

Article

Transparency and Digitalization in Water Services: Reality or Still a Dream?

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Abstract: The provision of public services, mostly by local governments, has been widely analyzed in the scientific literature. The relevance of these services has generated an incipient demand for information on the part of citizens, which makes it necessary for the bodies responsible for their provision to present adequate levels of transparency. In this context, digitalization is a crucial tool for providing information to citizens and, therefore, contributing to improving the levels of transparency of those organizations that provide public services. Among these, the drinking water supply service stands out, which is crucial for well-being and sustainable progress, and whose analysis is of vital importance, especially in countries such as Spain affected by factors such as climate change and urbanization. In this way, the aim of this paper is to analyze the degree of transparency of the companies providing water supply services in Spain, as well as their degree of digitalization. To this end, a relationship will be established between the Transparency Index of Public Enterprises (INDEP) and the Strategic Project for Economic Recovery and Transformation (PERTE), which measure the degree of transparency and digitalization, respectively. This relationship will be established for a sample of 59 companies responsible for water supply. The main results derived from this study show a wide margin for improvement on the part of the companies analyzed, both in terms of transparency and digitalization, as the vast majority of these companies show a medium–low degree of compliance in both aspects.

Keywords: transparency; water supply management; public services; digitalization; performance



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1. Introduction

The provision of public services is a widely studied and analyzed topic in the scientific literature [1–3]. Among these, the water supply service is one of the most studied in the scientific literature due to its importance, even more so considering the growing concern that exists due to the incipient scarcity of drinking water worldwide [1–7]. These services, the vast majority of which are provided by local governments [8], play a particularly important role in the daily lives of all citizens, as they have a direct impact on their well-being and quality of life [9].

Due to the significant influence of these services on citizens' lives, there has been an emerging demand for information from citizens, which has put pressure on public bodies to strive for higher levels of transparency. Transparency is generally regarded as a key element of good governance, and several studies have tried to highlight the factors influencing government transparency [10–15]. Access to information has become a fundamental right in many democratic countries, which has made transparency a priority for public administrations [8]. In this way, transparency plays a crucial role in facilitating accountability to citizens, allowing them to access and process government data that can provide them with valuable information, thus enabling them to judge the decisions made by the agents responsible for the provision of public services [11].

However, this need to provide useful information to citizens is not limited to local governments, but transcends to the companies in charge of providing different public services [8,16]. In order to achieve transparency in these companies, several authors advocate the need to invest in appropriate technologies to establish coordination systems that ensure the updating and reuse of information. In this way, digitalization will have a positive impact on transparency issues, as well as on the decision making carried out by water utilities [17,18].

Furthermore, in the context of water utilities, several authors identify significant advantages of digitalization, such as helping to improve efficiency and reduce costs, facilitating the monitoring and control of resource use, and facilitating access to information by administrations, stakeholders and citizens, allowing for more accountable and democratic management, helping to raise customer awareness of the value of water, and being financially sustainable through optimal operation and sustainable investments [19,20].

Given the importance of transparency in public entities and, by extension, in companies dedicated to the provision of public services, and the positive effect of digitalization on it, as well as on the performance of these companies, it is important to have measures of their compliance with transparency and digitalization standards. The publication of rankings of municipalities could encourage local authorities to improve communication tools and interaction with citizens in order to achieve a more open, accountable, and participatory government [21] (See Figure 1).

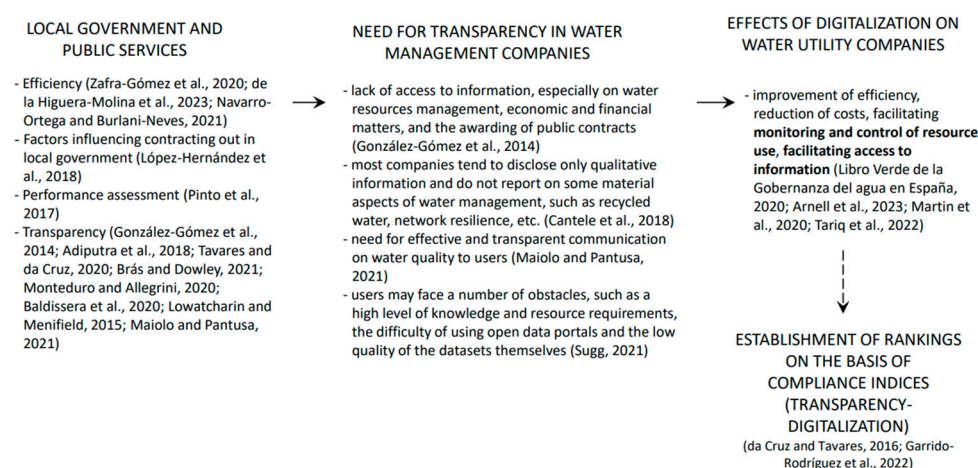


Figure 1. Key elements identified in the literature for the creation of rankings based on compliance indices [1,3,4,6–8,10–16,19–26].

In this scenario, the Transparency Index of Public Enterprises (INDEP) acquires special relevance, as it seeks to not only measure the levels of transparency of public enterprises, but also to promote an increase in the availability of information, facilitating its access to citizens and society in general [27]. This need for transparency has motivated the implementation of state action plans such as the Strategic Project for Economic Recovery and Transformation (PERTE) for the digitalization of the water cycle, whose purpose is to promote the use of new information technologies in the water cycle in order to improve its management and efficiency, as well as to ensure compliance with international regulations [28].

