Consumer Satisfaction with Water, Wastewater and Waste Services in Portugal*

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January 2016

Abstract

While the concept of consumer satisfaction is a central topic in modern marketing theory and practice, citizens' satisfaction with public services, and especially water and waste services, is a field that still remains empirically rather unexplored. The following study aims to contribute to this area by analysing the determinants of user satisfaction in the water, wastewater and waste sector in Portugal, using a unique survey of 1070 consumers undertaken by the Portuguese Water and Waste Regulator ERSAR. I perform an analysis of the relation between overall service satisfaction and attribute-specific service satisfaction with an ordered logit model. I then explore if subjective consumer satisfaction can be reflected by ERSAR's technical performance indicators. The results suggest that overall consumer satisfaction is driven by consumer's satisfaction with specific service aspects but unrelated to socioeconomic and demographic characteristics. Furthermore, I show that there is no monotonic association between ERSAR's technical performance indicators and consumers' levels of satisfaction.

Keywords: Consumer Satisfaction, Public Utilities, Water and Waste Sector, ERSAR

*The author is deeply grateful to Prof. Susana Peralta (Nova SBE) for her guidance throughout this research study. I also thank the entire Strategic Projects Department of ERSAR for the invaluable support and advice.

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1 Objective of the Study

This work project was carried out in collaboration with the Portuguese Water and Waste Services Regulation Authority ERSAR. The objective was to analyse data from a pilot national consumer satisfaction survey in order to understand which service aspects influence the overall consumer satisfaction in each of the three sectors regulated by ERSAR: water, wastewater and waste. Furthermore, ERSAR was interested in the relation between consumers' perceptions and technical key performance indicators that the regulator uses as benchmarking tool for service quality. Consumer protection but also consumer satisfaction are main concerns of ERSAR. Therefore, it is important to understand if their objective measurements reflect the opinion of the consumers. In addition, this study can serve as a source of improvement for the design of ERSAR's consumer satisfaction surveys in the future.

2 Introduction

Any firm would most probably agree on the importance of a satisfied consumer in a competitive market. Numerous studies provide evidence that consumer satisfaction is positively linked to economic returns and brand loyalty. Consequently, it has become a key concern in the modern business world [1]. Also public entities and regulators are increasingly interested in the subject, but having a rather different motivation than profit maximization. By understanding the level of satisfaction of consumers, regulators have the chance to positively influence their policies by shifting the perspective from the supply- to the demand-side. While service outputs and service outcomes are traditionally the two prevailing mechanisms to assess the performance of public services, consumer satisfaction has become a popular strategy to access the quality of services and institutional efficiency and to encourage service providers to improve their performance [17]. At the European level, the European Commission recently acknowledged the need to incorporate consumers' perspective into the design of service regulations, following an OCED recommendation [9]. In the context of citizen participation, consumer satisfaction surveys have become a new tactic for citizen involvement with public services. They have been applied by a great number of governments, such as in the UK within the framework of the "Citizen's Charter" [19].

Also in the water and waste sector governments have been increasing their attention to consumers' opinion, not only since the UN General Assembly recognized the access to drinking water and sanitation services as a human right [2]. Recent examples, such as the governmental regulator for water, wastewater, electricity

and gas industries in Northern Ireland, demonstrate that the trend is to include consumer satisfaction as a meaningful indicator about service quality next to technical performance indicators [31]. Vloerberg et al (2008) provide an overview of recent literature findings regarding consumer satisfaction with drinking water services. The report reveals that consumer satisfaction surveys are a frequent tool for regulators and service providers, but since researchers devised various indicator systems and instruments for consumer satisfaction on drinking water services, it is not possible to draw general conclusions from these studies. Interestingly, the report provides evidence that consumers tend to be rather satisfied with quality water services, and especially in countries with well-developed water systems. The authors see one reason in the little interest of consumers to know about details of water quality and related services. Water is considered to be a low-involvement product and questionnaires inquiring about the satisfaction of low-involvement services and products often result in "satisfied" [15].

2.1 Defining Consumer Satisfaction

Consumer satisfaction is a rather abstract concept and the literature offers a wide amount of related explanations and concepts. Nowadays, a popular and widely used model in satisfaction research is the expectancy-disconfirmation model. It suggests that satisfaction or dissatisfaction is experienced by relating prior expectations with regards to a service or product with confirmations or disconfirmations of these expectations when making the actual experience with the service or product [36]. The findings of empirical studies with data from public services have been largely supportive to this theory, suggesting that satisfaction with public services is related to citizen's expectations. Parasuraman, Zeithaml and Berry (1988) incorporated the expectancy-disconfirmation model into a general survey framework for the assessment of service quality. The authors argue that service quality is an elusive construct because of its unique features, intangibility, heterogeneity and inseparability of production and consumption. Therefore, it is essential to conduct surveys that allow to measure consumer satisfaction by identifying the gap between expectations and experience. The SERVQUAL model, that based on five dimensions: tangibility quality, reliability quality, responsiveness quality, assurance quality and empathy quality, is nowadays one of the most common tools for marketing researchers in this area [26][27].

2.2 Empirical Studies with an Econometric Approach

The first part of the study employs the ordered logit model to explore which factors impact the overall satisfaction of users with each of the three services that are regulated by ERSAR: water, wastewater and waste services. While econometric

models such as ordered logit and binary logit models are often used by researchers to evaluate consumer satisfaction surveys, research on public utilities is still scare and has mainly focused on the public health sector (see for example [20][24]).
For the water sector, the study of Vásquez et al. (2012) explores the determinants of citizen satisfaction with water services in León, Nicaragua. By using a generalized ordered logit model, the findings indicate that consumer satisfaction is influenced by the satisfaction with specific service characteristics and dissociated with personal characteristics. Furthermore, the results reveal that overall consumer satisfaction is influenced by consumers' perception about the water services received by their peers [38]. In contrast, Myburgh et al (2005) found that socioeconomic characteristics significantly influence the patient satisfaction with health care providers in South Africa [23].

