

Application and critical assessment of qualitative comparative analysis: determinants for the presence of service provision models for water supply and sanitation services in Brazil

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Abstract

The provision of water supply and sanitation services in Brazil is characterized by a diverse range of management models, public or private operators and various judicial-institutional arrangements. Using a quali-quantitative technique – qualitative comparative analysis (QCA) – this article presents an investigation of determining factors for the presence of different service provision models in Brazil, and discusses the application of said technique. In this study, four models were comparatively analyzed: direct municipal administration, indirect municipal administration, state utility company, and private enterprise (PRIV). Eight municipalities, with an urban population ranging from 10 to 20 thousand inhabitants, from Minas Gerais (a state in the Southeast region of Brazil) were selected for this study. The findings suggest that the decision-making process regarding a service provision model, in the cases studied, involves a combination of economic, political, social, institutional, and legal factors. The qualitative comparative analysis proved capable of compiling information for this analysis as it uncovered how determining factors are inter-related and allowed the predominant factors in each of the studied management models to be identified.

Keywords: Institutional models; QCA; Sanitation; Water supply

Introduction

Around the world, the water and sanitation sector is characterized by diversity in terms of institutional structures and political options (Castro, 2012). Such diversity corroborates the hypothesis that systemic determinants have significant sway on the design and even the organization of these services, making

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them the product of historical processes in which political and social factors wield significant influence. Furthermore, according to [Castro \(2012\)](#), commercial and financial interests are other systemic determinants that must be incorporated into analyses of public policy and management of the water and sanitation sector.

As [Rezende & Heller \(2008, p. 348\)](#) point out, ‘the history of water supply and sanitation service is not limited by itself nor does it explain itself. There are so many interfaces in the politics of water and sanitation, determining these politics and at the same time being shaped by them, that one must consider water and sanitation through the lens of these relations.’¹

However, and this is true for most countries, Brazil’s water and sanitation sector has been the territory of predominantly technocentric approaches, mainly dictated from the realm of sanitary engineering. [Heller & Castro \(2007\)](#) argue that a paradigm change from the technically formatted management of water and sanitation is indispensable.

The predominance of this vision has been evidenced in the field of sectorial public policy, which ‘often has not been capable of treating its object with an appreciation for its complexity and multidimensionality, with possible impacts on the effectiveness of decisions and activities’² ([Britto et al., 2012](#)). According to [Castro \(2012\)](#), a variety of systemic determinants with significant influence on the management of water and sanitation services – especially those of a social nature – have historically been overlooked or totally disregarded. [Swyngedouw \(2004\)](#) also highlights that urban water services have traditionally and predominantly been approached via the lens of economic engineering or management, paying little attention to the central role of social and political factors.

This article aims to present an investigation of determining factors for the presence of different water and sanitation service provision models (direct municipal administration (DMA), indirect municipal administration (IMA), state utility company (SUC) and private enterprise) in eight municipalities in Brazil, using qualitative comparative analysis (QCA). QCA is an established research method capable of detecting combinations of causal conditions that lead to outcomes of interest. The choice of the object of study and the methodological approach that was applied aims to fill certain gaps that exist in the field of public policies for water supply and sanitation.

[Heller & Castro \(2007\)](#) duly point out that multidisciplinary studies should be able to contribute to improving the quality of public policies in this field and to higher quality debates and deliberation. Specifically, this applies to methodologically consistent studies geared towards the assessment of empirical experiences on the interaction between public policies and water supply and sanitation services. Over time, such experiences may increase the effectiveness and efficiency of systems and public policies that respond better to the public’s interests. QCA was applied in this study in the interest of adopting a more systemic approach and overcoming apparent knowledge gaps in identifying which factors determine the application of different models for water supply and sanitation service provision in the chosen municipalities. Indeed, the QCA technique can be productively applied to research on water supply, sanitation and hygiene although it has not been used frequently in such studies to date ([Kaminsky & Jordan, 2017](#)).

The paper is organized as follows. Following the present introduction, the second section presents a brief overview of Brazil’s water and sanitation management sector. The third section introduces the

¹ Translated from the original text in Portuguese.

² Translated from the original text in Portuguese.

QCA technique and its potential application. The ‘Methods’ section describes the research’s analytical framework. The QCA’s combination of conditions for the four water and sanitation service provision models are presented in the ‘Results’ section and the following section discusses the findings and methodology of the research. The final section summarizes the key findings and offers some concluding thoughts.

Brazilian service provision models

It is an important time in Brazil for water and sanitation policies, as evidenced by a range of transitions in the sector. These changes are manifest in the recent regulatory framework and the institutional reorganization of the sector policy pursuant to the enactment of Law no. 11.445/2007 and the approval of the National Plan for Water, Sanitation, Solid Waste and Urban Drainage (PLANSAB), in 2013, via Inter-Ministerial Ordinance No. 571/2013.

However, historically, the management of water supply and sanitation services has not followed one model alone or been guided by a national policy. Policies for the sector have, in fact, been subject to variations concerning their management by different entities and levels of the federal government. In addition, the legal personality of service providers has also been inconstant. This undefined framework has provoked important consequences, mainly by contributing to a failure to achieve universal service coverage in the country. This has left a substantial proportion of the population, mainly the poor, either without access to these services or with unsatisfactory service (Heller *et al.*, 2014).