In this context, the main objective of this work is to analyze the degree of compliance of Spanish water companies based on Law 19/2013, of 9 December, on transparency, access to public information and good governance, as well as the management and degree of digitalization of these companies. To this end, the Transparency Index of Public Companies (INDEP) will be used, as well as the lines of action of Strategic Projects for Economic Recovery and Transformation (PERTE), for a sample of 59 water supply companies from the 100 most populated municipalities nationwide. The main contributions of this study reveal a wide margin for improvement on the part of the companies analyzed both in terms of transparency and digitalization. The novelty of this study lies in the analysis and

relationship between water companies' transparency and their level of digitalization, a key aspect of emerging interest among academics. This comprehensive approach provides a unique perspective on the interconnection between transparency and the adoption of digital technologies in the sector, identifying specific areas for improvements that can boost efficiency and accountability in water utility management.

The rest of this paper is structured as follows: First, a literature review is carried out to establish a contextual framework in relation to the transparency and digitalization of water supply companies. Next, the methodology used to achieve the main objective of this study is presented, followed by the main results obtained after the application of the methodology. Finally, some final conclusions are presented, as well as the future lines of action that we have identified in carrying out this work.

2. Literature Review

2.1. Transparency in Water Service

Transparency is one of the requirements often cited as a basis for trust in governments [29]. Focusing on local government, transparency can be defined as the disclosure of the various actions carried out by local governments with the purpose of providing information of relevance to citizens, constituting an important democratic value that fosters trust and governmental accountability [30,31]. Authors such as da Cruz et al. [21] highlight transparency as an essential principle within public administrations that allows them to inform citizens of why, how, what and how much they are involved in the performance of their activities.

Moreover, in recent years, several studies have tried to highlight the factors that influence transparency in public administrations, especially at the local level, as shown in Figure 2. These include factors such as the size of the municipality, population density, per capita income, educational level of the population, financial autonomy of the municipality, the level of indebtedness per capita, the degree of outsourcing, etc.

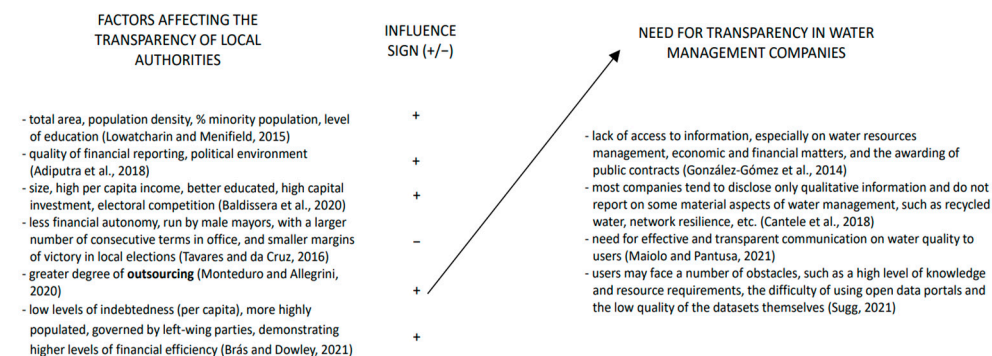


Figure 2. Main issues addressed by the recent literature on the transparency of local authorities and water utilities [8,10–16,23,24].

The incipient interest generated by this field of research, derived from the growing demand for public information, led to the development of regulations at a global level and, specifically in Spain, of Law 19/2013, of 9 December, on transparency, access to public information and good governance, whose entry into force urges local governments to provide the information necessary to be able to judge their actions [32].

There is no universal regulation of transparency, which implies a great diversity of regulations related to transparency and access to information. Thus, there are various ways of measuring transparency and organizations that develop indices to assess the degree of transparency of public bodies. In this sense, different indexes have been developed that try to measure the compliance of local administrations with their transparency obligations [22].

Among the public services for the provision of which local governments are responsible, water supply is one of the most studied due to its vital importance [3] and its provision is mandatory for local governments in many countries [4,5]. Such is its importance that the

United Nations, in the General Assembly Resolution of 28 July 2010, recognized access to water and sanitation as one of the fundamental and necessary human rights [33].

In the case of Spain, different management models coexist. Specifically, Navarro and Burlani [6] estimate that 35% of water supply services in Spain are managed by public entities, 33% by private companies, 22% by mixed companies, and the remaining 10% directly by municipal services.

Monteduro and Allegrini [13] attempt to analyze the impact that the provision of public services through outsourcing would have on the voluntary electronic disclosure of performance information by local administrations, compared to the option of direct provision of these services, reaching the conclusion that a higher degree of outsourcing would lead to a higher probability of greater voluntary disclosure of information on the basis of agency theory and the theory of organizational information processing.

According to the above, a higher degree of outsourcing should favor the transparency of local entities, which is especially relevant in relation to essential services for the population such as water supply, given that their mismanagement would have a strong impact on their welfare [12].

This need for transparency can be extrapolated to companies in charge of water management, where the lack of access to information, especially regarding water resource management, economic–financial matters, and the awarding of public contracts, generates opacity and difficulty of citizen control [8]. In this context, on 16 December 2020, the European Parliament formally adopted the revised Drinking Water Directive. The Directive entered into force in January 2021, and among its novelties was the need for effective and transparent communication to users about water quality to foster user confidence [16].