2.3 Objective vs. Subjective Perception of Service Quality

The issue of whether objective service indicators can reflect citizen satisfaction with public services is the object of an ongoing discussion, and studies often have not yield consistent results in favour of a direct relationship [18]. Brown et al. (1983) applied a multiple regression analysis to survey data about policy services in Alabama, US, and show that sector specific attributes influence the overall satisfaction with police services. However, they found that subjective perceptions are unrelated to actual objective measures. Hence, satisfaction with response time was unrelated to actual mean response time of the police in the neighbourhood. The authors explain this result with the expectation-disconfirmation model presented above. They argue that citizens evaluate objective service conditions through their subjective service expectations [4]. The studies of Roch (2006) and Ryzin (2004) confirm that citizen satisfaction is influenced by both, perceived service quality and their expectations, when asked about utility services, including waste services [33][37]. Variations in consumer satisfaction with services therefore may reflect differences between expectations rather than between service qualities themselves.

In the special case of network industries, such as the water and wastewater sector, Florio (2013) argues that service quality is a rather abstract concept since the perceived quality of network services depend on the amount of information that is available for the consumers. Users often lack information about the origins and technical reasons for visible disturbances like water supply interruptions, which could lead to a misinterpretation of service quality [13].

3 The Water and Waste Sector in Portugal

As in many other countries, the water and waste sector in Portugal is a stabilized market that is characterized by its complexity in terms of market structure and offered services. In 2014, the sector included 360 drinking water suppliers, 283 urban wastewater operators and 281 municipal waste management entities, serving about 10 million people in mainland Portugal.
The services within the water and waste management sector in Portugal can be divided into two categories: bulk services and retail services. For the water sector, water collection, treatment, and drinking water transportation to a general hydraulic system is done at the bulk level. Retail operators are in charge of the distribution of drinking water to the end-consumers and the drainage of wastewater. Afterwards, wastewater is treated and delivered to its final destination by the bulk operator. Compared to the water sector, the different stages at the waste sector are more complex, since waste can be differentiated into several waste streams that are treated in distinct ways. The entity that operates at the retail level serves as the waste collector, while valorization and waste elimination are done by the bulk operator. The responsibility for the bulk services (multi-municipal services) are at the central government level and the municipalities are in charge of the retail services at municipal level.

The central government and municipalities can decide between three different models of management of the water and waste sector at both levels: direct management, delegation and concession. They are able to cooperate with the private sector by either delegating the management or collaborating with the private sector by creating a common company that provides public services.
For 2014, for drinking water supply services, multi-municipal concessions were the most important management model at the bulk level, including 167 municipalities with a total of 4.9 million habitants (69% of the population). As an exception, 1.8 million people in the Lisbon area were served by EPAL, Empresa Portuguesa de Águas Livres, under the delegation model. At the retail level, 70% of the municipalities directly managed the drinking water sector, serving 53% of the population. The numbers look similar for the wastewater sector, whereas the multi-municipal and municipal concession model at the bulk level was even more predominating, serving about 97% of the population covered by the service. At the retail level, 78% of the municipalities provided the wastewater services under the direct management model to 61% of the population. For the waste sector, 12 multi-municipal concessions delivered bulk waste services to a total of 180 municipalities with 67% percent of the population. At the retail level, 91% of the municipalities provided the waste services under the direct management model to 86% of the population.

Due to the low population density in some regions of mainland Portugal, retail services are provided by a high number of entities serving a relatively small number of people in all there sectors. This high fragmentation causes that entities cannot take advantage of economies of scale while having high operational costs [10].

4 ERSAR

ERSAR (Portuguese: Entidade Reguladora dos Serviços de Águas e Resíduos) is the Portuguese Water and Waste Services Regulation Authority with headquarter in Lisbon, Portugal. The institute emerged in 2009 from IRAR (Portuguese: Instiuto Regulador de Águas e Resíduos), that had been the sector's regulator since 1998. ERSAR is a public institute that operates under the supervision of the Ministry for Environment and Spatial Planning, while having financial and administrative autonomy. It regulates three essential public services, the drinking water supply service, the wastewater management service and the municipal waste service. Furthermore, it is the national authority for drinking water quality for all drinking water utilities in Portugal. ERSAR aims at protecting the consumers in Portugal by promoting an equal and transparent access to all services and by ensuring that general information about the sector and the operators is made available for the public.
ERSAR's competences lie within the structural, economic and quality of service regulation. By assisting the Portuguese government with the elaboration of strategies for the water and waste sector and by monitoring their implementation, ERSAR takes the role of a supervisor and ensures the stability of the sector. Furthermore, ERSAR is given indirect control over operators' behaviour as it can propose new legislation changes and is able to adopt new regulations that are binding for the sector. The institute has an important role as economic regulator since natural monopolies and legal monopolies, like in the water sector and waste sector, respectively, tend to have higher prices. ERSAR advocates social acceptable pricing while ensuring the economic and financial sustainability of the operators. In order to promote high quality of service, ERSAR adopted an evaluation mechanism that assesses operators' behaviour with the help of 16 quality indicators, water quality being one of them. The results are published at the annual report on water and waste services in Portugal that is available for the public. Additionally, ERSAR offers service providers trainings and further technical support. It interacts with about 500 water and waste management operators.
ERSAR is financed through regulation fees and drinking water control fees charged to the operators.

5 Empirical Analysis

The main analysis uses household-level data drawn from a national survey on consumer satisfaction with water, wastewater and waste services in mainland Portugal. In a second step, this data is combined with indicators that describe the technical performance of all Portuguese operators in these sectors.

5.1 Consumer Satisfaction Survey

The survey data was collected in November and December 2014 in the framework of a pilot survey on consumer satisfaction ran by ERSAR. The regulator designed this study with the aim to get representative consumer-based evaluations about the entities and their services in the drinking water supply, urban wastewater management and urban waste management sector. The study consisted of two components: a household survey at the national (mainland Portugal) level and a household survey at the municipal level, conducted in six municipalities in mainland Portugal. For the purpose of the following analysis it was decided to focus on the data obtained from the national survey.
For the national study, a sample of 1070 households was drawn using a stratified random sampling method based on the NUTS 2 division of mainland Portugal.[1] After identifying the number of households to be interviewed based on the share of population of each NUTS 2 region, respondents within each strata were randomly selected for a telephone interview. In order to participate in the survey, the contact person of a household had to be resident in mainland Portugal and be at least 18 years old. Furthermore, she must have been a user of all three services for more than one year and had to be familiar with the invoices of all services. These conditions were checked by asking the correspondents in the beginning of each interview. The sample was diverse as it included respondents of different age and gender, with distinct backgrounds in terms of education, employment and household characteristics. The demographic composition of the participants is presented in Table 1.