In Brazil, the main service provision models for water supply and sanitation can be summarized as follows.

Direct municipal administration

DMA is a model in which the municipal city hall takes charge of managing services, including responsibility for the activities related to planning, projects, operation, and administration. These activities are carried out through secretariats, departments, or direct public administration offices. In this model, there is no defined legal entity or autonomous financing, since services are not exclusively linked to revenue originating from tariffs.

Indirect municipal administration

This model possesses judicial, administrative, and financial autonomy and commonly assumes the form of a local autarchy. Power is transferred via law from a public authority to a decentralized management body possessing legal personality governed by public law. The most commonly attributed name to this type of local autarchy is an Autonomous Water and Sewage Service (SAAE in Brazil).

State utility companies

These are public or mixed capital companies that obey an administratively and financially centralized system, with regional offices in municipal headquarters. These were created to be the main

agents of water and sanitation service provision in Brazil via municipal concessions authorized by specific law.

Private enterprises

With the introduction of private capital, another management model has emerged for the provision of water supply and sanitation services. The public administration and the private entities establish a judicial contract for either the full or partial implementation or management of services. This is not a particularly common model for the water and sanitation sector in Brazil, but it has gained popularity in recent decades.

Brazil's municipalities opt for any one of these different models, meaning that a common pattern of service provision is not observed in the country. For Nunes *et al.* (2010), 'municipal decisions regarding the most suitable management model for water supply and sanitation services is still the subject of controversies and dispute'³. Rossoni (2015) sought to associate the presence of models for water supply and sanitation service management in Brazil with determining factors using quantitative analyses based on secondary data through univariate nonparametric statistical tests and multivariate tests. The results obtained in that study evidenced associations between management models and municipalities' socio-demographic characteristics. One of the author's main realizations is that less attractive services in terms of potential users are under the management of DMA; criteria defining such cases include low indicators related to MHDI⁴, social and economic characteristics, housing, vulnerability to poverty, and sanitary conditions. Furthermore, local autarchies and state companies are present in more populous cities with healthier economies (Rossoni, 2015). Such studies highlight the need for more in-depth research that would evaluate further dimensions of interest using different analytical techniques. In this spirit, the present study aims to contribute to this discussion through the application of a quali-quantitative technique to assess the determining factors for the presence of management models for water supply and sanitation service provision in Brazil.

Qualitative comparative analysis

Charles Ragin introduced QCA in 1987 with the intention of bridging the gap between the qualitative and quantitative research methods. This comparative technique initially focused on case studies and aimed to integrate the best characteristics of the qualitative (case-oriented) and quantitative (variable-oriented) approaches (Ragin, 1987 *apud* Rihoux & Ragin, 2009). Therefore, the QCA methodology claims to achieve two apparently contradictory objectives. On the one hand, it aims to capture the complexity of the given cases by compiling in-depth information on them. On the other hand, it attempts to achieve a certain degree of generalization (Rihoux, 2006).

Qualitatively, QCA is a holistic approach inasmuch as each individual case is considered a complex entity that must be perceived as a whole and must not be forgotten in the analysis. This technique

³ Translated from the original text in Portuguese.

⁴ MHDI – Municipal Human Development Index. In accordance with the Human Development Atlas in Brazil, developed in partnership with the United Nations Development Programme (UNDP), the Institute of Applied Economic Research (IPEA) and the João Pinheiro Foundation (FJP) with data from the IBGE Demographic Censuses.

implies multiple causality, which is to say a combination of conditions that, in an average number of cases, produces a given phenomenon (Rihoux & Marx, 2013).

On the quantitative side, the technique is based on Boolean algebra, which demands that each case be reduced to a series of categorical variables. Therefore, QCA is an analytical approach that enables repetition. In addition, QCA allows for analyses on more than a small assembly of cases, which is rarely the case in qualitative studies. This is an interesting characteristic since it opens up the possibility of producing generalizations (Rihoux & Marx, 2013).

Rihoux et al. (2013) produced a systematic mapping of QCA applications and concluded that the main disciplines making use of it are those of political science, sociology, and administration. In the field of political science, QCA is a useful tool for macro analyses such as, for example, assessing the implementation of public policies (Sager & Rielle, 2012), coalitions in the context of political processes and transitions (Fischer, 2014), among other applications. In environmental studies, this technique has been used to analyze integrated regimes of water resource management (Huntjens et al., 2011) and the global water crisis (Srinivasan et al., 2012). In the water and sanitation sector, more specifically, a few studies stand out. These include Kaminsky & Javernick-Will's (2014) research on necessary factors to attain the social sustainability of sanitation infrastructure, and the research of Chatterley et al. (2014) on the sanitation conditions of schools in less developed countries. Also noteworthy is the study of Kaminsky & Jordan (2017) that, through the use of hypothetical data and a literature review, showcases where and how the method can be productively applied in research and practice on water, sanitation and hygiene.

The choice of applying QCA owes to the fact that this technique deals with two aspects of causal complexity that are of interest to the present study: multiple causality and equifinality. According to the principle of multiple causality, the outcome is generated by a combination of conditions, from a situation in which the effect of an explanatory factor depends on the presence, or alternatively the absence, of the conditions. Equifinality refers to the fact that different combinations are capable of producing the same outcome (Braumoeller, 2003).