Despite this, some studies show shortcomings in relation to the disclosure of information by water utilities. These shortcomings refer to the fact that most companies tend to disclose only qualitative information and do not report on some material aspects of water management, such as recycled water, network resilience, etc., which would contribute to protecting this fundamental resource and sustainable development in general [23]. On the other hand, Sugg [24] indicates that the ability of end-users being able to benefit from the information provided by companies is affected because these users may face a number of barriers, such as a high level of knowledge and resources required, difficulty in using open data portals, and the low quality of the datasets themselves.

2.2. Digitalization in Water Service

In recent years, digitalization has been presented as a fundamental tool for providing citizens with equal access to information and knowledge of the actions carried out by public bodies [34]. In this sense, digitalization has been defined by various authors throughout the literature. Thus, this concept can be broadly defined as a basic component of the fourth industrial revolution, due to its great impact on consumers, societies, and businesses around the world [35].

In the business context, digital transformation goes beyond the application of digital technologies to optimize business processes and reorganizes processes to change the business logic of a company [36]. Boyle et al. [34] mention some benefits of digital transformation for utilities, including increased flexibility and transparency, greater efficiency, better management of operations in the short and long term, and a better understanding of infrastructure and system performance, which will help to improve their maintenance and development.

In the case of entities that provide public water services, the need to achieve these benefits is even more evident, given the current situation, in which factors such as climate change or increased urbanization could have significant effects on water resources, which is especially evident in countries such as Spain [3]. On the other hand, the current water governance framework in Spain is complex, as it involves numerous actors with different responsibilities [28], which can make digitalization a key element for improving governance.

In the context of water supply, digitalization offers several significant advantages. Digitalization can help to improve efficiency and reduce costs by streamlining administration and management procedures, facilitating the monitoring and control of resource use and status, and making it easier for administrations, stakeholders, researchers and citizens to access all this information, allowing for more transparent, accountable and democratic management [19]. Along these lines, Arnell et al. [20] identify a number of benefits associated with digitization in water utilities, including helping utilities to be predictive and proactive, using models for monitoring and decision support, helping to raise customer awareness of the value of water, and being financially sustainable through optimal operation and sustainable investments.

On the other hand, authors such as Martin et al. [25] and Tariq et al. [26] highlight the need to digitize distribution networks, which provide up-to-date information on the management and distribution of water resources. This is very useful, as it allows for the identification and prevention of potential problems [37,38]. According to data published by the National Institute of Statistics (INE) [39], in 2020, the percentage of water losses over the volume of water supplied to the public supply network amounted to 15.36%. Thus, digitalization presents a valid solution to address the challenges related to unrecorded water losses [40].

In this sense, digitizing water distribution networks brings several environmental, social and economic benefits. In relation to the latter, authors such as Quaranta et al. [41] estimate that, in the member countries of the European Union, as well as in the United Kingdom, digitalization could bring an average of EUR 13.2 per person per year, which would motivate these countries to invest in digitizing the water sector [42].

However, despite the benefits that digitalization can bring to the sector, there are also some barriers that could delay progress, such as a lack of staff with the necessary skills to understand the value of data and their use for improved management, as well as insufficient funding [34]. To address these barriers, various actions can be found, such as the Spanish Government's Recovery, Transformation and Resilience Plan, approving twelve strategic projects for economic recovery and transformation (PERTE), including the Digitalization of the Water Cycle.

In this strategic project, digitalization plays a crucial role in achieving its objectives, which include the search for more efficient and sustainable water management, as well as accelerating the digital transition of the water cycle through investments and reforms that enhance the application of new technologies to the water cycle and the development of digital competences and skills [28]. In this way, the aforementioned barriers to digitalization are recognized and a series of actions are planned to mitigate them and thus achieve the modernization and sustainability of water management. This project defines four lines of action that cover the entire water cycle management, referring to the different agents involved in it, and focused on promoting digitalization and fostering training in digital skills in all sectors, administrations, technological companies and users, for the correct implementation of the PERTE and the promotion of adaptation to climate change.

2.3. Relationship between Transparency and Digitalization

In all the lines of action envisaged in the PERTE for the Digitalization of Water, the objective is to increase efficiency and transparency in water management. With regard to transparency, objective "B" consists of *"increasing transparency in water management in Spain and the information available to administrations, users, consumers and associations in general in order to establish the basis for raising awareness among the population and water users of the responsible and sustainable use of water and to strengthen and develop the capacities of the management bodies of the integral water cycle"* ([28] p. 12). In this way, through digitalization, it is possible to monitor and computerize information that can be of great relevance to society as a whole and thus be aware of how and where entities use their resources, such as the percentage of water meters that are more than ten years old and therefore need to be replaced with newer ones and ensure a proper service delivery [43] (see Figure 3).