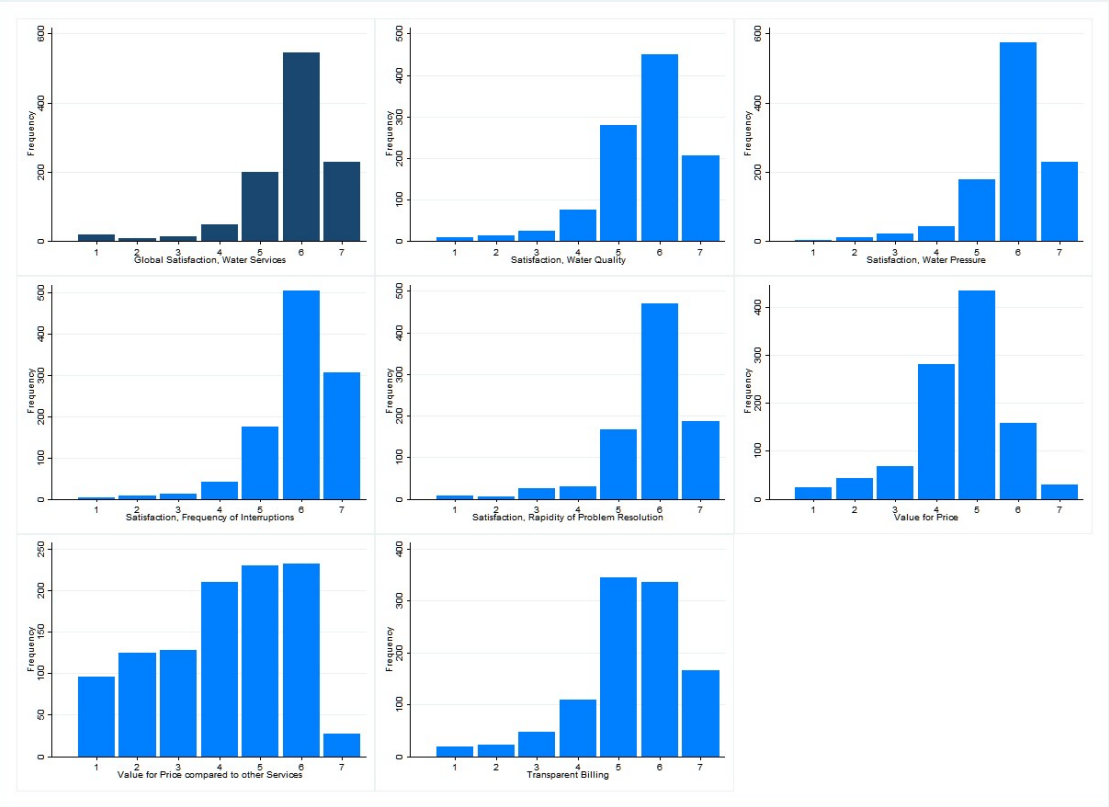
The survey consisted of three main parts (one block of questions for each service sector) and a last part for demographic information about the respondent. Each of the service blocks contained a similar set of questions related to service satisfaction, perception about pricing, operator's image, customer service and reclamations. In most cases, respondents were asked to answer on a scale from 1 to 7, whereby 1 represented the lowest and 7 the highest classification possible.

[1] NUTS 2, Nomenclature of Territorial Units for Statistics 2 by EuroStat, divides mainland Portugal into five areas: North, Center, Lisbon, Alentejo, Algarve.

Table 1: Demographics of Respondents

		Frequency	Percent (%)
Sex:	Male	448	41.87
	Female	622	58.13
Age:	18-25	46	4.30
	26-35	122	11.40
	36-45	171	15.98
	46-55	189	17.66
	56-65	232	21.68
	66 or more	306	28.60
	Missing Data	4	0.37
Education:	Does not know how to write and read	11	1.03
	Knows to read and write w/o schooling	69	6.45
	1st Cycle	351	32.80
	2nd Cycle	126	11.78
	3rd Cycle	167	15.61
	Secondary School	139	12.99
	Vocational Education	32	2.99
	Higher Education	158	14.77
	Missing Data	17	1.59
Employment Status:	Employed	528	49.35
	Unemployed	77	7.20
	Student	6	0.56
	Domestic	80	7.48
	Retired	370	34.58
	Missing Data	9	0.84
Household Income:	Less than 500€	194	18.13
	500 to 1000€	316	29.53
	1001 to 1500€	150	14.02
	1501 to 2000€	114	10.65
	2001 to 2500€	45	4.21
	More than 2500€	36	3.36
	Missing Data	215	20.09
Household Size:	1	160	14.95
	2	402	37.57
	3	280	26.17
	4	153	14.30
	5	47	4.39
	6	16	1.50
	7	2	0.19
	8	1	0.09
	9	1	0.09
	10	1	0.09
	Missing Data	7	0.65
Social Class:	Upper/ Middle upper class	62	5.79
	Upper middle class	168	15.70
	Lower middle class	421	39.35
	Lower class	204	19.07
	Missing Data	215	20.09

Figure 1: Histogram, Satisfaction with Drinking Water Services



Source: Own graphic based on survey data

Figure 1 shows the frequency distributions for satisfaction with drinking water services and illustrates that most of the questions, including the question about the global satisfaction, have a skewed left distribution. This means that the great majority of respondents are rather satisfied with overall water services and also with specific service attributes, such as the water quality. When comparing these results to other surveys that have been done in this sector, the bunching at the top end is not surprising. The literature suggests that consumers in developed countries are rather satisfied with water services. For wastewater and waste services the distributions of answers look very similar to those of the water sector. Most of the questions that have been considered for the regression analysis have low standard deviation scores (between 1 and 1.7) and 6 is the most frequent median satisfaction score, followed by 5.[2]

[2]The histograms for the wastewater and waste sector as well as a summary statistics table with medians and standard deviation scores can be found in the Appendix.

