters of water are produced per day?

**Treatment:**
- What’s the water quality before production/treatment?
- What kind of treatment technologies are applied in production?

**Pricing:**
- Which tariff levels do exit?
- Does the utility work with increasing-, decreasing-, or flat tariffs?
- Do different customer segments cross-subsidize each other? What’s the % of customers for each segment?
- How much does the utility charge for new connections? Are connection fees (cross-)subsidized?

**Delivery:**
- What kinds of pipes are being used for delivery?
- How is in-pipe pressure being hold up? What’s the distribution technology? – Gravity, pneumatic system, water towers, etc.
**Billing:**
- How is the monthly billing amount assessed? By whom - internal or external employees?
- What % of households is billed on the basis of micro-meters?
- At what rhythm is payment made?
- How is payment done?
- Do micro finance facilities exist?
- What sanctions do apply in the event of non-payment?

**Customer Management:**
- What interfaces exist between customers and the utility?
- Are there any pro-poor interfaces and activities?
- What kind of marketing activities does the utility undertake?
- What’s the degree of involvement of customers in strategic and operational decision making processes?

**Monitoring:**
- How and whom are the networks being monitored?
- How and whom monitors the financial performance of the utility?

**Maintenance:**
- How is maintenance organized? External support, platform support, plant operators, etc.?

**Sewage:**
- How is sewage organized?

**HR:**
- How many people are employed and what functional tasks do they fulfill?
- How are employees selected?
- What’s the average employee turnover in years each at strategic and operational level?

**IT:**
- Does IT support the utility operations?
# Financial Analysis

## Revenues

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>+ Revenues through water sales</td>
<td></td>
</tr>
<tr>
<td>+ other revenues</td>
<td></td>
</tr>
</tbody>
</table>

**Total revenues**

## Operational costs

- Water
- Electricity
- Chemicals
- Maintenance
- Salaries (if possible divided by functions)
- Taxes
- Interests
- Other costs

**Total operational costs**

## Capital costs

- Value of production infrastructure (pumps, treatment basin, etc.) divided by estimated average total life span in months
- Value of distribution infrastructure (pipes, water towers, etc.) divided by estimated average total life span in months
- *If assumed by utility*: Value of user infrastructure (meter, home connection, etc.) divided by estimated average total life span in months

**Total capital costs**

**Total Revenues – Total Operational Costs – Total Capital Costs**
### Performance Analysis

<table>
<thead>
<tr>
<th>Effectiveness</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service continuity</td>
<td>Operational costs per m$^3$ of water</td>
</tr>
<tr>
<td>• Average hours of water delivered per day</td>
<td>Capital costs per m$^3$ of water</td>
</tr>
<tr>
<td>Water quality</td>
<td>Employees/100 connections</td>
</tr>
<tr>
<td>• Potability of the water at the tap</td>
<td>Water losses</td>
</tr>
<tr>
<td>Environmental sustainability</td>
<td>• Water produced / Water successfully billed in</td>
</tr>
<tr>
<td>• % of HH connected to the sewage</td>
<td></td>
</tr>
<tr>
<td>• % of sewage treated</td>
<td></td>
</tr>
<tr>
<td>• Sustainability of water resources</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Legitimacy</th>
<th>Scalability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public interest</td>
<td>Scale</td>
</tr>
<tr>
<td>• How is the public interest or just the state being represented in the utility activities?</td>
<td>• Current scale</td>
</tr>
<tr>
<td>• How does the general public enforce the utility to act in a balancing manner, particularly towards the poor?</td>
<td>• Growth rates since establishment</td>
</tr>
<tr>
<td>• What is the public opinion towards the utility?</td>
<td>Obstacles to scale</td>
</tr>
<tr>
<td>Affordability</td>
<td>• What existing barriers prevent the utility from gaining scale?</td>
</tr>
<tr>
<td>• Price of 0.5m$^3$ / average daily household income (5% rule)</td>
<td>• What would be required to expand current operations to areas without access?</td>
</tr>
<tr>
<td>Coverage</td>
<td>Replicability</td>
</tr>
<tr>
<td>• % of new households connected/year</td>
<td>Obstacles to replication</td>
</tr>
<tr>
<td>• % of households covered in area of operation</td>
<td>• What conditions in the context would favor the replication of the model in other parts of the country, Latin America, or worldwide?</td>
</tr>
<tr>
<td>• % of households covered in potential area of operation</td>
<td>• Are there any factors intrinsic to the model which would restrict it to a specific geographical, or cultural region?</td>
</tr>
</tbody>
</table>
Guidelines for Interviews with Stakeholders

Basic Questions

- What does your organization and how does it contribute to the urban water sector?
- How would you describe the evolution of the water sector in your city? Milestones?
- What are major challenges in the urban water sector?
- What is the status of the small-scale sector in your city and what is your opinion about the small-scale operators?
- What is your opinion about the main water utility in the city?
- How do small-scale and large-scale operators differ in terms of the different performance dimensions?
- How would you like to see the future of the water sector in the city? Milestones?