The QCA methodology, according to Rihoux & Ragin (2009), can be applied through three main techniques: crisp-set (*csQCA* or simply QCA), multi-value (*mvQCA*) and fuzzy-set (*fsQCA*). *csQCA* was the original model developed by Charles Ragin in 1987. The two latter models are developments from that original model. A requirement of the original methodology is that data must be categorized as binary variables. The multi-value version maintains that requirement and a binary format in the result, but allows the use of several categories for the study conditions. In the fuzzy-set version – the closest to quantitative analysis – continuous variables (both conditions and result) are used in the range of 0 to 1, allowing for several intermediate scales.

For this study, the crisp-set version was chosen rather than the most sophisticated variation of the QCA (fuzzy-set) owing to the binary coding of the result. As presented below, the result of this project is the presence of four service provision models for water and sanitation, which cannot be continuously quantified. Furthermore, the multi-value version also proved not to be efficient as it generated individualized, non-holistic results. Indeed, according to Rihoux (2006), *csQCA* is more recommended in studies with a low number of cases.

In the present research, QCA was used after the execution of in-depth qualitative studies. The observations and analyses derived from this phase of the research constituted a theoretical and empirical foundation for the application of the QCA technique. They also influenced subsequent choices that were made throughout the application process. The application of the QCA

together with other methods for data analysis are encouraged by Schneider & Wagemann (2010):

‘QCA is particularly useful for combination with conventional (comparative) case studies. On the one hand, case studies help to acquire familiarity with the cases that are so indispensable both for generating the data (concept formation and measurement) and a meaningful interpretation of QCA results. On the other hand, due to its focus on complex causal structures, QCA solution terms provide more precise information about the analytically relevant similarities and differences between cases, by clustering them into different paths towards an outcome.’

Methods

To be able to perform the comparative analysis, it was initially necessary to have a more in-depth understanding of the problem, which was obtained through qualitative research. Thus, the investigative work was divided into two analytical phases, as presented in Figure 1.

The qualitative research performed in the first phase of the study consisted of semi-structured interviews with open-ended questions and no pre-established options for answers. For the interview, a list of topics was used as a guide to ensure that the interviewee addressed all the issues envisioned for this phase. The interview was relatively flexible. The questions did not have to be addressed in the order foreseen in the guide, which made it possible to formulate new questions throughout the course of the interview (Flick, 2011). In total, 45 people were interviewed in the eight municipalities visited.

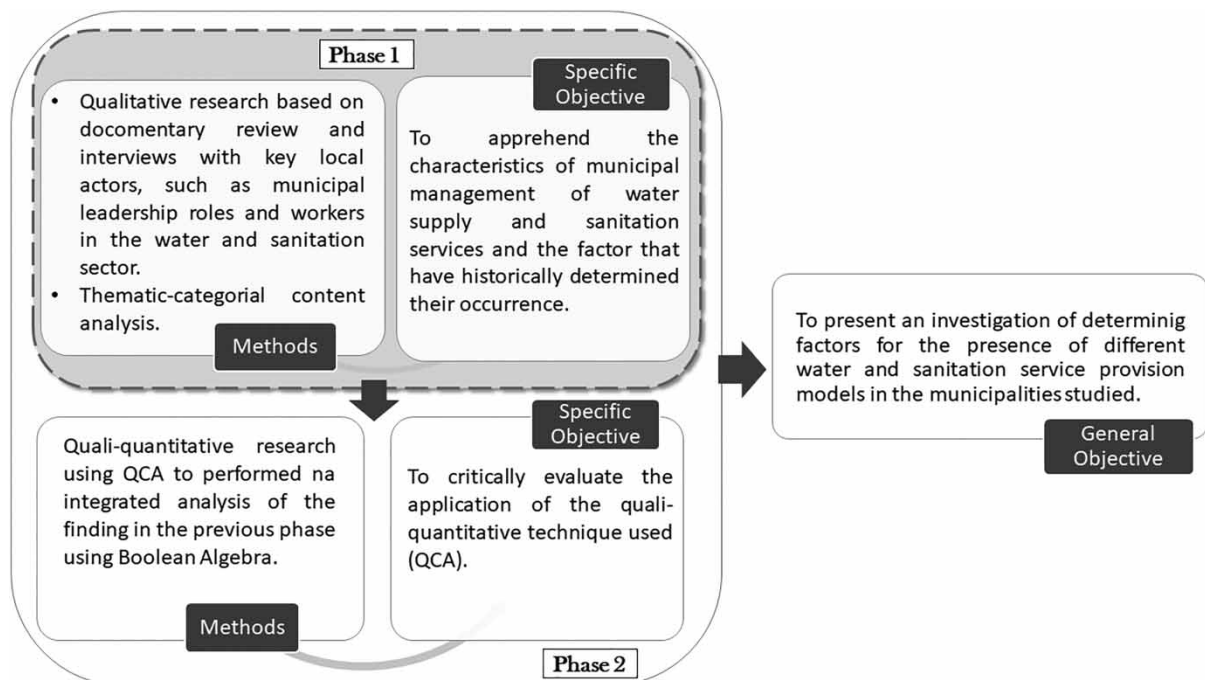


Fig. 1. Methodological procedure.