5.2 Analysing the Importance of Specific Service Aspects for Overall Consumer Satisfaction

In order to estimate the importance of the specific service aspects for the overall satisfaction in each of the sectors, the three main sections of the survey are analysed independently. For all models, the dependent variable is the overall service satisfaction and the independent variables are the attribute specific satisfaction levels plus individual characteristics. While recent studies on consumer satisfaction with survey data employ either ordinary least squares (OLS) methods or ordered probit (logit) models, the literature that compares the results of both methods suggests using the latter when the variable of interest is of ordinal nature as in the case of "Global Satisfaction" that takes values from 1 to 7 [29]. The OLS method would be biased and inefficient since it cannot provide the best linear unbiased estimators (BLUE) for categorical dependent variables, especially when the distribution is highly skewed [28]. Therefore, I decided to use an ordered regression model for the main analysis of the data. Since the differences between the probit and logit model are slight, the logit model is used for convenience [30].
There are different approaches to the ordered logit model that lead to the same form of the model. The ordered logit model, also called proportional odds model, can be seen either as a nonlinear probability model with a cumulative standard logistic distribution or as a latent variable model. The basic idea behind the latter is that an observed ordinal variable Y (with numerical values of a rating scale) is a function of an unobserved variable Y*. The continuous latent variable Y* has various threshold points and the values of Y depend on where Y* is located within the thresholds limits. The ordered logit model estimates the probability that the unobserved variable Y* falls within the various threshold limits, leading Y to take the specific values of the rating scale [21].

Before starting with the regression analysis, one has to pay special attention to a particular issue with the ERSAR survey data: the negatively skewed distribution of answers. The frequency histograms in Figure 1 clearly illustrate that the number of observations in the lower levels of satisfaction is very small, especially for the drinking water and wastewater sector. One way to deal with small samples is to collapse the categories in order to increase the size of the cells. This practice is widely common in recent consumer satisfaction literature since an increase of cells leads to higher statistical power and smaller standard errors of the sample mean. On the other hand, a simplification of the rating scale, either by creating dichotomous variables (high vs. low satisfaction) or reducing the number of categories (high vs. medium vs. low satisfaction), often comes with the risk of losing information [3]. When looking at literature on collapsing data with categorical variables, Murad (2003) suggests that it might not be necessary to reduce the

number of categories even if the sample size is small. He shows that a change in the outcome categories frequently influence the odds ratio estimate and the inferences drawn, and recommends to keep at least three categories, rather than collapsing categories into a binary variable [22].
In order to answer the question if it is necessary to collapse the categories of the independent variable I make use of the proportional odds assumption, a condition that has to hold for all ordered logit models.[3] The proportional odds assumption, also called parallel regression assumption, states that the probability curves for all outcomes are parallel. This means that the coefficients for the relationship between category 1 and all higher categories are identical to those that describe the relation between category 2 and all higher categories (the relationship between all possible pairs of groups of categories is the same) [21][14]. This assumption can be tested by the Brant test, a Wald test that was developed by Rollin Brant in 1990. At the first stage, the Brant test produces binary logits on cumulative probabilities (starting with a dependent variable with binary outcome "category 1" vs. "category 2 + 3", etc.). Afterwards, it tests for the equality of the estimated coefficients of all regressions. A highly significant test statistic means that the coefficients of the logit regressions substantially differ. Consequently, the parallel odds assumption does not hold [5].

The first ordered logit model to be tested has a dependent variable that keeps the original 7 outcomes while treating the independent variables as continuous. When testing in any direction, adding and dropping individual specific variables as well as specific satisfaction variables, the Brant test has for all three sectors a highly significant test statistic. The ordered logit model with these categories should therefore not be used [21]. This result is not surprising. In fact, the proportional odds assumption is often violated in practice since it is very sensitive to the sample size and the number of covariate patterns [25].
In order reduce the number of logit regressions of the Brant test and increase the probability that the parallel odds assumption holds, I collapse the outcome categories and test several combinations keeping in mind the distribution for global satisfaction. The model that performs best and is the only one that provides insignificant Brant test statistics is a model with three outcome categories. The first three categories (1,2 and 3) are collapsed into one single category containing all people that are rather unsatisfied. The fourth category (4) is the neutral response of the ranking and keeps its category. And the last three categories (5, 6 and 7), that stand for rather satisfied, are collapsed into one category as well. This combination appears to be logical since category 4 is the theoretical midpoint of the scale.

[3]Various studies use this technique to decide on the final outcome categories, for example Schaumberg et al. (2013) [34].

In terms of predictors, I follow Lee et al.(2009)and Peel(1998) treating the variables related to attribute specific satisfaction as continuous [20][29]. This method comes with the trade-off of losing information.[4] Nevertheless, given the distribution and sample size, it seems to be the most appropriate method for the given data. Treating variables as categorical always comes along with a significant increase of predictors because it results in the creation of n-1 dummy variables for n categories. Having this and the high bunching on top of the data in mind, it is not surprising that the parallel odds assumption does not hold for all sectors when treating the data as categorical. [5] While this topic is highly debated in the literature, a recent study of Rhemtulla et al (2012) point out that regressions with continuous variables will produce acceptable results when the number of categories is 5 or higher [32]. In addition, continuous predictors simplify the interpretation of the estimates.