Flexible Questions

E.g. CAPA (Association of Private Small-Scale Operators in Asunción)

- What is the number of “aguateros” in the city? How do they look like – size, history, staff employed, etc.?
- How has been the evolution of the small-scale operators over the last two decades?
- What is the ideal size of small-scale network?
- Why are there not more “aguateros”, owning multiple networks in the city?
- What are major obstacles for the “aguaterias” to grow and/or to replicate?
- ....
References


References


References


# Interviews

## Asunción Case (Field Visit: June 18 – July 3, 2012)

### Key Contacts

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization</th>
<th>Date</th>
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<tbody>
<tr>
<td>Paula Burt</td>
<td>AVINA</td>
<td>June 19 2012</td>
</tr>
<tr>
<td>Aricio Gamarra</td>
<td>Aguatería „YBU“</td>
<td>June 26 2012</td>
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<td>Marcelo Banti</td>
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<td>Jorge Pusineri</td>
<td>Ministry of Public Infrastructure and Communications / Ex-ESSAP</td>
<td>June 25/28 2012</td>
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### Complementary Contacts

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<thead>
<tr>
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<tr>
<td>Jorge Abbate</td>
<td>GEAM</td>
<td>June 25 2012</td>
</tr>
<tr>
<td>Isabelino Areco Arce</td>
<td>Junta de Saneamiento Posta</td>
<td>June 29 2012</td>
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<td></td>
<td>Ybyraro</td>
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<tr>
<td>Jorge Candia</td>
<td>Camara Paraguaya de Aguateros</td>
<td>June 20 2012</td>
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<tr>
<td>Sonia Chavez</td>
<td>ESSAP</td>
<td>June 29 2012</td>
</tr>
<tr>
<td>Alex Gaona Digalo</td>
<td>Ministry of Public Infrastructure and Communications</td>
<td>June 25 2012</td>
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<tr>
<td>Santiago Leguizamon</td>
<td>Junta de Saneamiento Itaugua</td>
<td>June 29 2012</td>
</tr>
<tr>
<td>Roberto Darío Lezcano</td>
<td>ERSSAN</td>
<td>June 20 2012</td>
</tr>
<tr>
<td>Cáceres</td>
<td></td>
<td></td>
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<tr>
<td>Roberto Lima</td>
<td>World Health Organization</td>
<td>June 27 2012</td>
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<td>Mirian Mancuello</td>
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<td>Roger Monte Domeq</td>
<td>Ministry of Public Infrastructure and Communications</td>
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<td>Jorge Oyamada</td>
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<td>Julio Alberto Rodas</td>
<td>United Nations Development Program</td>
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<td>Osmar Ludovico Sarubbi</td>
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<td>Luis Sisul</td>
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<td>Ulrich Velte</td>
<td>Independent WASH Consultant</td>
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<td>Félix Benjamín Villar</td>
<td>Victor Gonzalez y ASOC S.S.</td>
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<tr>
<td>Chiaki Kinjo</td>
<td>AVINA</td>
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<td>César Flores</td>
<td>SAGUAPAC</td>
<td>July 11 2012</td>
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<tr>
<td>Erwin Padilla Franco</td>
<td>SAGUAPAC</td>
<td>July 12/16 2012</td>
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<tr>
<td>Julian Ibarra</td>
<td>COOPLAN / COSPHUL</td>
<td>July 4 2012</td>
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<tr>
<td>Edwin Arrazola</td>
<td>COSPHUL</td>
<td>July 5 2012</td>
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<td>Luis Fernando Casanova</td>
<td>Gobierno Autónomo Departamental</td>
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<tr>
<td>Brian Costas</td>
<td>Ex - Comité Cívico Pro Santa Cruz</td>
<td>July 17 2012</td>
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<tr>
<td>Alberto Cronembold Bello</td>
<td>SAGUAPAC</td>
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<tr>
<td>Reimy Ferreira</td>
<td>Universidad Autónoma Gabriel René Moreno</td>
<td>July 13 2012</td>
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<tr>
<td>Gregorio Jaldín Ferrufino</td>
<td>Federación Departamental de Coopeerativas de Agua y Alcantarillado de Santa Cruz</td>
<td>July 4 2012</td>
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<tr>
<td>Arturo Moscoso Villacorta</td>
<td>ICEA</td>
<td>July 6 2012</td>
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<tr>
<td>Ramón Mario Roca</td>
<td>Gobierno Municipal Autónomo de Santa Cruz de la Sierra</td>
<td>July 17 2012</td>
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<tr>
<td>Fernando Trigo Muñoz</td>
<td>SAGUAPAC</td>
<td>July 11 2012</td>
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**Santa Cruz Case (Field Visit: July 3 – July 18, 2012)**

