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Cost analysis of water charge rates in the Czech Republic – Case study

Keywords: water charge rates, calculation formula, water management companies, regions of the Czech Republic, vertical analysis, horizontal analysis

Introduction

The issue of water is becoming increasingly important worldwide and is currently a broadly discussed topic. A significant loss of water is a result of global warming and lack of rainfall. Groundwater depletion and drying up of wells occur in the Czech Republic yearly. It is essential to manage water resources economically, protect them systematically and prevent their pollution. It is obvious that a shortage of goods or services on the market reflects their increase in the price. The analysis of wastewater management in small and medium-sized textile (batik) enterprises in Pekalongan City was addressed by Dwidayati (2020). Information publication and data provision are another big issues for individual companies. Water information provision, which is a carrier for corporate information on water resource management, is a means of expressing corporate environmental responsibility. Therefore, He, Shen, Xu, Sun and Wang (2023) focused on companies and their water information provision.

However, the price of water in the Czech Republic is not only driven by its deficiencies due to global warming. Drinking water and water diverted through sewers

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is included in the list of goods with regulated prices, which is issued annually by the Ministry of Finance of the Czech Republic under the Price Act and is available in the Price Bulletin. In her article, Kejser (2016) explores the spatial heterogeneity in the public attitude towards internalizing environmental and resource costs in the price of water across the EU regions.

There are different rules for water pricing around the world. Since water is a state issue in India, for example, there are huge differences in the pricing of irrigation water from state to state. Parween, Kumari and Singh (2021) review the structures of the water pricing mechanism in different states of India and suggest a way to achieve sustainable water resources management in India. Ashoori, Dzombak and Small (2017) discuss the determination of water price and population criteria for meeting future urban water demand targets. The research concluded that water demand in Los Angeles is expected to increase by 36% between 2014 and 2025 due to climate change. It also predicted that future residential water demand in Los Angeles will be largely driven by price and population, rather than climate change and savings. The same approach applies to the pricing level of water and sewerage charge rates, which represent the provision of public service in the sense of operating water and sewer systems.

The price of water has been constantly rising according to the internet server eAGRI.cz and the Czech Statistical Office (Český statistický úřad). While in 2010 the price of drinking water was 29.10 CZK·m^{-3} without value added tax (VAT), in 2020 the price of drinking water rose to 41.40 CZK·m^{-3} without VAT. Even the year 2022 has been experiencing a considerable increase in the price of water and sewerage charge rates. Water companies attribute this to the rising costs and the need to invest in infrastructure. The coronavirus pandemic has also had an impact on water price calculations since 2020. The war in Ukraine at the beginning of 2022 has triggered a new wave of a rapid increase in the price of products and services, so the increase in prices has affected and will continue to affect all sectors of the economy in the future. This concludes that the war in Ukraine has an impact on the price of water. At present and in the given situation, it is very difficult to estimate the development of water and sewerage charge rate prices in the Czech Republic in the future. However, some mathematical models can predict their course under appropriately set calculation conditions. Oblouková (2023) deals with the issue of water and sewerage charge rate prices in the Czech Republic. The aim of the paper is to use the obtained data to predict the development of average water and sewerage charge rate prices in the Czech Republic in the years 2022–2026 using the chosen mathematical method. The most appropriate method for this research is the linear trend technique. This method has been pre-tested for relevance and suitability in pre-

vious research. However, it must be said that the chosen method does not take into account any external macroeconomic influences. It does not even consider the huge increase in inflation since February 2022, when the rapid price increases caused by the war in Ukraine began. An increase in the inflation rate is considered only at the end of the calculation, where the effect of inflation on the water and sewage charge rate prices is shown. Volf, Sušanj Čule, Žic and Zorko (2022) indicate in their studies the water quality index prediction for improvement of treatment processes in a drinking water treatment plant. Therefore, obtained models can help in the optimization of treatment processes, which depend on the quality of raw water, and overall, on the sustainability of the treatment plant.

It is often stated in the scientific literature that the Czech Republic lies in the heart of Europe as it is located approximately in the centre of Europe. The Czech Republic is not a large country. According to the Czech Statistical Office (www.czso.cz), the population as of 31 December 2022 was 10.828 million. Since 2021 there has been an increase of 3.1 million inhabitants. This increase is due to the massive immigration wave related to the armed conflict in Ukraine. Except for the decline in 2013 (by 0.4 million people), the population has grown each year in the past 10-year period (between the beginning of 2013 and the end of 2022). The Czech Republic is divided into 14 regions – the Capital City of Prague, the Central Bohemian Region, the South Bohemian Region, the Plzeň Region, the Karlovy Vary Region, the Ústí nad Labem Region, the Liberec Region, the Hradec Králové Region, the Pardubice Region, the Vysočina Region, the South Moravian Region, the Olomouc Region, the Zlín Region, and the Moravian-Silesian Region. Individual regions have different performance levels. The performance of individual regions is measured by several factors, the main ones being macroeconomic, including gross domestic product, unemployment, and others.