The number of interviews was not previously defined. As Bauer & Gaskell (2003) affirm, only by knowing and producing the sources of their investigation does the researcher acquire the conditions to evaluate the adequacy of the material already obtained to the objectives of the study. And as the data begin to repeat in the interviews and no novelty is added to the research, a point of saturation is attained at which point the interviews can be concluded.

The selection of participants was based on some previous requirements (Minayo, 2007), taking into account the objectives of obtaining a heterogeneity of views to represent the complexity of the subjects and reducing bias:

- Stakeholders from different sectors (executive power, legislative power, and water and sanitation service provider) and different periods in time, possessing the information and experience required, were given priority.
- A sufficient number of interviewees was considered in the interest of attaining repetition and saturation of information.
- The set of interviewees chosen was intended to capture the main similarities and differences regarding their understanding of the problems addressed.

Case studies

As Jordan *et al.* (2011) highlight, QCA is a promising technique for researchers interested in causal relationships that occur from variable-oriented approaches (quantitative – high-*N* sample size) through case-oriented approaches (qualitative –small-*N* sample size). Possessing a focus on qualitative analysis, the present study opted for a small *N*, in accordance with Rihoux & Ragin (2009), ranging from 2 to 10 cases.

Thus, eight municipalities from the state of Minas Gerais were chosen in such a fashion as to have two representatives of each management model:

- (DMA: Cambuquira⁵ and Itanhandu
- IMA: Carmo de Minas and Carmópolis de Minas
- SUC: Perdões (the state utility is responsible for water supply and sanitation) and Santo Antônio do Amparo (the state utility is only responsible for water supply, while sanitation services are directly managed by the city hall)
- private enterprise (PRIV): Bom Sucesso and Paraguaçu.

The county seat of the municipalities served as the reporting unit as well as the main management model for water supply services, as registered in the National Sanitation Information System (SNIS) in 2013 (Ministério das Cidades, 2013).

Another criterion considered for the selection of municipalities was the homogeneity of the population size. The study opted for an urban population range of 10 to 20 thousand inhabitants in the municipal seat and in the nearby geographic proximity.

⁵ Despite recent modifications in the provider of water and sanitation services, until 2014 the municipality operated via direct municipal administration, which was the reference model adopted for the aims of this study.

It is important to emphasize that, assuming the premise of in-depth knowledge of the case studies, the research intended to reach conclusions about the phenomenon studied with a focus on its intensity and not on quantification or statistical representation. As pointed out by Yin (1994), case studies are generalizable for theoretical propositions and not for populations or universes. Thus, the purpose of a research project based on case studies is to expand and generalize theories (analytical generalizations) and not to extrapolate probabilities (statistical generalization). By using multiple case studies, as in the present research, it is possible to draw a single set of cross-case conclusions. This is in line with the capacities of the QCA technique – or in the more narrow sense of the term, the ‘comparative method’ – as it is distinguishable, ‘in particular, from the ‘statistical method’, which proceeds on the basis of a large number of cases’ (Rihoux & Ragin, 2009). According to those authors, although QCA combines distinctive strengths of both the quantitative and the qualitative approaches, it is a technique more clearly located on the side of ‘case-oriented’ (qualitative) methods (Rihoux & Ragin, 2009).

Qualitative comparative analysis

QCA is an iterative process that, in accordance with Jordan *et al.* (2011), involves:

- the definition of a desired outcome;
- the identification of conditions that could influence this outcome, deliberated through a review of the literature and the case studies in question;
- the quantification and tabulation of the results and conditions of the multiple case studies;
- the identification of patterns in the outcome table to isolate conditions that support the outcome.

The solutions brought forth by this technique are presented in minimal combinations of presence/absence of the causal conditions that are necessary and/or sufficient to produce the outcome. In this study, the conditions were identified through the qualitative research carried out in Phase 1. The methodological sequence performed is shown in Figure 2.

Based on a content analysis of the interviews, 10 variable categories were created that demonstrated remarkable differences in the presence of service provision models for water and sanitation among the municipalities under analysis (Table 1).

Since the QCA technique demands a small number of conditions, it is common to use criteria that regroup several variables into one condition, as many studies have done (Huntjens *et al.*, 2011; Sager & Rielle, 2012; Srinivasan *et al.*, 2012; Kaminsky & Javernick-Will, 2014). Different conditions, or conditions that are categorized differently, can produce diverse outcomes. After a few attempts at performing the categorization, economic, political and sociocultural variables were consolidated as binary indicators, making a total of five conditions (political, economic, social, institutional, and legal) used in the QCA, as shown in Table 2. This process was adopted to optimize the presentation of the final results (in minimal, more reduced formulae) in a way that would be compatible with the realities observed during Phase 1 of the research.

