



Comprehensive Regulation of Water Services. Why Quality of Service and Economic Costs Cannot be Considered Separately

Enrique Cabrera Jr.¹ · Elvira Estruch-Juan¹ · Elena Gómez¹ · Roberto del Teso¹

Received: 15 October 2021 / Accepted: 20 May 2022
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Abstract

Regulation in the water sector emerged as a formula to protect customers from the natural monopoly that conforms water and wastewater services. As there is little information about regulatory practices in the sector around the world, information has been collected through a survey sent to water regulators. The results of the survey provided enough information to understand how the different utilities' behaviours are regulated and the methodologies used. Among all the behaviours to be regulated, economic and quality of service regulation emerge as key aspects from a technical point of view. The first one supervises utilities' costs and tariffs while the second, the standards the service is provided. However, it has been detected that these aspects are regulated separately and the quality of service does not have an impact on economic regulation. This work quantifies the impact that the quality of services has on costs and the consequences derived from not considering it in the economic regulation. In addition, this study also lists all the different aspect of the quality of service with an impact on costs.

Keywords Regulation of water services · Regulation · Quality of service · Economic regulation · Urban water services

1 Introduction

In 2010 United Nations declared clean drinking water and sanitation to be an essential human right (UN 2010). However, they are often provided as network services operating under a natural monopoly, as the cost of supplying the service is lower if the demand is satisfied by one supplier than by more (Posner 1969).

Water regulators are the governmental answer to protect customers against possible monopolistic practices (Cabrera and Cabrera 2016). The aim of the regulation of water services, according to Marques (2011), is (i) to protect customer's interests, (ii) promote

✉ Elvira Estruch-Juan
maesjua1@ita.upv.es

¹ ITA, Universitat Politècnica de València, València, Spain

efficiency and innovation in the sector and (iii) ensure the stability, sustainability and resilience of the water and sewerage services.

The centralized regulation of water services is already well established in the water sector and is becoming an essential element for governance. There are more than 159 centralised water regulatory frameworks (namely, regulators) around the world, at a national or regional level. This figure has been obtained by the authors considering as a base line the list of water regulators collected by Marques (Marques 2011) and updating it, together with data from The Regulators Forum organised by the International Water Association and WAREG, the European Water Regulators Association (WAREG 2022).

The regulatory approach in the water sector varies widely as it depends on different legal and institutional traditions and it is influenced by local issues such as water scarcity, etc. (Salveti and Canneva 2017). Regulation in this sector differs depending on the body in charge of the regulation (municipalities, national or regional body), areas regulated (quality of service, economic regulation, etc.), regulatory methods employed, etc. The Lisbon Charter (IWA 2015) sets a broad framework that establishes the principles for sound public policy and effective regulation of water services.

Regardless of the regulatory framework adopted, there are functions that all regulators should follow in order to reach an integrated sound approach. Traditionally water regulation has been divided in two main independent areas: economic regulation and technical or quality of the service regulation (Cabrera 2016; Marques 2011).

Economic regulation supervises that expenses are prudent and prices are just (Beecher and Kalmbach 2013), protecting customers from monopolistic practices. If well implemented, economic regulation can promote efficiency and sustainability in utilities. Otherwise, it can cause important inefficiencies such as poorly designed tariffs that may not succeed in allocating the water appropriately between different consumers, non-recovered total costs, lack of incentives for minimising water production costs and a waste of economic resources when the costs of regulation exceed the benefits it provides (Mann 1993).

Quality of service regulation, technical regulation, or even called social regulation, targets to supervise health, safety, customer protection and environment (Vinnari 2006). The key issues to be observed for the provision of water services are covered by the ISO 24510 Standard (ISO 2007).

This separation of regulatory tasks may lead to the belief that these two regulatory areas are independent and can be implemented separately. However, regulating prices without considering the quality of the provided service may lead to wrong conclusions.

There is a trade-off between quality of service and utilities' technical efficiency as this one is based into the utility cost benefit relationship (Picazo-Tadeo et al. 2008). This means that quality of service has an influence on companies' costs. This correlation is clear in competitive markets where prices depend on the level of service provided. This is why there are companies offering lower prices in exchange for a lower quality of service and vice-versa. Both models succeed as they are addressed to different types of customers (Cabrera 2016). However, when water services are provided under a natural monopoly, customers cannot choose their provider, or their preferred cost-quality ratio. Therefore, as customers constitute a captive demand, there are little incentives for utilities to provide a service of quality.

In practice, tariffs do not usually depend on the quality of service provided, but rather on political reasons (Pulido-Velázquez et al. 2014). Reducing the quality of service will reduce costs and increase profits when tariffs remain constant (Cabrera 2016).

For this reason, regulators should not only control that the minimum established Quality of Service (QoS) levels are met. They should also ensure that the QoS factors affecting

costs are considered in economic regulation, in order to avoid the punishment of high-quality performance utilities for being “less efficient” (as efficiency is often considered as delivering the service at the minimum possible cost). In this way, a fair price for customers can be set according to the quality of service level received.