### Key Contacts

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### Complementary Contacts

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</table>
Parauapebas Case (Field Visit: September 24 – October 10, 2012)

Key Contacts

João Miranda  
*Constructora Miranda / Ex-Condominium Empreendimentos Ambientais*

Francisca de Almeida Sieirua  
*Serviço de agua e esgotamento de Parauapebas*

Cesar Augusto Rissoli  
*Companhia de Saneamento Ambiental do Distrito Federal*

Complementary Contacts

Luis Curridor  
*Degremont (Suez)*

André Dionísio  
*Companhia de Saneamento Ambiental do Distrito Federal*

Noelia Gomes da Silva  
*Companhia de Saneamento Ambiental do Distrito Federal*

Teresa Lampoglia  
*Independent WASH Consultant*

Carlos Eduardo Lima Passos  
*Ex – Companhia de Saneamento do Estado do Rio de Janeiro*

José Carlos Melo  
*Condominium Empreendimentos Ambientais*

Lourdes Mindreau  
*CARE Perú*

Klaus Dieter Neder  
*Companhia de Saneamento Ambiental do Distrito Federal*

Luis Valencia  
*WHO Peru office*

Miguel Vargas-Ramírez  
*World Bank*

Maputo Case (no field visit conducted)

Emmanuel Chaponnière  
*Hydroconseil / FIPAG*
### Other Interviews (Field Visit in Thalwil: January 18, 2013)

<table>
<thead>
<tr>
<th>Name</th>
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<tr>
<td>Johannes Brunner</td>
<td>Hamburg Wasser</td>
<td>January 10 2013</td>
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<tr>
<td>Alex Bucher</td>
<td>Dienstleistungszentrum Infrastruktur, Gas und Wasser, Gemeinde Thalwil</td>
<td>January 18 2013</td>
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<tr>
<td>Gion Hagmann</td>
<td>Dienstleistungszentrum Infrastruktur, Gas und Wasser, Gemeinde Thalwil</td>
<td>January 18 2013</td>
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<tr>
<td>Gustavo Heredia</td>
<td>Plastiforte / Fundación AguaTuya, Cochabamba</td>
<td>January 10-12 2011</td>
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<tr>
<td>Erich Mück</td>
<td>Wasserversorgung Zürich</td>
<td>January 9 2013</td>
</tr>
</tbody>
</table>
Curriculum Vitae

Christian Aristoteles Vousvouras (4/11/1983) from Switzerland, Greece and Germany

Awards and Scholarships
2009-2013  
*SNF ProDoc “The Dynamics of Transcultural Governance and Management in Latin America” / AVINA Foundation: CHF 12’000 for the elaboration of the PhD project*

2009  
*Fund for Latin American Studies at the University of St. Gallen: Latin America Award (CHF 3’000) for Master thesis*

Education
09/2009-09/2013  
*University of St. Gallen (CH): Ph.D. in International Business*

10/2007-10/2009  
*University of St. Gallen (CH): MA in International Affairs*

10/2004-10/2009  
*University of St. Gallen (CH): Teacher in Business Education*

02/2006-07/2006  
*Universidad del Pacífico (Peru): Exchange Term*

*University of St. Gallen (CH): BA in International Affairs*

Profession
02/2010-01/2012  
WASH consultant for private and public sector clients: *Veolia, Suez, Finagestion, Proparco, AFD, SDC, World Bank Group*

06/2008-09/2008  
Consultant at the *Water and Sanitation Program in Lima*

05/2009-07/2009  
High-School Teacher at *Cantonal School Alpenquai, Lucerne*

11/2008-04/2009  
Documentation Officer at *Avaloq Evolution AG in Zurich*

02/2007-03/2007  
Intern at the *German Consulate in Barcelona*

Intern at the *UN Mission of Greece in Geneva*

09/2005-11/2005  
Intern at the *Greek Ministry for Foreign Affairs in Athens*