Since the *cs*QCA technique with binary indicators was used in this research, the value of the sum of the variables comprising the indicators was cut in half whenever necessary. In cases where the cut-off point was a non-integer, as in economic and political indicators, for example, the decision was based on the in-depth knowledge of the cases obtained from the qualitative research phase. Different cut-offs were

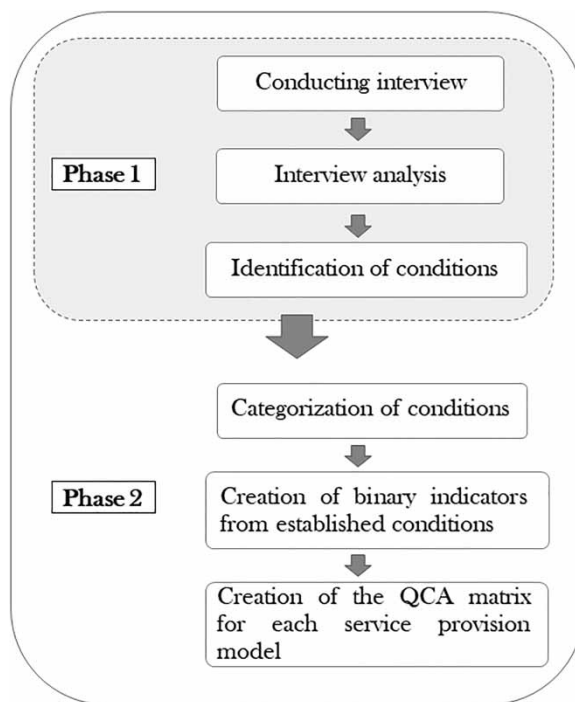


Fig. 2. Methodological sequence.

tested and this composition was the most compatible with the realities observed in the field and with the analysis of the interviews conducted in Phase 1 of the research.

The QCA matrix was initially designed containing the studied conditions and the duly categorized results. The presence of each of the four service provision models for water supply and sanitation under analysis was chosen as a desired outcome and, as cases, the eight selected municipalities. Since the outcome to be analyzed is the presence of four different management models, four different data matrices were created. As an example, the matrix of the DMA model is presented in [Table 3](#). The matrices for the other management models under analysis are identical, varying only in their outcomes (outcome code 1 signifies presence and outcome code 0 signifies absence). The analysis of the matrices were carried out with the Tosmana software ([Cronqvist, 2006](#)).

The QCA is based on the premise that different conditions combine rather than compete with one another in creating an outcome. Therefore, all logically possible combinations of the examined conditions are listed through Boolean operators. The three basic Boolean logical operators are *OR* (in QCA represented by +), *AND* (represented by *), and *NOT* (in QCA the negative is usually denoted in lowercase). With this basic language one can construct long and elaborate expressions, and perform a series of complex operations ([Fiss, 2007](#)).

The following step of constructing entry tables consisted of performing Boolean minimization. With a relatively small number of observed combinations, the QCA executes the minimization process. It is the instrument with which multiple causality patterns are identified and a tool to logically and holistically simplify the structures of complex data ([Dusa, 2010](#)). Thus, some causal combinations are excluded,

Table 1. Categorization of variables.

Value	Variable
Lack of municipal resources⁶	
0	Was a factor mentioned by 50% or more of the interviewees and the municipality possesses a high MHDI (0.700–0.799)
1	Was a factor mentioned by 50% or more of the interviewees and the municipality possesses an average MHDI (0.600–0.699)
Lack of access to government resources	
0	Was not a factor mentioned by the interviewees
1	Was a factor mentioned by at least 50% of the interviewees
2	Was a factor mentioned by at least 50% of the interviewees or the adoption of the service provision model for water and sanitation was perceived as an opportunity to overcome lack of access to government resources
Search for external resources	
0	The municipality did not request state or federal resources
1	The municipality received state or federal resources for water supply and sanitation in the past 5 years
2	The municipality requested state or federal resources and did not receive them
Influence of public administrator	
0	The executive municipal authorities do not adopt any particular posture intending to modify the current service provision model for water and sanitation
1	The executive municipal authorities adopt a posture demonstrating intention to modify the current service provision model for water and sanitation, but it was a factor mentioned in less than 50% of the interviewees
2	The executive municipal authorities adopt a posture demonstrating intention to modify the current service provision model for water and sanitation and it was a factor mentioned in more than 50% of the interviewees
Need for political contacts	
0	The municipal executive authorities did not use political contacts to facilitate/intermediate the adoption of the service provision model for water and sanitation
1	The municipal executive authorities used political contacts to facilitate/intermediate the adoption of the service provision model for water and sanitation
Political-party aspects	
0	Political groups did not show resistance or create opposition movements during the process of adopting and implementing the service provision model for water and sanitation
2	Political groups showed resistance or created opposition movements during the process of adopting and implementing the service provision model for water and sanitation
Social participation	
0	The public did not demonstrate in any organized fashion
1	The public was visibly contrary to the adoption of the determined service provision model for water and sanitation
2	Effective public participation in the process of adopting the service provision model for water and sanitation, via marches, demonstrations, or public hearings
Preoccupation with water and sanitation	
0	The supply of water supply services in the municipality was satisfactory
1	The supply of water supply services in the municipality was unsatisfactory but the population did not demand improvements
2	The supply of water supply services in the municipality was unsatisfactory but the population demanded improvements
Institutional aspects	
0	The municipality was seeking alternatives to improve the quality of the service provided independently of the specific characteristics of the management models
1	The municipality was seeking alternatives to improve the quality of the service provided, with a focus on particular aspects that were specific to the determined management models
Legal aspects	
0	Legislative or contractual matters with the provider of water and sanitation services were not taken into consideration in the adoption of the given model
1	Legislative or contractual matters with the provider of water and sanitation services were taken into consideration in the adoption of the given model

Table 2. Indicators created from the study variables.