The novelty of this work is that, in first place, it centralizes and analyses the actual regulatory practices and methods used in the water sector. Nowadays there is little information about regulation and the available one is either outdated or decentralized. Secondly, this paper determines the quality of service aspects affecting costs, based on the ISO 24510 Standard. Finally, it aims to quantify the impact of the quality of the service in utilities’ costs, demonstrating that its assessment should be intrinsically linked to economic regulation. In other words, regulators should consider all aspects of service quality in order to set a fair price for the services.

2 Current Regulatory Practices in the Water Sector

In order to analyse the regulatory practices in the water sector, a survey was prepared and disseminated to all regulators on record.

The survey focused on how the economic regulation is performed and whether it considers the quality of service. It was divided in different areas:

- Characterisation of the regulator
- Economic regulation
- Comparative performance assessment between utilities
- Quality of the service

The analysis of the survey results does not intend to cast a judgement on the actual regulatory practices of the regulators that answered the survey.

2.1 Description of the Sample

The survey was sent to 159 water regulators and 44 replies were received (28%) from 31 different countries (some countries have several regional regulators). All data collected correspond to the year 2019.

The replies to the survey were mainly received from regulators located in America and Europe, with a few answers from Africa and Oceania as seen in Fig. 1a. The authors consider this a representative sample of the sector, given the percentage of regulators represented in the survey and their geographic diversity.

All regulators that replied to the survey were in charge of the regulation of water supply services. Additionally, most of them also regulated the sewerage and wastewater treatment services. More than the half of the sample also covered other services such as gas supply, electricity supply, telecommunications or solid waste services (Fig. 1b).

The survey asked the type of regulation performed according to the 5 behavioural characteristics defined by Baptista (2014). Figure 1c shows that all regulators of the sample supervised the economic aspect of the services. Only the 73% of them were also in charge of the quality of service regulation. 57% of regulators supervised the legal and contractual aspects, 48% the consumers’ interface and 41% the drinking water quality. This does not mean that some of these aspects were not regulated, as in some cases there is more than

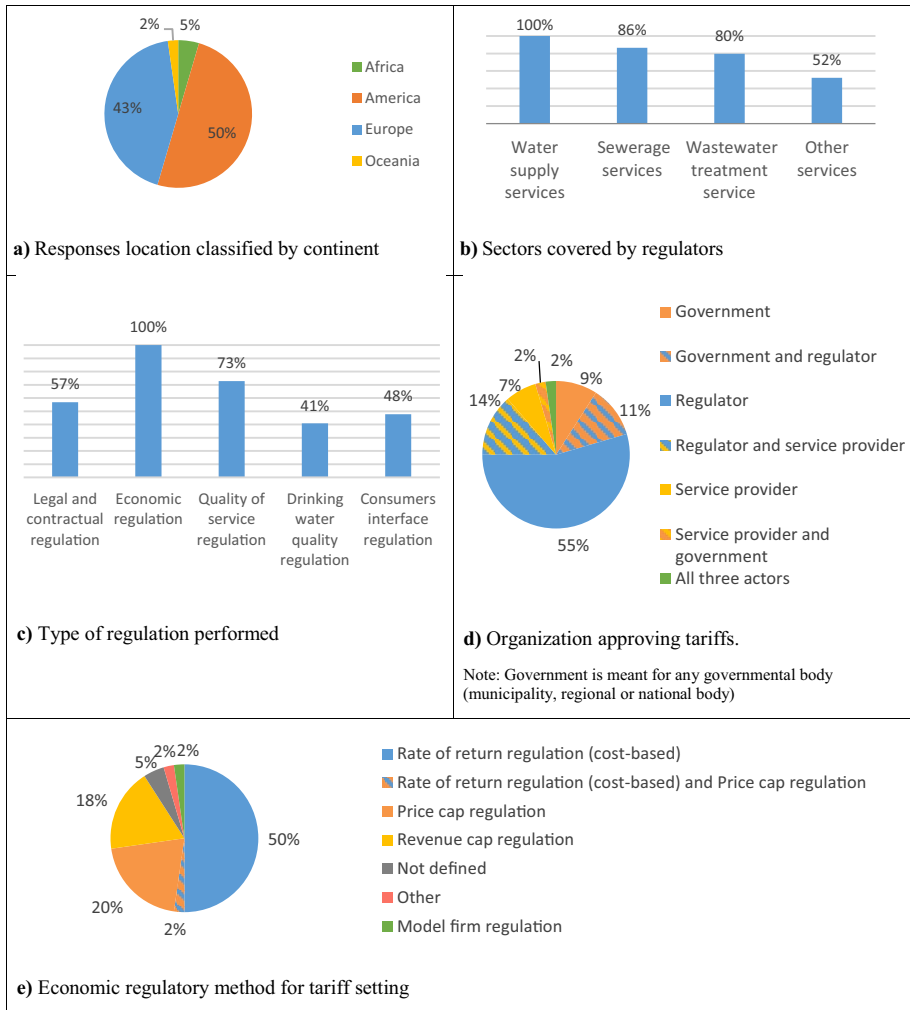


Fig. 1 Results of the survey: Sample description and economic regulation (data from 2019)

one regulator, each one covering different aspects. For instance, OFWAT (Office of Water Services), the regulator of England and Wales, covers the economic, quality of service and customers interface regulation (OFWAT 2019) and the Drinking Water Inspectorate (DWI) is in charge of the quality of the water served in the same area (Drinking Water Inspectorate 2017).