With regard to the service specific satisfaction, not all questions from the questionnaire are used for the analysis. Questions that were only asked when the respondent had contacted the service provider before are discarded since their inclusion would lead to a substantial reduction of observations. In the case of wastewater services, just 36 out of 1070 contacted the entity before. Also questions for which one would rather expect a yes/no answer instead of a Likert scale are not considered for further analysis since the answer might not be reliable. This is for example the case for the statement "It is easy to inform myself about the quality of water".
A more general problem with the predictors is endogeneity. In this context, it is possible that consumers are driven by an unknown variable that influences both global satisfaction and attribute specific satisfaction. Being aware of the high potential for endogeneity with this data, I try to minimize this risk by excluding the question "Did you contact your service provider before?". Here, the unknown motivation of calling might have influenced the overall satisfaction as well. Although endogeneity is a potential problem, using attribute specific satisfaction as covariates of global satisfaction is a common strategy in the empirical satisfaction literature (see for example Eboli and Mazzulla (2009) [11]).

In addition to attribute-specific satisfaction of services, each regression model

[4]Long and Freese (2001) recommend the usage of a likelihood ratio test to check whether categorical independent variables can be treated as intervals. When applying this test to the ERSAR data, it turns out that a transformation from categorical to continuous variables leads to a loss of information about the association between the independent and dependent variable [21].

[5]For some combinations of variables, the Brant test could not be performed using STATA.

includes a set of variables related to the individual characteristics. I include gender (female =1), age and two dummy variables for the monthly household income (more than 1000€ =1) and the educational background (secondary education and higher =1) in order to check if socio-economic and demographic characteristics have an influence on the overall satisfaction of consumers. In the case of drinking water services, it was decided to extend the model by including dummies for the region.[6] Table 2 describes the service related questions that are included in the final regression model for each sector. Based on the nature of the waste sector, it was decided to estimate two separate regressions for general waste and recycling waste.

Table 2: ERSAR Survey Questions

Drinking Water Supply	**Wastewater Management**	**General Waste Management**	**Recycling Waste Management**
Global satisfaction	*Global satisfaction*	*Global satisfaction*	*Global satisfaction*
Satisfaction with the water quality	Satisfaction with the frequency of visible wastewater in public areas	Satisfaction with cleaning and maintenance of containers	Satisfaction with cleaning and maintenance of containers
Satisfaction with the water pressure	Satisfaction with the rapidity of problem resolution	Satisfaction with the proximity of general waste containers	Satisfaction with the proximity of recycling containers
Satisfaction with the amount of interruptions	Satisfaction with the smell of waste water in consumer's residential area	Satisfaction with the accumulation of waste next to containers	Satisfaction with the accumulation of waste next to containers
Satisfaction with the rapidity of problem resolution	"There is no direct discharge of wastewater into the river/sea in the municipality"	Trust in the general waste treatment	Trust in the recycling process
Service and product quality for price paid	Trust in the wastewater treatment	Service and product quality for price paid	Service and product quality for price paid
Value for money in comparison with other essential services (electricity, electronic communication, post)	Service and product quality for price paid	Value for money in comparison with other essential services (electricity, electronic communication, post)	Value for money in comparison with other essential services (electricity, electronic communication, post)
Transparent billing of drinking water services	Value for money in comparison with other essential services (electricity, electronic communication, post)	Transparent billing of waste management services	Transparent billing of waste management services
	Transparent billing of sewage water services		

[6] I do not include the "region" variable for the wastewater and waste sector analysis since the Brant test could not be performed in both sectors. Due to the high bunching on top of the data, the underlying logistic regressions of the parallel odds assumption could not be computed with information about the regions.

5.3 Main Drivers of Consumer Satisfaction

The results of the analysis are presented as odd ratios from the ordered logit model in Table 3. In addition, I show marginal effects at the mean from a simplified logit model that treats the dependent and independent variables as binary with only two possibilities of outcome: satisfied (category 5-7) and not satisfied (category 1-4). This coding leads to an easier interpretation of the marginal effects because it allows to disentangle the influence of being satisfied vs. unsatisfied with one specific service attribute on the probability to be overall satisfied. Contrary to that, marginal effects of continuous predictors, as in the case of the ordered logit model, measure the instantaneous rate of change [6].[7] These effects appear to be very small due to the high mean values of the predictors and are much less convenient for interpretation.

In general terms, it can be seen that individuals' characteristics do not have a significant influence on the overall satisfaction in any of the three sectors. This means that global satisfaction is not based on personal characteristics such as age and monthly household income and supports the hypothesis that overall satisfaction is mainly influenced by the perceptions that individuals have regarding specific service attributes. In the case of drinking water, these findings confirm those of Vásquez et al. (2011) who showed that personal characteristics are disassociated with the satisfaction levels for the city of León in Nicaragua [38].

With regard to drinking water services, consumer satisfaction seems to be highly driven by consumers' perception of water quality, water pressure and their level of satisfaction regarding the frequency of interruptions. The odd ratios in Table 3 show that for a 1-unit increase in satisfaction with water quality, the likelihood of being overall satisfied is 1.488 times the likelihood of being either overall neutral or unsatisfied, given that all other variables in the model are held constant. Similarly, people that are one point more satisfied with the water pressure or the frequency of interruption, are 1.355 times or 1.496 times more likely to be satisfied with the overall services, respectively. Also the pricing of drinking water plays a role for consumers, albeit the odds ratios for consumer's perception about the services in terms of prices are only statistically significant at the 10% percent level (signalized by the stars in the table).

For the wastwater sector, trust seems to be the most important factor for the consumer's overall satisfaction. With each one-point increase on the Likert Scale for this question, the odds of being overall satisfied is 1.848 times greater than be-

[7] The marginal effects for the ordered logit model can be found in the Appendix.