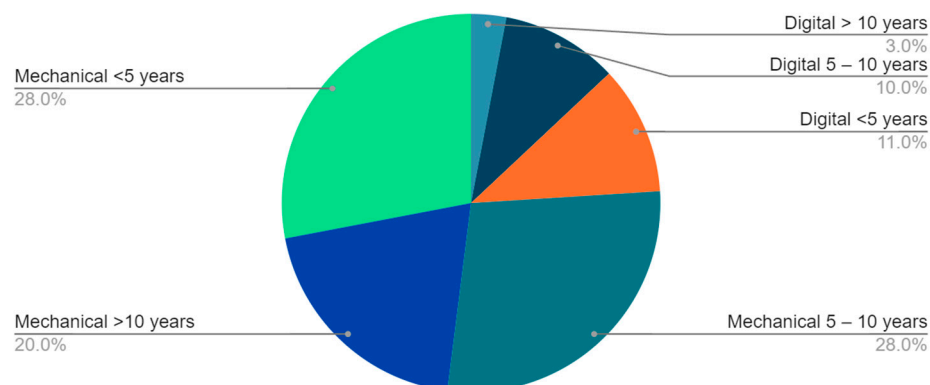


Figure 3. Meter renewal needs in 2022. Source: Spanish Water Supply and Sanitation Association (AEAS).

Although transparency is identified with the disclosure of information by entities and, therefore, with the availability of data to different users, the simple publication of data is not considered sufficient, and features such as ease of use, real-time data provision and comparability are important to achieve transparency [44]. In complex governance models such as water management, adequate coordination between the different actors involved is essential. Interoperability of systems must be ensured. For this whole system to work, it is necessary to invest in the right technologies and to generate coordination and mutual support systems that ensure that information flows, that some of it is not lost, that it is up to date and that it is reusable [17].

Several studies recognize the positive effect of digitalization on transparency in management and decision making in water supply management companies [18,41]. In line with this author, Stein et al. [45] highlight the need to take digitalization into account as an important element within the water sector, which will make it possible to propose digital solutions that achieve or improve transparency and efficiency in decision making within integrated water resources management. However, while acknowledging the positive effect of digitalization on transparency, authors such as Lowe et al. [18] also point out the dangers that could arise from the use of, for example, artificial intelligence, as transparency and explainability are increasingly difficult to achieve in such applications.

3. Methodology and Data

The methodology developed, which is based on the use of the Transparency Index of Public Enterprises (INDEP) as well as the action lines of Strategic Projects for Economic Recovery and Transformation (PERTE) as fundamental tools to analyze the transparency and management of public and mixed entities, as well as to measure the degree of digitalization of the water cycle, is detailed below.

3.1. Data

In order to achieve the objective of this work, an exhaustive research and analysis of the most relevant water supply companies has been carried out. To carry out this study, a sample of 59 companies responsible for water supply, belonging to the 100 most populated municipalities of Spain, has been selected. The size of these municipalities was determined on the basis of article 121 of Law 7/1985, (incorporated by Law 53/2003, on measures for the modernization of local government), which defines the category “large population municipalities”, which classifies as such municipalities that meet at least one of the following characteristics: they have more than 250,000 inhabitants, are provincial capitals with a population of more than 175,000 inhabitants, or are regional capitals (see Appendix A).

3.2. Methodology

3.2.1. Proposed Approach to Assess the Degree of Transparency through the Transparency Index of Public Companies (INDEP)

This paper aims to analyze and study the compliance of these companies with the active disclosure obligations established in the Law on Transparency, Access to Public Information and Good Governance 19/2013 of state level (LTAIBG). For this purpose, an evaluation of each of the 59 companies responsible for water supply has been carried out by searching and matching the information required for each of the indicators that make up the Transparency Index of public entities obtained from the transparency portals of each of these companies. This index is composed of 60 indicators that are grouped, in turn, into 6 areas of evaluation [27].

However, within the framework of this research, it should be noted that the water supply companies under study are not exclusively limited to publicly owned entities, as this study includes public–private partnership, as well as companies whose nature is private. Article 3 of Law 19/2013 establishes as other obligated subjects political parties, trade union organizations and business organizations, as well as private entities that receive during the period of one year public aid or subsidies in an amount greater than EUR 100,000 or when at least 40% of their total annual income has the character of public aid or subsidy, provided that they reach at least the amount of EUR 5000. In the context of this study, despite the fact that the index is mainly aimed at companies of a public nature, its choice is based on the regulatory imposition established by the Law on Transparency, Access to Public Information and Good Governance 19/2013 of state scope. This legislation designates, among others, certain entities as obligated subjects, thus justifying the choice of such an index as a relevant indicator for the proposed analysis [46].

In this study, of the 59 water supply companies selected, 27 operate a public management model, 22 follow a public–private partnership, and 10 are privately managed (see Appendix A).

3.2.2. Proposed Approach to Assess the Degree of Digitalization through the Action Lines of Strategic Projects for Economic Recovery and Transformation (PERTE)

This paper aims to analyze and study the degree of compliance with digitalization, for which an exhaustive review of the indicators that make up the lines of action of the PERTE for the 59 companies responsible for water supply corresponding to the 100 most populated municipalities of Spain has been carried out. Likewise, the main objective of this study is to check how digitalization is progressing in water supply companies, as well as to analyze the relationship between digitalization and transparency of information to the public.

PERTE is an innovative public–private partnership instrument whose main objective in terms of the digitalization of the water cycle is to achieve improvements in the efficiency and sustainability of water management based on three fundamental pillars: digitalization, innovation, and training. This main objective is further broken down into four specific objectives. Firstly, the aim is to improve the understanding of water uses in order to contribute to an integrated management of resources. Secondly, and thirdly, it aims to increase transparency in water management and to contribute to the achievement of environmental objectives. Finally, the objective is based on the creation of highly qualified jobs from the technical point of view [28]. The objective of the present work is oriented towards the analysis of the level of compliance in the achievement of such objectives.