2.2 Economic Regulation

Regulators were asked about the body in charge of establishing tariffs. 3 main actors were identified: the regulator, the service provider and the government (any governmental body, e.g. municipality, regional or national body).

Figure 1d reveals that regulators are the main actors approving tariffs, participating in 82% of the cases (either as a single entity – 55% of cases – or in conjunction with water providers or the government). Governments participate in 24% of the cases (alone, together with the regulator or the water service provider). Finally, water service providers are present in 25% of cases. In 7% of the cases, they are the sole tariff approving body.

Concerning the economic method used for setting tariffs, the options according to the survey were rate of return, price cap, revenue cap and model firm regulation. These methods are briefly described below.

Rate of return (ROR) is historically the most widely used economic regulatory method (Rossi and Ruzzier 2001), used even when there is no economic regulatory body (Marques 2011), for instance in franchise regulation. This method offers the lowest risk for utilities, as they are allowed to recover costs with a pre-established profit.

The other economic regulatory approaches consist in using performance incentives that encourage cost reduction when setting tariffs. There are 4 main methods: price cap, revenue cap, yardstick competition and model firm regulation.

Price cap method establishes the maximum price a company can charge for the service. Revenue cap fixes the revenues obtained by a utility. It is similar to price cap but utility has freedom to establish tariffs as the tariffs structure and concepts are not controlled.

In Yardstick competition the performance of different utilities is compared with the aim of simulating a competitive market (Marques 2006). It can be used either in quality of service regulation (sunshine regulation) and/or in economic regulation. In the case of economic regulation, its results are used for setting tariffs. In its purest form, tariffs are set using the results from the best in class (best results and lowest costs). On its hybrid form, it is combined with price cap or revenue cap methods.

Finally, model firm regulation consists on the comparison of utility performance against a model firm which is a hypothetical utility based in the same area, with an optimum network system and operating efficiently (Ferro and Romero 2009). Therefore, environmental factors that affect comparisons between different utilities are suppressed.

Figure 1e displays the different economic methods used by regulators for approving tariffs and the percentage of regulators using them. As observed, the preferred method in the sector is the rate of return regulation, used by half of the sample. It is followed by price cap regulation (20%) and revenue cap (18%).

The remaining regulators either use a model firm regulation approach (2%), a combination between rate of return and price cap (2%) or other methods such as regulation based in goals. In this last one, performance goals are set for utilities. Then, tariffs are revised according to the achievement of these goals. Finally, 5% of the regulators did not establish methods for the tariff setting process.

These setting tariffs methods were analysed in conjunction with the information on who is establishing them. An analysis of the data reveals that:

1. Price cap regulation is a method only used when regulators play a relevant role in the tariffs setting procedure.
2. In all the cases when there is no methodology used for setting tariffs, the service providers are the body setting tariffs.
3. Rate of return is the preferred methodology in the sector and it is used regardless of the body establishing tariffs.

4. Usually, when a government body is involved in the tariff setting process, price cap is not used. Rate of return is applied or revenue cap regulation, being both of them the most conservative approaches.
5. Model firm regulation and regulation by performance goals are the least implemented methods in the sector. They are only used when a regulator is present in the tariff setting process.

2.3 Comparative Performance Assessment Between Utilities

The use of comparative performance assessment systems is a practice often used by regulators, as it may stimulate competition between utilities. It consists in the comparison of utilities' performance through performance metrics (such as performance indicators or indices) in order to identify who is the best performer in each of the evaluated areas (Cabrera et al. 2011).

This section analyses comparative performance and the role this analysis plays in the regulatory system. Comparative performance assessment results can be applied in both quality of service and economic regulations.

When applied for quality of service regulation, comparative performance assessment is carried out through performance assessment systems (with performance indicators or other measures). The results are used to supervise if the quality of service standards are met.

When applied for economic regulation, it is used for setting tariffs with methods that use performance incentives (as previously described). In this case, the tools used are performance indicators or/and econometric methods that can be non-parametric (Data envelopment analysis–DEA) or parametric (Ordinary Least Squares – OLS, Stochastic frontier analysis – SFA, etc.).

An analysis of results discloses that more than three-quarters of the sample perform comparative performance assessment. From them, the preferred method are performance indicators, as seen in Fig. 2a. Econometric methods are also used by a small but non-negligible number of regulators (alone or combined with performance indicators).

Concerning to the use given by regulators to comparative assessment, half of them use it to oversee the quality of service. 20% uses it to set tariffs and 5% for both (Fig. 2b). The remaining regulators do not compare performance between utilities.

2.4 Quality of Service

One of the main objectives of the survey was to analyse the impact of the quality of service in the economic regulation. For this reason, regulators were asked about the practices used to promote such quality. As Fig. 2c shows, the preferred action by regulators is to penalise or reward companies according to their quality of service. The public exposure of performance results (sunshine regulation, or “name and shame”) is also popular among regulators.