Table 3: Odds Ratios for Global Satisfaction

	(1) Water	(2) Sewage	(3) General Waste	(1) Recycling
Specific Satisfaction				
Water Quality	1.488***			
Water Pressure	1.355**			
Frequency of Interruptions	1.496**			
Problem Response	1.112	1.350		
Frequency of visible WW		1.156		
Bad Smell		1.175		
Contamination		1.002		
Cleaning + Maintenance			1.719***	1.710***
Proximity of Containers			1.267**	1.515***
Waste Accumulation			1.253**	1.195*
Trust		1.848***	1.429***	1.444***
Value for Money	1.333*	1.276	1.428***	1.338**
Value for Money, compared	1.190*	1.267*	0.954	0.863
Transparent Billing	1.185	1.346**	1.131	1.282**
Demographics				
Female (=1)	1.201	0.897	1.542	1.520
Age	0.995	1.019	1.012	1.005
Secondary or higher education (=1)	1.276	0.814	0.773	1.113
More than 1000€monthly income (=1)	0.985	1.189	0.815	0.624
Region (Baseline: North)				
Center	1.225			
Lisbon	0.799			
Alentejo	0.697			
Algarve	2.998			
Observations	678	419	532	531
Pseudo R^2	0.180	0.270	0.315	0.314
LR chi2	86.620	73.136	191.739	180.792
Prob >chi2	0.000	0.000	0.000	0.000

Exponentiated coefficients
** p<0.10, ** p<0.05, *** p<0.010*

ing unsatisfied or having a neutral opinion.[8] This finding is very interesting since it suggests that consumers do not care much about service attributes that they (can) actually experience, but more about the wastewater treatment. The odds ratios for trust are also highly significant for the general waste and the recycling sector. For these services, it is therefore important to find measures that positively influence the level of trust that consumers have in the treatment process such as the provision of additional information on how wastewater and waste is treated.

Concerning the wastewater sector, the ordered logit model does not provide

[8]The odds is the probability that an event will happen divided by the probability that it will not happen.

Table 4: Marginal Effects on Global Satisfaction

WATER	Marginal effects	WASTE-WATER	Marginal effects	GENERAL WASTE	Marginal effects	RECYCLING	Marginal effects
Quality	0.0848***	Flooding	0.0155	Cleaning	0.131***	Cleaning	0.117***
	(0.0197)		(0.0205)		(0.0260)		(0.0251)
Pressure	0.0745***	Problem	0.0492**	Proximidity	0.0780***	Proximidity	0.120***
	(0.0223)	Response	(0.0211)		(0.0301)		(0.0247)
Problem	0.0515**	Smell	0.0337**	Waste	0.0707***	Waste	0.0655***
Response	(0.0231)		(0.0157)	Accumul.	(0.0241)	Accumul.	(0.0232)
Value	0.0211	Contamin.	0.0278	Trust	0.0763***	Trust	0.0618**
	(0.0178)	Sea/ River	(0.0178)		(0.0295)		(0.0286)
Value,	0.0245	Trust	0.0619***	Value	0.0610**	Value	0.0282
compared	(0.0179)		(0.0220)		(0.0255)		(0.0246)
Billing	0.0416**	Value	0.0154	Value,	0.0418*	Value,	0.00994
	(0.0181)		(0.0160)	compared	(0.0254)	compared	(0.0247)
		Value,	0.0158	Billing	0.0291	Billing	0.0416*
		compared	(0.0171)		(0.0239)		(0.0226)
		Billing	0.0386**				
			(0.0152)				
Demo	YES	Demo	YES	Demo	YES	Demo	YES
Regions	YES	Regions	NO	Regions	NO	Regions	NO

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

any other significant odds ratios than for "Transparent Billing", "Value for Money compared to other Services", and "Trust". In contrast, the marginal effects from the binary model reported in Table 4 suggest that the satisfaction with the smell of wastewater in public and operator's response to problems indeed effect the probability of being satisfied. The probability to be overall satisfied is 3.4 percentage points higher for people that do not have any complaints about the smell of wastewater in public than for people that are bothered by bad smell. Consumers that think that operators quickly react to problems with wastewater have a 5 percentage points higher probability to be overall satisfied.

The odds ratios from the ordered logit model and the marginal effects from the binary logit model yield quite similar results for the general waste and recycling sector. For both sectors, cleaning/maintenance and proximity of containers, the waste accumulation next to the containers and trust in the general waste and recycling waste treatment are significant drivers of overall consumer satisfaction. Hereby, consumers seem to be especially concerned with clean waste containers. People that are one point more satisfied with the cleaning and maintenance of containers, are 1.719 times and 1.70 times more likely to be generally satisfied with general waste and recycling services, respectively. When comparing both services, the marginal effects reveal that the proximity of recycling containers has a higher influence on consumer satisfaction than the proximity of common waste containers, influencing the probability of satisfaction by 12 and 7.8 percent, respectively. This

result makes a lot of sense since there are much more general waste containers than recycling containers in public areas. In order to increase general consumer satisfaction with recycling services, service providers should therefore ensure that recycling containers are easily reachable for consumers.

5.4 Technical Indicators on Service Quality

After determining which service attributes drive global consumer satisfaction, I focus in the second part of the study on the relation between consumer satisfaction and objective performance measures. The objective performance indicators of ERSAR are technical indicators on quality of service and drinking water quality. As part of its mandate, ERSAR annually assesses the performance of all regulated operators of drinking water supply, urban wastewater management and urban waste management services. A total of 48 of indicators related to these services, including drinking water quality, are used for benchmarking to identify areas for improvement. The results of the analysis are published in the Annual Report on Water and Waste Services in Portugal [10].[9]

ERSAR generated 16 performance indicators per service sector which can be grouped into three areas: protection of users' interests, operator's sustainability and environmental sustainability. Especially the indicators of the first group are strongly related to the quality of services that directly affect consumers, such as the indicator for the physical accessibility of services. Each technical indicator is calculated with qualitative data that is reported by the service operators. External auditors verify the data on a regular basis. The technical indicators have a three-point scale with 1 indicating "good", 2 "medium" and 3 "unsatisfied" performance. The threshold values for each indicator are defined by ERSAR.

Intuitively, we would assume that consumers are more satisfied with operators that deliver good performance measured by technical indicators and therefore expect a positive relation. For example, an operator with a low number of interruptions in the drinking water supply should have more satisfied consumers than an operator that delivers poor service quality and has often problems with interruptions. On the other hand, the literature suggests that this assumption often does not hold in real life. I assess the hypothesis of a positive relation between consumer satisfaction and objective indicators by using data from the pilot survey and ERSAR's Technical Indicators on Quality of Service and Drinking Water Quality from 2014.