Value	Indicator
Economic determinant	
0	Sum of the variables: lack of municipal resources, lack of access to government resources and search for external resources, lesser than or equal to 2
1	Sum of the variables: lack of municipal resources, lack of access to government resources and search for external resources, equal or greater than 3
Political determinant	
0	Sum of the variables: influence of public administrator, need for political contacts and political-party aspects, less than or equal to 3
1	Sum of the variables: influence of public administrator, need for political contacts and political-party aspects, equal to or greater than 4
Social determinant	
0	Sum of the variables: popular resistance to paying tariffs, social participation, and absence of preoccupation with the environment, less than or equal to 2
1	Sum of the variables: popular resistance to paying tariffs, social participation, and absence of preoccupation with the environment, equal to or greater than 3
Institutional determinant	
0	The municipality was seeking alternatives to improve the quality of the service provided independently of the specific characteristics of the management models
1	The municipality was seeking alternatives to improve the quality of the service provided, with a focus on particular aspects that were specific to the determined management models
Legal determinant	
0	Legislative or contractual matters with the provider of water and sanitation services were not taken into consideration in the adoption of the given model
1	Legislative or contractual matters with the provider of water and sanitation services were taken into consideration in the adoption of the given model

Table 3. DMA data matrix.

Cases	Conditions					Outcome Management model
	Econ. ^a	Pol. ^b	Soc. ^c	Inst. ^d	Leg. ^e	
Cambuquira	1	0	1	0	0	1
Itanhandu	0	1	0	0	0	1
Carmo de Minas	1	0	1	1	0	0
Carmópolis de Minas	1	1	0	1	0	0
Perdões	1	0	0	0	1	0
Santo Antônio do Amparo	1	1	0	0	0	0
Bom Sucesso	0	1	0	1	1	0
Paraguaçu	1	0	0	1	1	0

^aEconomic.^bPolitical.^cSocial.^dInstitutional.^eLegal.

enabling so-called prime implicants to be identified. The process of minimization is based on the following procedure: if two Boolean expressions differ in merely one condition of causality and produce the same outcome, the causal condition that distinguishes the two expressions can be considered irrelevant and removed from the equation to create a simpler combined expression.

For a better understanding, an example of Boolean minimization is:

$$A \times B \times C + A \times B \times c \rightarrow R \quad (1)$$

A, B, and C are the conditions and R is the result. Equation (1) can be interpreted as follows: the presence (capital letter) of A, combined with the presence of B and the presence of C *or* the presence of A, combined with the presence of B and the absence (lower case letter) of C lead to the occurrence of the result R. Thus, since the result is independent of the condition C, the equation should be represented as follows:

$$A \times B \rightarrow R \quad (2)$$

The resulting expression, Equation (2), is a prime implicant. These prime implicants represent which combinations of conditions are necessary or sufficient for the outcome to occur. They are the most reduced form possible of the solution. The outcome is a minimized logical solution or, in other words, the causal complexity reduced to its simplest form. For a small number of conditions, the minimization process can be performed manually. However, upon each new condition added to the analysis, the number of possible combinations expands exponentially. For further explanations about the QCA technique, see [Rihoux & Ragin \(2009\)](#).

Results

This section presents the results from the QCA matrices for each management model that was analyzed, supported by the qualitative analysis conducted as part of the research.

Direct municipal administration

The following combinations of determinants were found through the QCA analysis for the DMA model:

$$ECON \times pol \times SOC \times leg + POL \times soc \times inst \times leg \rightarrow DMA \quad (3)$$

For simplicity, Equation (3) can be rewritten as follows:

$$leg \times \begin{cases} ECON \times pol \times SOC \\ POL \times soc \times inst \end{cases} \rightarrow DMA$$

It can be inferred from the studied cases that the DMA model is maintained when a lack of municipal financial resources occurs together with a marked presence of social movements that are mobilized owing to lack of popular awareness. An unsustainable service provision model risks perpetuating

itself when the public opinion turns contrary to the modification of the model. This could mean by increasing tariffs or by the absence of a political factor, such as when political stakeholders on the municipal level take the initiative of changing the active configuration.

Another scenario that also produces the same outcome is the presence of a political factor paired with the absence of social and institutional questions. This occurs when municipal administrators, often changed exclusively according to the political cycle, are not aware of the necessity and importance of efficient provision for water and sanitation services. At the same time, a lack of popular demand produces a situation of inertia that also contributes to this outcome. Owing to this, initiatives to study new systems management alternatives remain neglected.

The absence of a legal factor is notable in both cases. Despite the existence in Brazil of specific legislation aiming to ensure the quality of water supply and sanitation services, conformity with the relevant legislative obligations was disregarded owing to the absence of regulation and monitoring. Consequently, the DMA model was maintained even when the services did not meet standards pertaining to the quality of drinking water and the proper disposal of wastes.

Indirect municipal administration

The following combinations of determinants were found through the QCA analysis for the IMA model:

$$ECON \times pol \times SOC \times leg + ECON \times POL \times soc \times leg \rightarrow IMA \quad (4)$$

For simplicity, Equation (4) can be rewritten as follows:

$$leg \times ECON \times \begin{cases} pol \times SOC \\ POL \times soc \end{cases} \rightarrow IMA$$

A lack of preoccupation for legal factors was also manifest in the presence of the IMA model. In the first scenario produced by the QCA analysis, the presence of economic and social questions was observed, identically to the DMA model. However, in this case, the indication of popular dissatisfaction with the services provided seemed to be an important factor that contributed to the adoption of a new service provision model.