Other practices for promoting the quality of service make use of tariffs, threats to revoke the license or the comparative assessment between utilities. However, there is a significant percentage of regulators (25%) without any practices established for promoting the quality of service.

Only 70% of regulators consider quality of service aspects when assessing the efficiency of utilities. The remaining 30% do not contemplate the cost that the provision of a higher quality service has when assessing the efficiency of the utility. This fact could penalise

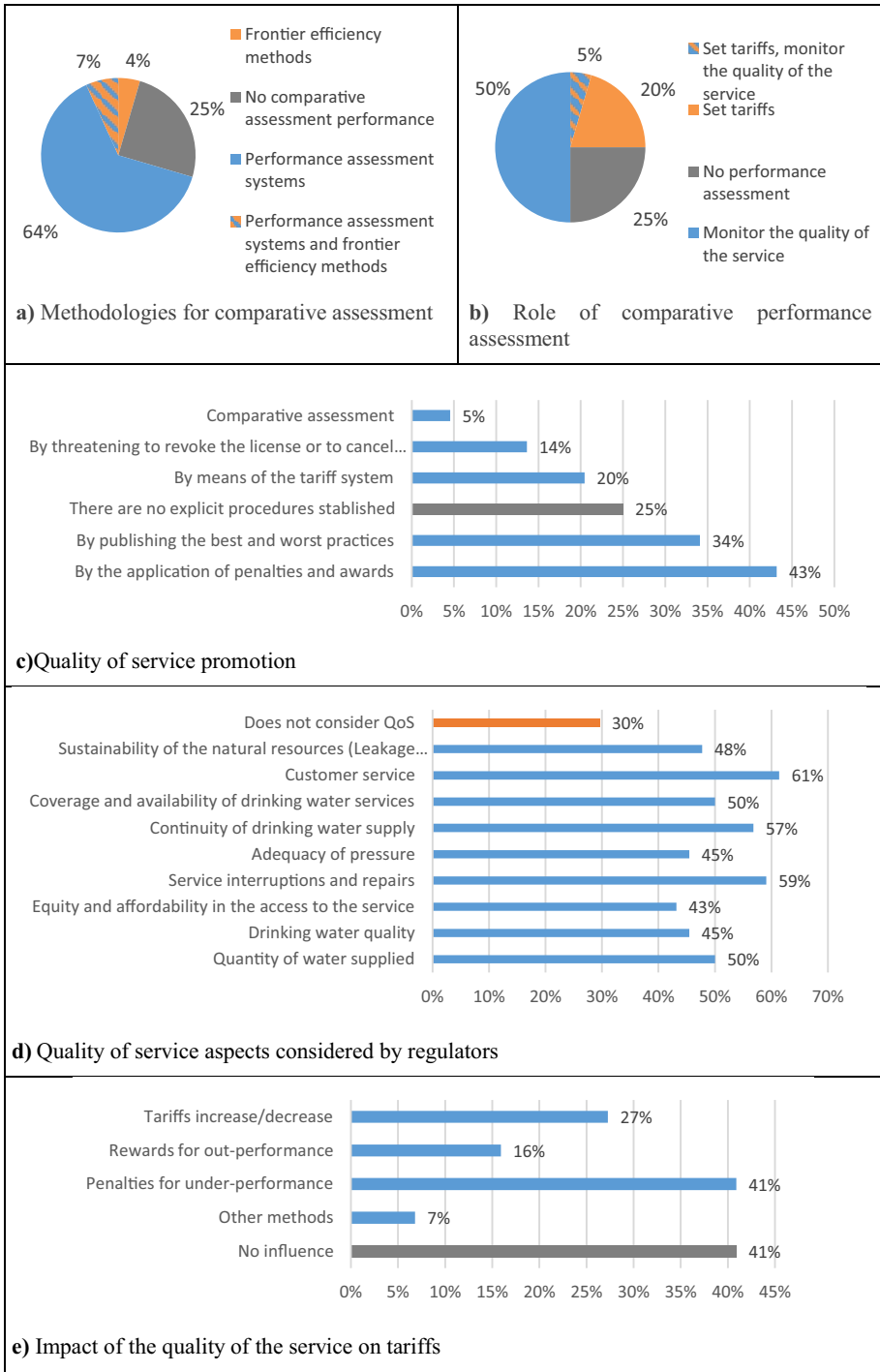


Fig. 2 Results of the survey: Comparative assessment and impact of QoS in economic regulation

utilities with higher quality of service standards, as their higher costs resulting from providing a better service could be considered inefficiencies.

In any case, regulators do not consider all aspects of quality of service that could potentially impact costs. Figure 2d shows different dimensions of service quality with an impact on costs (extracted from the ISO 24510 (ISO 2007)) and the percentage of regulators from the total considering them. As seen in this figure, there is no consensus among regulators in the quality of service aspects to be contemplated. Not a single QoS aspect is considered by the entire sample of regulators and there is seldom a dimension that is used by more than 60%.