The eagri.cz website (www.eagri.cz) lists the price of water and sewerage charge rates nationwide and for individual regions. As water and sewerage operators transformed from state-owned companies to mostly joint stock companies in the 1990s, i.e. capital companies that aim to satisfy their shareholders through dividend payments, it is not always the case that the well-performing region has the highest water and sewerage charge rates. Therefore, Vítková, Vaňková and Oblouková (2022) focused both on the performance of the regions and the performance of the water and sewerage management companies that run them. Oblouková and Vítková (2023) in another article examined the development of water and sewerage charge rates in the Czech Republic over the last 14 years and pointed out the difference in the percentage ratio between the components of water and sewerage charge rates in the regions in comparison to the national average values. Liu, Wu, Xu and Pan (2018) examined

the relationship between wastewater discharge, river water quality in the Pearl River Delta, and gross domestic product per capita. They used a logarithmic mean Divisia index (LMDI) decomposition model as well as an environmental Kuznets curve (EKC) model for their research. Maziotis, Saal, Thanassoulis and Molinos-Senante (2014) investigated changes in profit, productivity and price performance in the water and sewerage industry: an empirical application for England and Wales. This study analysed the impact of regulation on the financial performance of water and sewerage companies in England and Wales over the 1991–2008 period. In another paper, Molinos-Senante and Maziotis (2021) examined productivity growth, economies of scale and scope in the water and sewerage industry: the Chilean case, in another article. In this paper, they focused on the performance evaluation and cost driver analysis of water management companies, where they used quadratic cost functions to investigate the existence of savings in the Chilean water and sewerage industry during the 2010–2017 period.

The article deals with the issue of the price of water charge rates. The article is focused only on one aspect of the research, namely on the cost analysis of water charge rates in the Czech Republic. The sample was selected to include individual groups of company sizes, as well as cities or municipalities as public administrators. When selecting the samples, the criterion was observed that the subject should operate in a certain area, i.e. all regions of the Czech Republic should be included in the analysis.

In environmental projects, decision-making can be a complex and challenging task due to the in-built existence of compromises between environmental, sociopolitical, and economic factors. Jajac, Marović, Rogulj and Kilić (2019) explore a systematic approach to developing a decision support concept that includes the analysis of wastewater treatment problems, knowledge acquisition, and the identification and evaluation of criteria that bring forth an optimal solution to the location selection of wastewater treatment plants (WWTPs).

The environment is one of the most discussed topics today. It permeates all sectors of industry and services. Water management is a separate chapter. Water companies increase the price of water every year. However, each business may be affected by other factors that impact the price of water. The research described in the article aims to assess or challenge the conclusion of whether any dependence can be found between the size of the company within the representation of each price cost of water charge rates. The paper focuses specifically on water charge rates as it concerns more than 96% of the population of the Czech Republic. Sewerage charge rates have a lower percentage representation due to non-connection to the sewerage system, e.g. due to a septic tank for the house. Many variables enter the cost price

of water management companies. It is known which cost components are included in the price of water, but not the average values or the percentage representation of the individual components. The result of the research is finding out which costs have the greatest influence on the price of water.

The article represents only an initial insight into the issue. The total number of samples assumed in the analysis was in the order of 100 operators in the Czech Republic, which amounts to working with 400 pieces of calculation samples, thus analysing more than 26,000 pieces of data. As the criteria for the selection of operators were set for the case study, the final number of samples was narrowed down to 14 representative operators. The article is not focused on the statistical evaluation of the analyzed data, it is an analysis of the specific costs shown in the price of water and the possible finding of connections between the amount of specific costs and the size and type of companies.

Material and methods

The Ministry of Finance is the price regulator in the water supply and sewerage sector, which regularly rearranges the price regulation settings, and the Ministry of Agriculture is the substantive regulator. The Act No. 274/2001 Coll., on water supply and sewerage for public use, as amended, regulates certain relations arising in the development, construction and operation of water supply and sewerage systems intended for public consumption in the Czech Republic. A Decree of the Ministry of Agriculture implementing Act No. 274/2001 Coll., on water supply and sewerage for public use as amended was also issued for the purpose, which is Decree No 428/2001 Coll. The primary source for determining the development of average water charge rates in the Czech Republic was the Czech Statistical Office. This is the central government body of the Czech Republic. It was established on 8 January 1969 by Act No. 2/1969 Coll., on the establishment of ministries and other central bodies of state administration. The Water supply and sewerage act as well as the price regulation use a unit price in Czech crown per cubic meter ($CZK \cdot m^{-3}$).