When a social factor was not present, a political factor was notable. Thus, another possible scenario that also results in the presence of municipal local authorities is when a lack of municipal financial resources is paired with a strong political posture. In such cases, political-administrative training on the municipal level favors the search for alternative service management models, and the autonomy provided by the IMA model presents itself as an attractive characteristic.

State utility company

The following combinations of determinants were found through the QCA analysis for the SUC model:

$$ECON \times POL \times soc \times leg + ECON \times pol \times soc \times LEG \rightarrow SUC \quad (5)$$

For simplicity, Equation (5) can be rewritten as follows:

$$ECON \times soc \times \begin{cases} POL \times leg \\ pol \times LEG \end{cases} \rightarrow SUC$$

In opting to provide water and sanitation services via concession to state utilities, two factors are common to the resulting scenarios identified through QCA: the presence of economic factors together with the absence of social participation. In the first scenario, like the IMA model, the presence of political and economic factors is paired with the absence of social and legal determinants. However, when SUCs are present, the political factor, rather than seeking for autonomy, opted for the security and quality of a company with consolidated experience. The different outcomes also demonstrate the influence of the need for political contacts in order to adopt these models. In the municipalities under analysis, the adoption of local authorities and state companies relied on political contacts between municipal administrators and state or federal political leaders.

Another scenario is when political matters are absent, but the legal factor is more pronounced. The macro measures taken throughout the country's political history of water and sanitation services, which were characterized by a business-oriented view of this sector and were based on economic-financial feasibility criteria, had a determinant influence on the adoption of state utility companies for water and sanitation services.

Private enterprise

The following combinations of determinants were found through the QCA analysis for the PRIV model:

$$ECON \times pol \times soc \times LEG + econ \times POL \times soc \times INST \times LEG \rightarrow PRIV \quad (6)$$

For simplicity, Equation (6) can be rewritten as follows:

$$soc \times LEG \times \begin{cases} ECON \times pol \\ econ \times POL \times INST \end{cases} \rightarrow PRIV$$

The same combination of determinants that results in the presence of an SUC can also lead to the concession of services to a PRIV: the absence of political and social factors paired with the presence of economic and legal determinants. In the case of private initiative, the modernization of the legal and judicial framework (Law on Concessions, Law on Water and Sanitation, and the Law on Public-Private Partnerships) provided security to investors, guaranteeing the presence and growth of this model in the sector with consolidated legal and regulatory structures.

The importance of the legal factor is also notable in the second proposed scenario, which is produced even when economic questions are not determinant. In this situation, the model's institutional characteristics prevail according to public administrators, who associate the model with better quality and more efficient service provision. In addition to the legal and institutional factors, the presence of a political factor and absence of a social determinant are observed. This combination can result in a lack of transparency and the absence of social control during the process of granting the concession.

Discussion

The expressions attained through the QCA indicate that the options of models for water and sanitation service provision are influenced by determinants of various types, as advanced by [Castro \(2012\)](#) and [Heller et al. \(2014\)](#). Therefore, it is important that analyses of the water and sanitation sector perceive it as an essential public policy, as opposed to a vision that sees these services as a marketable good subject to economic forces.

As [Britto et al. \(2012\)](#) highlight, it appears necessary to seek out cross-cutting perspectives that consider phenomena in their complexity and interdependency. In this respect, the present article's findings, attained via application of the QCA technique, expose the dependence of public policies for water and sanitation services on the social-political-economic context, as highlighted by [Heller & Castro \(2007\)](#).

In economic terms, the main determinants that inspired initiatives for new management models for the provision of water and sanitation services were a lack of municipal resources required for investments and dependence on the federal government for financial resources. However, as indicated by [Almeida & Moraes \(2015\)](#) and [Van den Brandeler et al. \(2014\)](#), there are several obstacles to accessing public funds for water and sanitation in Brazil due to the sector's entangled institutional structure. To overcome this challenge, commitment of an actor with political influence sometimes appears necessary.

However, financial resources alone are not sufficient to provide effective services. For [Estache & Kouassi \(2002\)](#), ongoing financing of the sector in Africa without significant improvements in efficiency attests to a major waste of scarce resources. The authors show that a country's institutional capacity, as well as the quality of its governance, are significant driving factors in the performance of water utilities. Lower corruption and adequate governance – issues that appear to be a global problem – are associated with better coverage levels. In the present article, in terms of political context, the influence of public managers and political parties in decision-making were also identified as key determinants.

Social participation was also highlighted in this research as a determinant factor for the presence of different service provision models for water and sanitation. Local demonstrations were reported in most of the municipalities studied, often in association with resistance to paying tariffs. If, on the one hand, civil society's participation exerts influence on the management of water and sanitation services, on the other, its absence also has consequences. As [Teixeira & Heller \(2003\)](#) emphasize, when decisions are made exclusively by governments and managers, investments in the water and sanitation sector privilege political demands – not always legitimate ones – to the detriment of social interests.