The PERTE is made up of 22 indicators (see Appendix B) that make up the 4 lines of action into which it is divided and which are detailed below:

- Line of action 1: Improvement of governance in water use management (6 indicators).
- Line of action 2: Promoting the digitalization of basin organizations (6 indicators).
- Line of action 3: Development of aid programs for the promotion of digitalization for the different water users (5 indicators).

- Line of action 4: Promotion of training and innovation in digital competencies in water administration and management (4 indicators).

After analyzing and reviewing each of the indicators that make up the four lines of action mentioned above, significant limitations have been identified. There is a lack of information related to action line 1 from the water supply companies. This line of action, corresponding to the updating of regulations, is only available in the Official State Gazette; so, these indicators will not be included in the index as this updating of regulations does not correspond to the water supply companies. As for action line 3, which deals with the subsidies granted to the companies, only 1 indicator has been used, due to the fact that currently only a provisional resolution is available corresponding to the first call for subsidies in competitive concurrence for the development of projects to improve the efficiency of the urban water cycle. In relation to action line 4, 3 of the 4 indicators established have been retained. Consequently, a restricted index is established, which was initially composed of 22 indicators, but as a result of the limitations identified during the course of this study, it is reduced to a total of 8 indicators (see Appendix B).

For the evaluation of the indicators of the strategic project for economic recovery and transformation, an approach based on dichotomous indicators has been adopted.

The water utilities being managed by different management models and covering different population sizes have meant that some of the indicators are not available on the websites or have been difficult to find.

4. Results

After carrying out the evaluation of the Transparency Index and the Strategic Project for the Recovery and Economic Transformation of the water supply companies [27,28], through the measurement of the indicators that these companies should take into account, the results shown in the following Table 1 have been obtained.

Table 1. Results and rankings obtained in the evaluation of the Transparency Index of public utilities and the Strategic Project for the Recovery and Economic Transformation of the Water Cycle in Spain.

Water Company	Ranking INDEP/PERTE		INDEP	PERTE	Water Company	Ranking INDEP/PERTE		INDEP	PERTE
Emasesa	1	8	83.33%	63%	Chiclana natural	31	44	36.67%	38%
Ayto Logroño	2	17	75%	50%	Aguas de Añarbe	32	26	35%	50%
Agua municipal de Terrasa	3	37	71.67%	38%	Aguas de Avilés	33	27	35%	50%
Aquavall	4	51	71.67%	25%	Hidralia	34	28	33%	50%
Ematsa	5	2	68.33%	75%	Emmasa	35	29	31.66%	50%
Emaya	6	18	66.67%	38%	Aguas de Albacete	36	30	30%	50%
Mancomunidad de la Comarca de Pamplona	7	52	65%	25%	Aqualia	37	5	28.33%	75%
Canal de Isabel II	8	19	63.33%	63%	Global Omnium	38	13	26.67%	63%
Concello de Lugo	9	38	63.33%	38%	Canaragua	39	31	26.67%	50%
Aigües de Barcelona	10	1	60%	88%	Emalgesa	40	32	26.67%	50%
Aguas de León	11	20	60%	50%	Aguas de Alicante	41	45	26.67%	38%
Emasagra	12	21	60%	50%	Aigües de Sabadell	42	46	26.67%	38%
Aguas de Cádiz	13	3	58.33%	75%	Agamed	43	33	23.33%	50%
Aguas de Elche	14	9	58.33%	63%	Emalsa	44	14	23.33%	63%
Aguas de l'horta	15	22	58.33%	50%	Hidrografia	45	6	20%	75%
Emasa	16	39	58.33%	38%	Aquona	46	34	20%	50%

Table 1. Cont.

Water Company	Ranking INDEP/PERTE		INDEP	PERTE	Water Company	Ranking INDEP/PERTE		INDEP	PERTE
Emacsa	17	40	56.67%	50%	Empresa Municipal Aguas de Gijón	47	47	20%	38%
Aguas de Huelva	18	10	56.67%	63%	Aigües de Girona	48	35	18.33%	50%
Aguas de Lorca	19	23	56.67%	50%	Viaqua	49	15	15%	63%
Aguas de Murcia	20	4	55%	75%	Aguas de Alcalá	50	48	13.33%	38%
Consortio de aguas Bilbao Bizkaia	21	41	55%	50%	Aquajerez	51	57	13.33%	13%
Amvisa	22	11	51.67%	63%	Ayto Zaragoza	52	7	13.33%	63%
Aigües de Mataró	23	42	50%	38%	Facsa	53	36	13.33%	50%
Acosol	24	24	48.33%	50%	Sorea	54	49	13.33%	38%
Aguas de Telde	25	25	46.67%	50%	Gestagua	55	58	13.33%	13%
Teidagua	26	43	45%	38%	Aguas de Burgos	56	16	10%	63%
Apemsa	27	53	45%	25%	Guadalagua	57	59	10%	13%
Aguas de Reus	28	12	43.33%	63%	Tagus	58	50	6.67%	38%
Emalcsa	29	54	43.33%	25%	Aguas de El Ejido	59	56	6.67%	25%
Aguas de Manresa	30	55	40%	25%					

The results show that none of the companies evaluated achieve 100% of the score. Only 3.4% of these companies achieve full compliance with the law, according to the “traffic light” evaluation system, followed by 35.6%, which comply with the law but show deficiencies, and the majority, 61%, do not comply with it.