The last aspect to be analysed is whether regulators contemplate the quality of service for the purposes of economic regulation. As seen in Fig. 2e, for 41% of regulators, quality of service is not considered at all for tariff-setting purposes. Among the remaining 59% of regulators, the preferred strategy is to set penalties to utilities with under performance. Rewards for performance are also a recurrent strategy. However, only in one case, the regulator rewards utilities based on their actual level of performance above the established standards of quality of service, while the remaining ones reward all utilities reaching the quality of service baseline, regardless of how well perform beyond this limit.

Another method used by 27% of the regulators is the tariffs increase/decrease. However, there is little information available on how quality of service affects tariffs.

Other regulators use other methods such as: revoking license contracts if the QoS standards are not met, considering the QoS when setting the funding requirements for utilities or not allowing new tariff rates until the QoS standards are met.

Finally, almost all regulators analysed believe that the quality of service is an important factor in regulation. However, most of them seem to fail to translate this belief into effective policy. The reasons for this are diverse, and include lack of a guided approach for considering the quality of the service, poor data, lack of consensus in the elements of quality of service that affect costs, etc....

2.5 Conclusion of the Survey

It may be concluded from the answers to the survey that, in practice, the quality of service and Economic regulations are considered as separate efforts and there is little influence from one into the other. As a matter of fact, for 41% of the regulators that replied to the survey, quality of service plays no role whatsoever in economic regulation.

This would mean that, if quality of service has a direct impact on costs, the economic regulation function would be undertaken under inaccurate or incomplete premises, as none of the regulators that replied considers all QoS factors that could have an impact on costs.

The next section will consider the relationship between providing a greater quality of service and the associated costs, and its consequences for economic regulation.

3 Costs Associated to the Quality of Service

Providing a service of a greater quality has a direct impact on costs and, as a consequence, on perceived efficiency. If, when assessed, the water services are considered as an “all or nothing” service (the services are either provided or not, the quality standards are either met or not), the service with the lowest costs that checks all the boxes is considered the most efficient.

It could be argued that service providers only need to meet the minimum quality of service standards, and improving service beyond this point should not be financially rewarded. However, the ISO 24510 standard (ISO 2007) clearly indicates that the level of service should be dictated by the users. In other words, users from a certain service may desire a QoS above the minimum standards (e.g. cleaner, healthier water than the one required by the WHO or the local regulations) and may be willing to pay a higher price for this better service.

However, as shown in the previous section, none of the regulators that replied to the survey considers all QoS factors that may have an impact on the costs. This results in a structural handicap to accommodate the users' needs and expectations of the service while setting fair prices (that consider all cost driving factors) for the service providers.

This section will show the impact of QoS levels in service costs, and hence, the need for an integrated approach in economic and quality of service regulations.

The list of quality of service factors (those with an impact on costs) has been obtained from the ISO 24510 standard (ISO 2007). These factors are classified in the following categories:

- Access and provision of the service
- Contract management and billing
- Promoting a good relationship with the users
- Protection of the environment
- Safety and emergency management

The standard specifies the user's expectation concerning water and wastewater services. The following analysis will be focused only in those factors with an impact in costs in the service provision of water supply through a network.

3.1 Access and Provision of the Service

A service with good quality in terms of access and provision of the service affects costs in the following ways:

- **Time to establish new service provisions.** Reducing the time for establishing new connections may be improved through the optimization of processes, but ultimately depends on the number and qualification of staff assigned to this task and therefore it has an impact on the workforce costs.
- **Repairs.** The adequate and timely repair of the network and other infrastructures can be linked again to the number and qualification of staff, but also to having an adequate stock of parts, materials and tools for the repairs, means of transportation and an efficient reporting system. Improving the repair times has a direct impact on costs.
- **Quantity of drinking water supply.** Securing enough quantity of water for the users is never without a cost. Whether new infrastructures need to be built (reservoirs, desalination plants, abstraction facilities, etc.) or new water rights secured, the increase in the availability of water usually has significant costs associated to it.
- **Drinking water quality.** Meeting all water quality standards has a cost for the utility. Regardless of the raw water quality, providing water of an exceptional quality at the tap implies additional investment in infrastructure (e.g. in The Netherlands ultraviolet disinfection treatment is already in place—(Smeets et al. 2008) – a change that implied reconsidering all pipe diameters in the network to increase water velocity in pipes).

These investment costs may range from new water treatment plants or pipes, to investment also in the catchment improvement and maintenance.

- **Aesthetic aspects of water.** Even in the cases where all requirements on organoleptic aspects of water are met, improving the quality of service on the aesthetics of water (odour, colour, taste, etc.) is linked to substantial infrastructure investments. Some examples can be found in the industry where investments have been made in order to improve aesthetics aspects of water supply (Global Omnium 2018).
- **Pressure of drinking water supply.** Maintaining an adequate level of pressure throughout the network is not an easy or cheap task. Utilities may need to actively manage pressure by setting up District Metered Areas (DMA), invest in pressure management measures and avoid excessively low or high pressures throughout the network. Furthermore, leakage in a network is directly linked to high pressure. Having the right pressure for all users may require significant investments, and improving the quality of service in this dimension is never without a cost.
- **Continuity of drinking water supply.** Moving from intermittent water supply to continuous water supply implies a significant investment in network infrastructure. Intermittent water supply only makes sense when a network is severely leaking (as operating in an intermittent fashion is more difficult and creates many problems that are avoided in 24-h operation). If a network is leaking so much that water needs to be operated in an intermittent fashion, the costs to the transition to a greater continuity of the supply are very significant.
- **Coverage and availability of drinking water services.** Increasing water coverage in order to connect new developed areas implies an obvious cost. Although these costs may (or may not) be recovered through new contracts and income, there is a clear cost associated to improving this QoS parameter.