The study has limitations in its capacity to produce generalizations from its findings owing to its focus on a few municipalities with a defined population size in a specific Brazilian region. It is known that a number of determining factors emerged in studies developed with other case studies. For example, the number of users is an important point of attraction for water and sanitation providers ([Rossoni, 2015](#)). Other factors capable of influencing the choice of a management model include a range of complex local political processes related to patronage politics, union interests, electoral issues, and pressures exerted by the state level of government, among others ([Nunes et al., 2010](#)). In addition, the municipalities under study are located in Brazil's Southeast region, which is the most developed region in the country and, thus, certainly influences the results.

However, despite these limitations, the empirical findings from the case studies validate the theoretical factors highlighted by [Pinto et al. \(2015\)](#) as characteristics of the different management models that were studied. Indeed, social participation is more accentuated in the municipal models such as DMA and

IMA; economic performance is cited to justify the adoption of the PRIV model, alleging increased efficiency and process optimization; political factors are identified in association with the DMA model, which presented greater propensity of political interference, such as decision-making based on projected electoral gains.

With regard to the research methodology, a few limitations were identified in the applied technique's capacity to produce generalizations in this study. While Rihoux (2006) and Rihoux & Ragin (2009) present the QCA technique as being initially applicable to a small or medium-size quantity of cases, in the mapping of Rihoux et al. (2013) the authors point out the high number of cases (an average of 23) used in the analyses. In QCA, beyond the number of case studies, the number of conditions is essential to properly apply the technique, making it necessary to achieve balance between these two factors (Schneider & Wagemann, 2010). This is similar to statistical models, in which many independent variables weaken the outcome since the coefficients can appear not to be significant. Regarding the number of conditions adopted, the median found in the survey of Rihoux et al. (2013) was five. In otherwise usual practice, this number varies between four and six conditions, while the most ever observed is nine (Rihoux et al., 2013).

Compared to Rihoux et al. (2013), although the total number of conditions used in this research is within the usual standard, the number of cases studied was relatively low. Despite Huntjens et al. (2011) having obtained satisfactory findings in comparing eight cases of water management regimes through the *mvQCA*, the outcome – consisting of levels of policy learning within river basin committees – was dichotomous. Moreover, in the present research, there are four different results characterized by the adoption of service provision models – DMA, IMA, SUC, and PRIV – meaning that only two cases were analyzed at a time.

Regardless of the technique's ability to provide an adequate generalization, the resulting combinations of conditions explaining the presence of the different service provision models for water and sanitation clearly illustrate the situations of the municipalities under analysis. These combinations also complement some of the findings of Rossoni (2015); namely, those related to discrepancies in the implementation of policies by the relevant public authorities (political factors) and the public's response to water and sanitation problems (social factors).

Conclusion

This article presents an investigation of determining factors for the presence of certain service provision models for water supply and sanitation in Brazil. It also assesses the application of QCA, aiming to identify those determinants through a comparison of four different models: DMA, IMA, SUC, and private enterprise. Scientific publications adopting such a perspective are scarce as this approach applies a different rationale than that which is more commonly studied, which evaluates only the efficiency and efficacy of the models.

The use of QCA in eight Brazilian municipalities provided an in-depth understanding of the present subject. Through the case studies it can be affirmed that political, economic, social, cultural, and legal factors influence the process by which management models for the provision of water and sanitation services are adopted, implemented, and maintained. Moreover, these factors are intimately tied to the historical trajectory of water and sanitation services in Brazil. Certain periods in Brazil's history were important milestones in determining service provision models in the country. Examples include the

creation of autonomous water and sanitation services with the support of a federal autarchy, the Special Public Health Service Foundation (FSESP), in the 1950s; the creation of state utility companies, implemented via the National Plan for Water and Sewage (PLANASA), in the 1970s; and the adoption of neoliberal ideology by the federal government in the 1990s.

Based on the expressions obtained through QCA, it is concluded that economic and political factors are determinants for the presence of the four service provision models under analysis. However, the processes that unfolded in each of the different locations, considering their diverse contexts and different combinations of influential determinants, led to a variety of outcomes. While social questions were notable in municipal-level management models (DMA and IMA), legal questions were more strongly associated with concession-based models (SUC and PRIV). The institutional characteristics of the private model also proved to be important for this option.

Identical scenarios were observed for the presence of the different management models, with some determinants having contributed to the eventual adoption of one model or another. In this respect, the particularly determinant factors were: social demonstrations for the maintenance of the DMA model and the adoption of the IMA; political positioning for the choice of the IMA or SUC models; and legal questions as key comparative factors in the choice between SUC or PRIV.

As described above, the present study was limited to municipalities with a restricted population size (between 10 and 20 thousand inhabitants) and in a specific region of Brazil. Therefore, it presents limitations regarding the generalization of its findings with respect to other population sizes. New research is recommended in other locations with different characteristics. Different service provision models existing in other countries should also be assessed.

The QCA proved to be a technique capable of compiling information in the present analysis as it revealed how the determinants were inter-related and enabled the identification of predominant factors for each of the studied management models. It is recommended that future studies take certain precautions in applying the technique, notably to carefully assess the number of case studies to be performed and to establish a dichotomous outcome. Those factors are identified in the literature as key hindrances for research of this nature.

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