The case study, which deals with the cost analysis of water charge rates in the Czech Republic, focuses on the operators of water supply and sewerage systems in the Czech Republic. All data obtained from the operators in the Czech Republic was narrowed down to the time horizon of the past four years, i.e. 2018–2021, due to the complexity of the available information. All formulas and calculations were made using Microsoft Excel software.

The article first examines the issue of the price level of the water rate development in the Czech Republic as a whole and subsequently in the individual regions of the country. For each region, one representative – a water management company, which usually has only one specific supply point – was selected for the cost analysis of water charge rates, where the percentage interval of each type of cost entering the water charge price was set. Large and medium-sized companies, small and micro companies as well as specific municipalities or cities were chosen as representatives.

The following factors were observed in the selection of the sample operators:

– selection of one operator per region of the Czech Republic;
– the selection of the operator had to fulfil the condition of only one location of supply (or maximum two) within the given region of the Czech Republic;
– selection of the operator based on the above-stated points must not have interfered with other regions of the Czech Republic;
– selection of the operator was limited by the size of the company (micro, small, medium-sized, and large entities) in a 3 : 3 : 3 : 3 ratio;
– selection of the operator was limited by the representation of at least one representative of the public sector, i.e. a city or a municipality (two such representatives were considered in the case study).

To comply with the above-mentioned factors, it was necessary to work first with about 100 operators, i.e. work with 100 calculation formulas each year, i.e. a total of 400 calculation formulas (the years under consideration were 2018–2021). In total, 26,000 values were worked with to select suitable representatives of water management companies. The shortlist needed to study approximately 50 annual reports and financial statements from 2021 to establish values for number of employees, total assets, and sales to identify and select the correct size of water management companies. Following a complex and time-consuming selection process, 14 selected operators as well as representatives from each region have already been worked with and 1,736 values have been processed. Furthermore, 1,736 values were determined by vertical analysis with their assistance. These values have already been used in the analysis to establish whether there is a relationship between the percentage of costs and the size of the company in the pricing of water charge rates.

The vertical analysis is the basic methodology chosen for the cost analysis of the water charge rates of the selected Czech operators. It is one of the basic methods of financial analysis. Financial analysis is used to assess the financial performance of an entity and to evaluate the financial position of that entity. It works with data obtained from the financial statements. The outputs are primarily used for tactical and strategic investment and financing decisions and for reporting to owners, creditors, and other stakeholders. The principle of the analysis is the calculation of indica-

tors (elementary, ratio, aggregate) that have good explanatory power concerning the economic reality under study. Elementary indicators include horizontal and vertical analysis. Vertical analysis describes the representation of individual items related to the whole. It is expressed as an absolute number or as a percentage. The second elementary indicator is the horizontal analysis, which describes the annual change of items in absolute terms or as a percentage and expresses how the items have changed compared with the previous year. In other words, it is a horizontal, i.e. a line-by-line comparison of the absolute or relative changes in the items of a given statement over time. It is a useful indicator for determining the annula percentage change (increase or decrease) in the average price of water and sewerage charge rates in the Czech Republic. The horizontal analysis is calculated according to the following relation:

$$horizontal\ analysis = \frac{indicator_t - indicator_{t-1}}{indicator_{t-1}} \cdot 100, \tag{1}$$

where *horizontal analysis* is the year-on-year change of items [%], $indicator_t$ is the price of water charge rates in the year under review [CZK·m^{-3}] and $indicator_{t-1}$ is the price of water charge rates in the previous year [CZK·m^{-3}].

A vertical analysis is suitable for the research dealt with in this paper, i.e. the cost analysis of water charge rates of selected operators in the Czech Republic. It is calculated according to the relation:

$$vertical\ analysis = \frac{indicator_i}{indicator_x + indicator_y} \cdot 100, \tag{2}$$

where *vertical analysis* is the representation of individual items related to the whole [%], $indicator_i$ is the individual cost component in the year under review [CZK], $indicator_x$ is the full own cost for calculating water charge rates in the year under review [CZK] and $indicator_y$ is the calculation profit of the year under review [CZK].

The arithmetic mean was used to determine the average values:

$$\overline{x} = \frac{1}{n}\sum_{n=1}^{n} x_i, \tag{3}$$

where $\overline{x}$ is the average values [CZK], x_i is the sum of all values to determine the average [CZK] and n is the number of values to be summed [-].

Vertical analysis is used in this paper to calculate the percentage representation of the different cost components in the pricing of water charge rates. Horizontal analysis is used to determine the evolution of water charges over the period under consideration.

The mathematical median function was also used in the Microsoft Excel calculations. The median is a value that divides a series of results into two halves. Thus, at least 50% of the values are less than or equal to the median and at least 50% of the values are greater than or equal to the median. This method is useful in calculating the representation of the main cost items in the calculation formula.