[9] In Portuguese: Relatório Anual dos Serviços de Águas e Resíduos em Portugal (RASARP)

5.5 Estimating the Relationship between Consumer Satisfaction and Technical Indicators

In order to test the hypothesis of a positive significant relation between ERSAR's technical indicators and consumer satisfaction, I employ a Spearman rank correlation analysis using both datasets. The municipalities of the survey respondents are known. It is therefore possible to identify which water, wastewater and waste operators are responsible for their households at the retail level. This allows to get information about both the technical performance of the service provider as well as the satisfaction levels of all respondents that are served by this very operator. Following this strategy, the analysis includes in total 80 retail operators for each of the three service sectors. Due to the sampling method of the survey and the differences among entities in terms of size and geographical area, the number of respondents is not the same for all operators as it would be ideally the case. Being aware of this limitation, the following analysis can be nevertheless used to identify tendencies in terms of a potential relation between consumer satisfaction and technical indicators. A significant positive correlation means that the perception of consumers is reflected by the technical indicators that are employed by ERSAR. A non-significant correlation indicates that it is not possible to make any inferences about consumers' satisfaction by looking at ERSAR's rating that uses technical data. In the second case, both performance measurements cannot be substitutes for each other, but should rather be used as complements.

In terms of selection of technical indicators, I use the findings from the first part of the study to identify the areas of services that drive the consumer's overall satisfaction. Based on that, I select these technical indicators that can be intuitively related to the specific service areas. It has to be said that it is not always possible to link a question from the consumer satisfaction survey with one of the 16 technical indicators employed by ERSAR for each service sector. Therefore, it was necessary to modify some of the ERSAR indicators to match with the specific service aspect that respondents were asked about. Table 5 shows the final selection of technical indicators for each service sector that are used for the correlation analysis.

For each service sector - drinking water, wastewater and waste - I test the hypothesis of a positive and significant relation between technical performance measures and levels of satisfaction from the survey. Besides correlating attribute specific satisfaction variables with the corresponding technical indicators, I also check whether there is a significant relation between the level of overall satisfaction with each of the technical assessment measures. This allows to determine if the overall satisfaction level of consumers can be reflected by any of the technical indicators of ERSAR and if there are indicators that can be used as a good ap-

proximation for general consumer satisfaction.

Table 5: Technical Performance Indicators

Technical Indicator	**Related Survey Question**
Water	
Safe water (compliance with parametric values)	Water quality
Compliance with water turbidity	Water quality
Affordability in terms of regional average disposable income	Value for money, Value for money compared to other services
Relative number of problems with the water supply	Interruptions
Level of rehabilitation of water pipes	Water pressure
Volume of real losses of water	Water pressure
Wastewater	
Affordability in terms of regional average disposable income	Value for money, Value for money compared to other services
Relative number of flooding	Visible wastewater in public
Relative number of collapses of collection drains	Visible wastewater in public
Shortage of labor (relative number of workers)	Problem response
Adequate destination of wastewater	Trust in the sewage process, Contamination of sea/rivers
Fulfillment of discharge criteria	Trust in the sewage process, Contamination of sea/rivers
Waste	
Accessibility of general waste services (relative number of general waste collection points)	Proximity of general waste containers
Recycling of packaging material	Trust in the recycling process
Accessibility of selective collection services (relative number of recycling collection points)	Proximity of recycling waste containers
Relative number of clean containers	Cleaning and maintenance

Since the variables of both datasets are of ordinal nature, the Spearman rank correlation is here the preferred correlation measure.[10] In contrast to Pearson's ρ, that is the most common correlation coefficient for finding a linear relationship between two variables, Spearman's ρ determines the strength of a monotonic relationship between variables and is a nonparametric statistic. The Spearman rank correlation does not assume a normal distribution and is appropriate when one or both variables are skewed, as it is the case of the survey data [35][7][8]. In the consumer satisfaction literature, the Spearman rank correlation is a common method to assess the relation between consumer satisfaction and other service quality measures (see for example Jenkinson et al. (2002) [16]).

[10] An alternative for measuring the association between two ordinal variables is the Polychoric correlation coefficient. While the Polychoric correlation assumes a continuous joint distribution of the variables, Spearman's rank coefficent is based on an inherently discrete joint distribution assumption and is therefore more appropriate for this analysis [12].

In order to have the same scaling across all variables and to increase the number of observations per category, I use the modified 3-point scale for the satisfaction variables from the first part of the analysis. Like this, we have on one hand the categorical variables for technical performance with a 3-point scale from "unsatisfied" to "good service quality" and on the other hand categorical variables for satisfaction with a 3-point scale from "unsatisfied" to "satisfied".

5.6 Consumers are not Technicians: Technical Indicators do not capture Consumer Satisfaction

Table 6, 7 and 8 show the reduced form of the Spearman correlation matrix for the water, wastewater, general waste and recycling sector, respectively. The number of observations for each pair of variables is reported below Spearman's ρ values. The extended matrix including all Spearman's ρ values can be found in the appendix.

Table 6: Spearman Correlation, Drinking Water

	Global Satisfaction	Water Quality	Water Pressure	Inter -ruptions	Problem Response	Value	Value, compared
Safe Water	-0.0353	0.0329	-0.0691*	-0.0320	-0.0279	0.0206	-0.1023*
	1067	*1059*	*1063*	*1051*	*893*	*1041*	*1047*
Turbidity	-0.0217	-0.0381	-0.0398	-0.0132	0.0121	0.0186	-0.0684*
	1067	*1059*	*1063*	*1051*	*893*	*1041*	*1047*
Affordability	0.0227	0.0023	-0.0965*	-0.0098	-0.0291	0.0244	0.0438
	1067	*1059*	*1063*	*1051*	*893*	*1041*	*1047*
Supply Problems	-0.0028	0.0280	0.0621	0.0136	0.0768*	0.0070	-0.0357
	964	*957*	*961*	*949*	*796*	*939*	*943*
Rehabilitation	0.0020	0.0754*	0.0197	-0.0187	-0.0215	-0.0012	0.0699*
	966	*960*	*964*	*953*	*805*	*942*	*946*
Real Water Losses	-0.0379	0.0155	0.0013	-0.0133	0.0151	0.0480	-0.0257
	992	985	989	977	826	967	973