From these data, the companies Emasesa, Logroño City Council, Agua municipal de Terrasa and Aquavall stand out as those offering the highest level of transparency, with 83.33%, 75% and 71.67%, respectively. This allows citizens to obtain greater access to the information offered by the companies or city councils of their city regarding the water supply service; so, it can be guaranteed that the cities of Logroño, Terrasa, Seville and Valladolid comply with the principle of transparency and access to information and have a transparency portal on their websites.

In the evaluation of water cycle management companies with the Transparency Index, it has been observed that the greatest compliance with the Transparency Law is in the area of prevention of corruption and compliance with transparency and good governance. However, the area of active transparency and company information and the economic-financial area are indicators that need to be improved.

On the other hand, Aguas de Burgos, Guadalajara, Tagus and Aguas de El Ejido have a very low compliance with the principle of transparency with respect to the rest of the companies. Aguas de Burgos and Guadalajara comply with barely 10% of the indicators established by INDEP, and Tagus and Aguas de El Ejido with 6.67%, which denotes a lack of disclosure of information on water supply in the cities of Burgos, El Ejido, Toledo and Guadalajara. An important feature to highlight is that none of these companies contain a transparency portal on its website and present a lack of information in all areas proposed by the Transparency Index.

After the INDEP evaluation, the PERTE evaluation has been carried out, using the eight indicators with a current possibility of measurement, due to the early implementation of the water cycle plan.

The Table 1 shows, as in the INDEP evaluation, that none of the water supply companies achieve 100% effectiveness in terms of service digitalization, reflecting the need for technological progress in terms of service provision. The companies with the highest scores are Aigües de Barcelona, Ematsa, Aguas de Cádiz, Aguas de Murcia, Aqualia and Hidrogea, with 88% and 75%, respectively.

There are 31 water supply companies that exceed 50% of the PERTE and remain below 75%, which are positive results in terms of the involvement of the companies in moving towards the digitalization of the water cycle.

In terms of those with the worst results in their evaluation are Guadalajara, Gestagua and Aquajerez, the three private companies that have obtained 13% in terms of the digital development of the water service, guaranteeing only two of the eight indicators to which the PERTE has been limited.

Thus, with the data obtained from the Transparency Index of public entities and the Strategic Project for the recovery and economic transformation of the 59 water supply companies, a comparative analysis has been made regarding the disclosure of information offered to the users of this public service and the direct relationship it maintains with the development of the digitalization of the water cycle of these companies.

For this purpose, a position ranking of the results of each index has been carried out to check the differences in terms of transparency and digitalization. Table 1 shows how there are differences between the position of the water supply companies between INDEP and PERTE. Only 3% of the water supply companies are aligned in terms of transparency and digitalization.

In the first positions of the Transparency Index of public companies, it can be observed that there is a delay in the digitalization of the water cycle, especially in the case of the public companies Agua municipal de Terrasa, Aquavall and the Mancomunidad de la Comarca de Pamplona. All three have major deficiencies in digitalization with respect to the transparency offered by them, thus causing possible shortcomings in the transparency of water supply management.

However, it is observed that the City Council of Zaragoza and Aguas de Burgos, despite the lack of transparency in terms of the information disclosed in the provision of this public service, ensure its adequate digitalization, facilitating administrative procedures and the control of the use of this natural resource for citizens.

Among the 59 water supply companies, Canal de Isabel II supplies the Autonomous Community of Madrid or Aiguës de Barcelona, which manages the entire province. There is also the case of companies that supply several municipalities in a province (see Appendix A). It has been found that companies that serve a higher population density are more transparent and digitized in terms of water service management on the website compared to those that only cover smaller municipalities.

It should be noted that the different management models of these companies (contracting out, public–private partnership or direct model) are not decisive in ensuring better transparency or digitalization of the water service (see Appendix C). It should also be mentioned that the private water supply companies Aqualia, Global Omnium, Emalsa and Hidrogea occupy low positions within the transparency ranking; nevertheless, in the ranking elaborated with the PERTE indicators, these show a wide development in terms of digitalization of the service.

Having commented on the main results of INDEP and PERTE, Table 2 shows the most noteworthy results in a descriptive analysis of the two indexes:

Table 2. Average, maximum and minimum scores of the water supply companies in each index.

INDEX	Average%	Max%	Min%
INDEP	39.85%	83.33%	6.67%
PERTE	48.00%	88%	13%

This Table 2 shows the average percentage of compliance with each of the indicators under study, as well as the maximum and minimum percentage of compliance with the indices in the total of the 59 water supply companies.

As can be seen, the PERTE evaluation is more demanding than the INDEP since the average PERTE score is 48% compared to 39.85% for the INDEP despite the adjustment

made for the PERTE evaluation. Both indexes must improve both at the level of compliance with the Transparency Law and the development of digitalization, as neither covers at least 50% compliance.

In terms of the maximum score obtained for each index, 83.33% is the highest percentage of compliance in the INDEP study and 88% in the PERTE study.

Finally, the minimum score is very notable in both indicators, although INDEP (6.67%) is the one that gives the lowest percentage of transparency of the water supply service to citizens with respect to the digital improvements suggested by PERTE (13%).