3.2 Contract Management and Billing

Regarding factors impacting on contract management and billing:

- The **availability of a clear service agreement, clarity of billing and methods of payment** have an impact on cost as they require competent and sufficient staff together with an appropriate information management system.
- **Accuracy of billing** is highly related with the percentage of metered customers. An unmetered customer is unlikely to have an accurate bill. In addition to have a meter, it has to be in good condition, have a frequent read and minimise reading errors (either by manual reading, with a high cost of personnel, or remote reading, with a significant cost of installation and data processing).

3.3 Promoting a Good Relationship with the Users

Customer service is another cost driver when looking for high quality of service. Customers value being able to contact the provider by telephone, on the Internet or in the office. In addition, they also expect that their complaints are responded in an appropriately and timely manner. This requires well-trained and sufficient staff.

Also, sufficient physical offices and a call centre are needed to provide adequate support to users. The quality of service is also influenced by the working hours when users can be attended. All these elements all have a significant impact on costs.

3.4 Protection of the Environment

Users also expect utilities to protect the environment while providing a good service. For this reason, they expect:

- A **sustainable use of natural resources**, such as reducing leakage, energy consumption and demand reduction. Reducing these resources involves investments such as actively search for leaks, carrying out energy studies which can lead to new efficient equipment acquisitions, implementing demand management plans, etc. In fact, some studies quantify the increasing impact on marginal costs reducing water leakage has (Molinos-Senante et al. 2021). However, it is true that, after the initial investment, these measures can save operational costs in the long run. For example, if demand or leakage is reduced, less water will be treated in the water treatment plants and the costs associated will be reduced due to a reduction in chemicals and energy involved in the process. Energy reduction, on the other hand, has an impact on the electricity bill, kWh consumed and, in some cases, it is even possible to reduce the contracted power.
- A **reduction of the environmental impact of the water service** can be reached, for instance, avoiding overexploitation of wells or reducing the environmental impact in catchment areas. These impacts can be reduced finding new water sources, buying water to other utilities or reducing the water demand, strategies that entail a cost for the utility.

3.5 Safety and Emergency Management

Finally, users expect utilities to have a **safety and emergency management plan**. This plan may include additional infrastructures such as pumping stations or alternative sources of water which have a cost for the utility and rarely come into service.

3.6 Relationship Between the Quality of the Service and Costs

It can be concluded that a high quality of service does have an impact on costs. This means that quality of service and economic regulation are highly related and regulators should therefore consider this relationship when performing the economic regulation.

4 Case Study

This section will illustrate, through a synthetic case of study, the impact quality of service has in utility's costs. This case of study considers two water service utilities, Utility A and Utility B. Both utilities are only dedicated to water supply and have the same characteristics: number of customers, length of the network, raw water quality, same average consumption per capita, etc. The difference between these two services is the level of quality

of service provided. While utility A is happy to provide the minimum quality of the service required, Utility B is making efforts for providing an excellent service.

These utilities are not real. They have been created synthetically for the purposes of the study, adapting data from real utilities as indicated below. This decision has been driven in order to minimise the impact of context between utilities and focus all the differences in cost on the quality of service provided.

Therefore, this is not a real case of study, and exact numbers may change in the real world depending on the context. However, this will prove *reductio ad absurdum* that improving water service quality has a direct impact on costs, as it is virtually impossible to find improvements without cost increases (ideally, it could be argued that some QoS dimensions may be improved by optimization of processes. However, the objective of this work is to establish a clear and direct relationship between economic and QoS regulations, and the need to consider them as one and the same, and for this purpose it is enough to show that most QoS level improvements require additional costs).

Table 1 displays key data for both services classified according to the different quality of service parameters described in the previous section.

The included costs of the different quality of service aspects have been adapted from real utilities. The active leakage reduction program and the infrastructure asset management plan have been adapted from the investment plan of Anglian Water for 2020 (Anglian Water 2019a). This utility is leader in the water sector for its quality of the service, operating in a strictly regulated environment.

Since Anglian Water is a regional utility and provides services to more than 6 million people in an area of 27,500 square kilometres (Anglian Water 2019b), results have been downscaled to fit the size of the utilities of this synthetic case study (500.000 customers) to allow for an easier analysis and comprehension.

The cost of the improvement in the taste of water has been obtained from EMIVASA, a Spanish water utility that supplies the metropolitan area of Valencia.

The cost of the installation of new water meters and renewal of the existent ones was obtained from a water meter supplier (CONTHIDRA 2017). Finally, the time of new connections, time of reparations and customer service was reflected in the number of employees.