* *p<0.05*

Generally speaking, it can be seen that the hypothesis of a monotonic positive and significant relation between technical indicators and consumer satisfaction is not confirmed by the findings from the correlation analysis in any of the sectors. The values of Spearman's ρ are almost always close to 0, reflecting a very weak monotonic relationship ($\pm$ 1 would be perfect positive/negative relationship), and are often not statistically significant at the 5% level.
For the drinking water sector, global satisfaction cannot be reflected by any of the technical indicators and also the attribute specific satisfaction variables do not have any strong and/or significant monotonic association with the technical indicators. Interestingly, some of the consumer satisfaction variables have a significant, although very weak, correlation with technical indicators that are intuitively not related to each other. An example is the relation between "Consumer satisfaction

Table 7: Spearman Correlation, Wastewater

	Global Satisfaction	Flooding	Problem Response	Smell	Contami -nation	Trust	Value	Value, compared
Affordability	-0.0116	-0.0124	-0.0433	-0.0539	-0.0601	0.0329	-0.0633	-0.1437*
	1068	*1054*	*821*	*1069*	*778*	*1004*	*841*	*851*
Flooding	0.0903*	0.0723*	0.0628	0.1775*	0.0769	0.0221	0.1323*	0.1187*
	890	*876*	*678*	*892*	*640*	*832*	*723*	*726*
Collapse	0.0781*	0.0703*	0.0941*	0.1424*	0.0243	0.0140	0.0240	0.0533
	926	*912*	*695*	*928*	*663*	*868*	*749*	*757*
Labor	-0.0695*	-0.0624	-0.1041*	-0.0274	-0.0137	0.0068	0.0499	-0.0303
	977	*963*	*743*	*978*	*702*	*920*	*774*	*784*
Destination	0.0442	0.0113	0.0151	0.0629*	0.0164	-0.0269	0.0710*	0.0242
	999	*985*	*758*	*1000*	*726*	*938*	*797*	*806*
Discharge	0.0112	-0.0630	-0.0180	0.0150	0.0479	0.0157	0.0181	-0.0692
Criteria	*711*	*700*	*538*	*711*	*512*	*667*	*544*	*554*

** p<0.05*

Table 8: Spearman Correlation, Waste

	Global Satisfaction	Cleaning / Maintencance	Waste Accumulation	Trust	Trust	Value	Value, compared
General Waste							
Accessibility	-0.0628	-0.0462	-0.0674*	-0.0818*	-0.0551	0.0025	0.0226
	967	*926*	*942*	*954*	*857*	*680*	*666*
Clean Containers	-0.0155	-0.0053	-0.1037*	-0.1356*	-0.0543	0.0127	-0.0027
	1025	*992*	*1007*	*1015*	*909*	*723*	*709*
Recycling Waste							
Accessibility	-0.0280	-0.0436	-0.0360	-0.0387	-0.0259	-0.0434	-0.1386*
	853	*846*	*869*	*869*	*784*	*626*	*615*
Clean Containers	-0.0130	-0.0053	-0.0283	-0.1356*	-0.0271	0.0127	-0.0027
	997	*992*	*1016*	*1015*	*917*	*723*	*709*
Recycling	-0.0256	-0.1636*	0.0234	-0.1436*	-0.0306	0.0194	-0.0535
	1038	*1027*	*1057*	*1055*	*954*	*750*	*738*

** p<0.05*

with the water pressure" and "Service affordability in terms of regional disposable income"(ρ=-0.0965). This finding just confirms that one cannot be confident by making any general inferences about consumers' satisfaction by simply looking at the results from ERSAR's technical assessment.

For the other sectors, the results from the Spearman correlation analysis are very similar, both in terms of ρ values and significance. Although we find some significant monotonic relations, they are very weak and not in line with our initial assumptions. For example, the variables "Consumer satisfaction with the proximity of containers" and "Accessibility in terms of the relative number of waste collection point" have a monotonic significant relation with ρ=-0.0674 for the general waste sector, but the negative value disconfirms the hypothesis of a positive relation of both variables.

6 Conclusions

This study aimed at understanding consumer satisfaction with water, wastewater and waste services in Portugal using unique national survey data collected by the Water and Waste Services Regulation Authority ERSAR. The analysis reveals that the large majority of survey respondents are generally satisfied with the water, wastewater and waste services provided by operators. This fact is not surprising, also because these services can be considered as low-involvement services. The lack of variety in terms of overall and attribute-specific satisfaction is at the same time the biggest limitation of this study since it constrained the analysis in terms of methodology. I followed the literature in adopting an ordered logit model for the given survey data.

The findings provide evidence that overall consumer satisfaction in each of the three sectors- water, wastewater and waste- is significantly influenced by attribute-specific satisfaction, but unrelated to socioeconomic and demographic characteristics of users. For the water sector, water quality, water pressure and the frequency of interruptions are the most significant drivers of overall satisfaction. Consumers that are higher satisfied with these service attributes are more likely to be generally satisfied with their drinking water operators. With regard to wastewater services, the level of trust in the wastewater treatment resulted to be the most important factor for the consumer's overall satisfaction. Therefore, operators should focus on initiatives that can strengthen the confidence of their users in order to improve the overall satisfaction of their clients. The results for the waste sector exhibit that general satisfaction is significantly influenced by consumers' satisfaction with the proximity and the cleaning and maintenance of containers, their satisfaction with the waste accumulation next to the collection points and their confidence in the treatment of general and recycling waste. The findings offer important suggestions to service providers, pointing at those service aspects that should be considered when defining strategies that focus on improving the overall satisfaction of users.

Regarding the relation between subjective and objective service quality measurement, the results do not provide evidence to support the claim that technical indicators can reflect consumers' satisfaction levels. This finding is in line with the literature that suggests that consumer satisfaction is rather influenced by expectations then by actual service quality. Therefore, it would be interesting to explore consumers' expectations with regard to water, wastewater and waste services in Portugal to find further explanations for the differences in satisfaction levels among consumers. The fact that one cannot make inferences about consumer satisfaction from technical indicators underlines the importance of consumer satisfaction surveys as an additional source for service quality measurement.

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