5. Conclusions

Currently, given the various socio-political crises that have occurred in recent years, transparency in the public sector has taken on great importance, and public information has experienced a growing demand from a large segment of the population. Therefore, there is a need to promote transparency in public administrations in order to increase public confidence. On the other hand, access to drinking water plays an essential role in the well-being of society and the sustainable progress of a community. In larger urban areas, the need for water increases considerably, bringing with it additional challenges in terms of infrastructure, quality of services and sustainability. Consequently, it is crucial to examine and understand the dynamics of the entities responsible for supplying this vital resource in highly populated urban environments. As a consequence of this and due to the increasing demand for water and the essential role it plays for life, the need arises to address energy efficiency in water supply systems as well as data digitalization. In order to address this, strategic projects for economic recovery and transformation are created to enable the digitalization of the water cycle.

In this context, an analysis of the 59 water companies responsible for water supply belonging to the 100 municipalities with the largest population at the national level has been carried out in this paper, for which two different approaches have been used. First, an approach is proposed to evaluate the degree of transparency through the Transparency Index of Public Companies (INDEP). In terms of the application of this approach, only 22 of the 59 water companies exceeded more than 50% compliance with the indicators. Furthermore, none of the companies evaluated exceeded 100% compliance, with Emasesa being the company with the highest level of compliance, achieving 83.33% in the evaluation. Therefore, it can be concluded that it will be necessary to continue investigating in this area in order to raise the transparency standards in the water companies and make the Transparency Index a dynamic tool that allows for the analysis of information.

In the second phase of this research, a second approach has been implemented to evaluate the degree of digitalization of the 59 water companies, using the Strategic Projects for Economic Recovery and Transformation (PERTE) action lines as indicators. PERTE is made up of 22 indicators, divided by four lines of action. However, at the time of conducting the study, a series of limitations were identified as regards obtaining information for the preparation of this research; finally, eight indicators were evaluated, and we concluded that none of these achieve 100% effectiveness in terms of service digitalization, expressing the need to advance technologically in terms of service digitalization. The company that obtained the highest score is Aigües de Barcelona, with a score of 88%, compared to Guadalagua, which obtained only 13%.

Although transparency in the provision of public services is enhanced with digitalization, in the case of water supply companies, this has not been reflected in this way since the companies present different results in terms of transparency and digitalization, thus causing a disconnection between the two, making accessibility to information and process optimization difficult. It could be confirmed that barely 3% of these companies are aligned in these aspects. Regulation plays a very important role in the efficiency of transparency, water supply and its digitization. However, regulation could improve this issue by taking a number of actions, such as establishing clearer and more specific regulations that incentivize digitization by increasing subsidies to encourage the implementation of digital

technologies in water management. Another possible improvement measure would be to establish accountability mechanisms such as the creation or contracting of independent regulatory companies to evaluate the performance of water utilities in terms of digitization and transparency, as well as to establish sanctions for non-compliance. However, a number of actions could be carried out by those responsible, such as assessing and periodically updating the regulations in order to have up-to-date information reflecting technological and digital developments. In line with these actions, it is proposed to develop public awareness programs. These programs aim to educate society on the importance of sustainable water use and the need to actively participate in practices that promote water efficiency.

As future lines of research, it would be interesting to evaluate all the lines of action proposed by PERTE to check the degree of commitment on the part of water supply companies and thus be able to compare whether they are fulfilled to a greater or lesser extent with respect to the results obtained in this work. It would also be interesting to analyze the correlation of the different management models and the results obtained from the indices proposed in this study. On the other hand, the growing interest in AI in recent years has led companies around the world to integrate algorithms into their decision-making processes [47]. In this sense, it is of particular interest to analyze how this implementation contributes to or hinders transparency in water supply service providers, addressing technical aspects of the implementation of these algorithms in service management, as well as the different communication challenges that may arise as a result. Based on the above, analyzing whether the convergence between AI, transparency and digitalization of the water cycle offers greater accountability on the part of public entities, as well as greater sustainability and stability in the management of this service, may prove to be a particularly relevant topic in a constantly evolving global context.

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Appendix A

Descriptive water supply companies.

Table A1. Municipality and management model of water supply companies in Spain.

Water Companies	Municipality	Management Model
Acosol	Mijas (Málaga)	Public
Agamed	Torreveja (Alicante)	*PPP
Agua municipal de Terrasa	Terrasa (Barcelona)	Public
Aguas de Albacete	Albacete	Public
Aguas de Alcalá	Alcalá de Henares (Madrid)	Public
Aguas de Alicante	Alicante	PPP
Aguas de Añarbe	San Sebastian (Guipúzcoa)	Public
Aguas de Avilés	Avilés (Asturias)	PPP
Aguas de Burgos	Burgos	Public
Aguas de Cádiz	Cádiz	Public
Aguas de El Ejido	El Ejido (Almería)	PPP
Aguas de Elche	Elche (Alicante)	PPP
Aguas de Huelva	Huelva	PPP
Aguas de l'horta	Torrent (Valencia)	PPP

Table A1. Cont.