The differences in quality of service levels for both synthetic utilities are explained below:

4.1 Sustainability of the Infrastructure

Sustainability of the infrastructure is not a direct concern of customers. However, it influences the quality of the service in the medium – long term. Not maintaining or renewing the infrastructure results, for instance, in higher leakage rates, lower water quality and more pipe failures (which result in more service interruptions).

Utility B has an infrastructure asset management plan. This utility manages actively its infrastructure, prioritising the most critical areas and acting proactively before the failure, guaranteeing the sustainability of the service. Utility A however, has a reactive water repairing strategy, only repairing when there are important pipe failures. The cost of the active infrastructure asset management actions costs 2.795.000€/year to Utility B (Anglian Water 2019a). This is an additional cost to Utility B, as Utility A is not investing actively in infrastructure asset management.

Table 1 Data from Utility A and B

Basic information	Utility A (low QS)	Utility B (high QS)
Number of customers	500.000	500.000
Total costs	6.200.000€	19.305.000€
Network length (km)	10.000	10.000
Continuity of the service	24/7	24/7
Average water consumption (domestic)-l/day/person	150	150
Population coverage	97%	97%
Standards water quality compliment	100%	100%
Environmental impact		
Active leakage reduction program	No	Yes
Cost active leakage reduction program	0	2.700.000,00 €
Sustainable use of resources		
Infrastructure asset management plan	Passive	Active
Cost of network and tanks preventive maintenance and renovation	0	2.795.000,00 €
Provision of the water service		
Time new connections (days)	7	2
Time reparations (days)	4	1
Cost	*Cost is reflected in the number of employees	
Annual payment of the advanced oxidation process for taste removal	0	200.000,00 €
Contract management and billing		
Percentage of metered customers	75%	90%
Cost of the installation of new water meters and maintenance of the utility installed water meters	750.000,00 €	3.750.000,00 €
Percentage of cost of the installation of new water meters and maintenance of the utility installed water meters	12%	24%
Customer service		
Customer attention in office (From 9am to 8 pm)	Yes	Yes
Average waiting time in office	30 min	10 min
Call centre (phone, emails and social media)	From 10am to 7 pm Only working days	24/7
Response to written complaints (days)	7	2
Total number of employees	150	300
Manpower cost (yr.)	3.660.00,00 €	7.320.000,00 €
Difference in costs		13.105.000 €

4.2 Sustainable use of Resources

In order to ensure a sustainable use of resources, Utility B has an active water leakage reduction program. It aims at reducing the amount of water leakage and decreasing the environmental impact of extracted water. This programme has an additional cost of 2.700.000€/year which includes all the field revisions, material and repairs (Anglian Water 2019a).

4.3 Contract Management and Billing

Utility B advocates for a clear and accurate billing. For this reason, they have a high percentage of customers metered and are investing in the renewal and maintenance of the water meters. All renovated water meters are read remotely on a monthly basis, in order to avoid manual readings, which are costly in terms of manpower and especially sensitive when the water meter is located inside the customer's property.

Utility B is renewing 5% of its meters every year. Utility A is also increasing the number of metered customers at a lower rate, 1% per year. Table 1 shows the investment costs from both utilities (adapted from (CONTHIDRA 2017)). The installation costs are accounted for in the manpower cost section.

4.4 Provision of the Service

4.4.1 Time for New Connections and Reparatons

Utility B needs less time for new connections and reparations (see Table 1). New connections time is defined as the time between the customer request and the availability of the service (for existing connections).

Reducing this average time has an impact on a higher number of employees hired by Utility B. It has been estimated that Utility B needs a team of 20 additional employees, achieving response times are practically 4 times faster, as can be seen in Table 1. Consequently, utility B is facing more costs, not only in manpower costs but also in materials and tools.

4.4.2 Quality of Water

Concerning the quality of water, in both utilities water is safe and meets all standards and requirements. However, due to water catchment conditions, water is hard and has a strong taste. As a consequence, customers do not generally drink tap water. In order to encourage customers to do so, Utility B has invested in an advanced oxidation process to be installed in the water treatment plant, with a cost of 4 million euro, reflected in an amortization cost of 200.000€/year. This process will also reduce the hardness and taste of water, increasing the life expectance of domestic appliances such as washing machines or dish washers. The cost of this process has been obtained from a similar project in Valencia (Spain), where its first phase of the project will improve the quality of water of 500.000 customers (Global Omnium 2018).

4.5 Customer Service

Finally, when considering the customer service, both utilities have offices to attend customers. However, Utility B has a 24 h call centre available for the user in case there is an emergency. They also have a lower time for responding complaints and their waiting time at the office is also lower, as seen in in Table 1.

In order to reach this quality of service in customer service, it has been estimated that Utility B needs 30 additional workers that make possible the 24/7 call centre, reduce the waiting time at the office and the response time for written complaints.

Thus, as the number of employees is more elevated, therefore the labour costs too.

4.6 Manpower Costs

The total number of employees is almost the double in utility B than in Utility A. In order to reduce leakage, perform an infrastructure asset management program, provide a better customer service, etc. having enough and well-prepared personnel is essential. The cost of personnel has been calculated according to the Spanish average wage in the last register of the National Statistics Institute (INE 2021).