Water Companies	Municipality	Management Model
Aguas de León	León	PPP
Aguas de Lorca	Lorca (Murcia)	PPP
Aguas de Manresa	Manresa (Barcelona)	Public
Aguas de Murcia	Murcia	PPP
Aguas de Reus	Reus (Tarragona)	Public
Aguas de Telde	Teldes (Las Palmas)	PPP
Aguavall	Valladolid	Public
Aigües de Barcelona	Barcelona, L' Hospitalet de Llobregat, Badalona, Santa coloma de Gramanet, Cornellà de Gramanet, sant Boi de Llobregat, Rubí	PPP
Aigües de Girona	Girona	Public
Aigües de Mataró	Mataró (Barcelona)	Privatization
Aigües de Sabadell	Sabadell (Barcelona)	PPP
Amvisa	Vitoria (Álava)	Privatization
Apemsa	El Puerto de Santa María (Cádiz)	PPP
Aquajerez	Jerez de la Frontera (Cádiz)	Public
Aqualia	Vigo, Oviedo, Almería, Santander, Badajoz, Salamanca, Lérida, Jaén, Talavera de la Reina, Vélez-Málaga	Public
Aquona	Ciudad Real y Palencia	Privatization
Ayto Logroño	Logroño	Public
Ayto Zaragoza	Zaragoza	Public
Canal de Isabel II	Madrid, Móstoles, Fuenlabrada, Leganés, Getafe, Alcorcón, Torrejón de Ardoz, Parla, Alcobendas, Las Rozas, San Sebastián de los Reyes, Pozuelo de Alarcón, Rivas-Vaciamadrid, Coslada, Valdemoro (Madrid); Cáceres	Public
Canaragua	Arona (S.C.Tenerife)	PPP
Chiclana natural	Chiclana de la Frontera (Cádiz)	Public
Concello de Lugo	Lugo	Public
Consortio de aguas Bilbao	Bilbao, Baracaldo, Getxo	Public
Bizkaia		
Emacsa	Córdoba	Privatization
Emalcsa	A Coruña	Public
Emalgesa	Algeciras (Cádiz)	PPP
Emalsa	Las Palmas de Gran Canaria	PPP
Emasa	Málaga	Public
Emasagra	Granada	PPP
Emasesa	Dos Hermanas, Alcalá de Guadaíra, Sevilla	Public
Ematsa	Tarragona	PPP
Emaya	Palma de Mallorca	Public
Emmasa	Santa Cruz de Tenerife	PPP
Empresa Municipal de Aguas de Gijón	Gijón	Public
Facsa	Castellón de la Plana	Privatization
Gestagua	Fuengirola (Málaga)	Privatization
Global Omnium	Valencia	Public
Guadalagua	Guadalajara	PPP
Hidralia	Roquetas de Mar (Almería) y Marbella (Málaga)	Privatization
Hidrogrea	Cartagena (Murcia)	Privatization
Mancomunidad de la Comarca de Pamplona	Pamplona	Public
Sorea	San Cugat del Vallés (Barcelona)	Privatization
Tagus	Toledo	Public
Teidagua	San Cristóbal de la Laguna (S.C.Tenerife)	PPP
Viaqua	Ourense, Santiago de Compostela y Pontevedra	Privatization

Note: *PPP: Public–Private Partnership.

Appendix B

Table A2. Lines of action and indicators PERTE.

Lines of Actions	Indicators
1. Improvement of governance in the management of water uses.	1.1. Modification of the Revised Text of the Water Law (TRLA).
	1.2. Transposition of the new Directive on the quality of water intended for human consumption.
	1.3. Modification of the Public Hydraulic Domain Regulations (RDPH).
	1.4. Updating of the Ministerial Order regulating the systems for effective control of the volumes of water used and discharges.
	1.5. Updating of the Ministerial Order developing the legal regime of the entities collaborating with the water administration.
	1.6. New Royal Decree regulating the content and operation of the Spanish Water Observatory and the seal of transparent water management.
2. Promotion of the digitalization of basin organizations.	2.1. Digitalization of the administrative management of the water administration. *
	2.2. Implementation of the electronic Water Register, giving decisive impetus to the work currently underway and the start-up of the Central Water Database.
	2.3. Promotion of the technological development of the Hydrological Information networks, in relation to the management of hydrological data, the control of water uses and compliance with ecological flows. *
	2.4. Promotion and progress in the numerical modeling of the hydrological cycle. *
	2.5. Action program for the digital modeling of state-owned hydraulic works using BIM methodology and a specific program for the digitalization of the entire safety cycle of dams and reservoirs.
	2.6. Improvement of existing computer systems for water status and quality. *
	2.7. Drawing up the Digital Water Book.
3. Development of aid programs to promote digitalization for different water users.	3.1. First call for subsidies in competitive concurrence for singular programs for the digitalization of the urban water cycle. *
	3.2. Distribution of funds to the Autonomous Regions at the Sectoral Conference on the Environment.
	3.3. Second call for subsidies for urban water cycle digitalization programs.
	3.4. Call for subsidies in competitive concurrence of singular programs for the digitalization of Irrigation Communities and Groundwater User Communities.
	3.5. Call for subsidies in competitive concurrence for singular digitization projects in water management in the industrial sector.
4. Promotion of training and innovation in digital competences in water administration and management.	4.1. Preparation of technical guides, recommendations and informative materials. *
	4.2. Specific internal training and innovation programs for staff involved in digitalization.
	4.3. Development and collaboration in specific R&D&I projects for water management. *
	4.4. Development of dissemination and training campaigns aimed at citizens and water users. *

Note: * The indicators marked in bold type are used in the study.

Appendix C

Table A3. Percentage of transparency and digitalization according to the management models of water supply in Spain.

	Model Management		
	Public	Contracting Out	PPP
Transparency	40.7%	30%	40.9%
Digitalization	51.8%	70%	72.7%

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