As can be seen at the bottom of the table, Utility B spends 13.105.000€/year more than Utility A, dedicated exclusively to provide a better quality of the service. This difference in costs would impact in an increase in tariffs of Utility B by 26,21€/year and customer, a 2,18€/month and customer.

5 Discussion

With some notable exceptions, and in very limited cases (OFWAT 2021), in the water sector, users are not consulted on the quality of service level received. In a competitive market, customers choose the option with their preferred cost/quality ratio. However, this is not possible in a natural monopoly such as the one conformed by water services. Therefore, it is up to the regulatory bodies to tackle this market anomaly and protect customers from the possible monopolistic practices that could occur, establishing the relationship between the quality of the service and the cost of water services.

As described in the ISO 24510 standard, water services can be provided with a diversity of quality of service levels. The synthetic case of study presented here, demonstrates that improving those levels leads to higher costs for utilities.

Therefore, users should be aware of two facts: in first place, there are different options in the quality of service provided. The better the quality of service provided, the higher the costs utilities have to face. Consequently, tariffs should also vary accordingly in order to allow utilities to recover costs.

In second place, users, supported and guided by the water regulatory authority, should be able to decide the level of quality of the service provided they are willing to pay for. This process has to ensure that the agreed level of quality will be always above the minimum established quality standards.

Given the impact of the quality of service on costs, all quality of service levels (and metrics) should be considered when performing economic regulation. Therefore, QoS would have an impact determining efficiencies and setting a fair price for water services. In other words, quality of service should be intrinsically related to the economic regulation. To achieve this, regulatory authorities should remove the boundary between quality of service regulation and economic regulation, as both behaviours are intrinsically linked and should be regulated following an integrated approach.

However, providing a higher quality of service than agreed by customers will increase utilities' costs. In this case, utilities should not be allowed to increase tariffs if users have not agreed on such an improvement of service.

On the other end of the spectrum, it is advisable to act against utilities not meeting with the agreed quality of service levels, regardless these are the minimum standards established or those agreed between users and the utility (which entail an increase in tariffs).

6 Conclusion

Although most regulators supervise both economic and quality of service regulation, they are considered as independent areas with no connection between them. This separation may result in the belief that these two regulatory areas are not related.

Furthermore, water and wastewater services have many aspects that impact on the quality of the service provided. For the same utility it would be possible to select different levels of quality.

As demonstrated in the Case study, the quality of the service is intrinsically related with its cost. Nonetheless, economic efficiency is, in general, assessed without considering the quality of service provided as demonstrated by the survey. This fact could result in utilities providing an excellent service and being penalized by the regulator for being less efficient due to higher operational costs. Therefore, economic regulation must consider when setting tariffs whose standards of service are provided by utilities.

The survey has highlighted that there is a lack of consensus concerning the aspects of the quality of service to be supervised. Even if regulators would consider quality of services aspects when assessing the economic efficiency, this could lead to leaving out some of the aspects with an impact on costs. This work intends to unify those QoS aspects with an economic impact on efficiency.

Water services conform a natural monopoly and besides, they are a human right. Thus, on one hand, regulatory authorities should be responsible for setting the minimum service level of quality and supervising that these standards are met.

On the other hand, public participation of the users in regulatory processes should be ensured. They should be able to participate actively in the decision-making concerning the trade-off among quality of the service and its costs. The increase of the quality of service cannot be used to increment costs and, consequently, tariffs without the approval of users.

A fair tariff should reflect the cost of the quality of service provided while allowing utilities to recover costs. Utilities providing a higher QoS level (above the established minimum standards) should reflect these costs on tariffs. However, users are those who, together with the service provider—and supervised by the regulator —, should decide the level of quality of service provided and, consequently, paid for.

To sum up, the findings of this work point towards merging the economic and quality of service regulatory aspects. Future research is working towards designing a methodology that facilitates it. The integration between both regulatory behaviours would lead to a regulatory model that compensates the anomalies of a natural monopoly market. This study has demonstrated the importance of considering all the aspects of the quality of service when performing economic regulation in order to establish a fair tariff. With a proper implementation, this approach enables the establishment of tariffs that ensure the total cost recovery while promoting a water service of excellence.

Authors Contributions All authors contributed to the study conception and design. The first draft of the manuscript was written by E. Cabrera Rochera. Material was prepared by E. Gómez and R. del Teso. Data collection and analysis were performed by E. Estruch-Juan. All authors read and approved the final manuscript.

Funding Open Access funding provided thanks to the CRUE-CSIC agreement with Springer Nature. The authors have no relevant financial or non-financial interests to disclose.

Availability of Data and Materials All data used in this study are available from the corresponding author by request.

Declarations

Ethical Approval All authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed.

Consent to Participate Informed consent was obtained from all individual participants included in the study.

Consent to Publish The participants have consented to the submission of the paper to the journal. Additional consent was obtained from participants on the survey.

Competing Interests No potential conflict of interest was reported by the authors. No funding was received to assist with the preparation of this manuscript.

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