The Czech Republic is divided into three areas Bohemia, Moravia and Silesia, which are divided into 14 regions – the capital City of Prague, Central Bohemia Region, South Bohemia Region, Plzeň Region, Karlovy Vary Region, Ústí nad Labem Region, Liberec Region, Hradec Králové Region, Pardubice Region, Vysočina Region, South Moravia Region, Olomouc Region, Zlín Region, and Moravia-Silesia Region (Fig. 1).

FIGURE 1. Regions of the Czech Republic
Source: own elaboration.

Table 1 presents the price level of the average water charge rates of the Czech Republic for the 2018–2021 period. The price increases each year by an average of 4.76%. In 2019, the price increased by 3.15% compared to the previous period, while in 2021 the largest increase was 5.80%. Then, the development of average water charge rate prices in individual regions of the Czech Republic is presented.

TABLE 1. Average prices of water charge rates in the Czech Republic and in the regions of the Czech Republic without VAT in 2018–2021

Specification	2018	2019	2020	2021
	CZK·m^{-3}			
Czech Republic	38.10	39.30	41.40	43.80
Capital City of Prague Region	42.00	42.70	45.20	49.90
Central Bohemia Region	40.90	41.90	45.10	47.10
South Bohemia Region	37.00	37.60	39.20	40.50
Plzeň Region	39.20	40.80	43.60	46.10
Karlovy Vary Region	38.20	40.10	41.90	43.60
Ústí nad Labem Region	43.40	44.20	46.00	48.80
Liberec Region	44.20	44.80	45.60	48.10
Hradec Králové Region	34.90	36.10	37.40	39.00
Pardubice Region	34.10	35.90	37.40	39.40
Vysočina Region	37.10	38.50	40.10	41.80
South Moravia Region	34.50	36.10	39.40	41.60
Olomouc Region	33.10	34.10	35.80	37.10
Zlín Region	35.80	37.20	38.30	40.10
Moravia – Silesia Region	34.40	36.20	37.90	39.90

Note: 1 EUR = 25.00 CZK.

Source: own elaboration based on www.eagri.cz, www.czso.cz.

Table 2 then shows the annual percentage increase in average water charge rates in the regions of the Czech Republic over the period under review.

TABLE 2. Horizontal analysis: year-on-year change in the average water charge rates in the Czech Republic in the period of in 2018–2021

Region	2018/2019	2019/2020	2020/2021	Average
	%			
Capital city of Prague	1.67	5.85	10.40	5.97
Central Bohemia	2.44	7.64	4.43	4.84
South Bohemia	1.62	4.26	3.32	3.06
Plzeň	4.08	6.86	5.73	5.56
Karlovy Vary	4.97	4.49	4.06	4.51
Ústí nad Labem	1.84	4.07	6.09	4.00
Liberec	1.36	1.79	5.48	2.88
Hradec Králové	3.44	3.60	4.28	3.77
Pardubice	5.28	4.18	5.35	4.93
Vysočina	3.77	4.16	4.24	4.06
South Moravia	4.64	9.14	5.58	6.45
Olomouc	3.02	4.99	3.63	3.88
Zlín	3.91	2.96	4.70	3.86
Moravia – Silesia	5.23	4.70	5.28	5.07

Source: own elaboration.

Representatives of individual regions were selected for the purpose of cost analysis of water management companies in the Czech Republic. These representatives of water management companies in each region were analysed over a period of four years, i.e. 2018–2021. According to the Accounting Act No. 563/1991 Coll., it is possible to categorize entities (companies) according to their size. Following this law, companies are divided according to the number of employees, the amount of assets and the number of sales:

– micro companies;
– small companies;
– medium-size companies;
– large companies.

The size of the selected water management companies was verified on the website Justice.cz, where the Ministry of Justice of the Czech Republic presents legislation that affects the life of every citizen in the areas of civil, commercial, criminal, and procedural law. The Ministry of Justice is also the source of the regulations governing professions such as judges, lawyers, notaries, and executors. On this web portal, among other things, each company is required to publish its annual final accounts, where the information on assets and sales can be found.

The selection of operators was very difficult due to the set of variety factors mentioned above. It is typical for some operators to supply water to multiple locations, i.e. multiple regions. Another difficulty was in determining the water charge rate within the setting of the calculation formula, i.e. publishing this data for four years under review, 2018–2021. Information on the costs of individual water management companies was obtained from the eagri.cz website. According to the provisions of Section 5(3) of the Act on Water Supply and Sewerage, owners of water supply and sewerage systems are obliged to submit annually the selected data from the Property Register of Water Supply and Sewerage Systems, the so-called VÚME (*Vybrané údaje majetkové evidence*), and the selected data from the Operational Register of Water Supply and Sewerage Systems, the so-called VÚPE (*Wybrané údaje provozní evidence*), to the water authorities in whose territorial jurisdiction the property is located. It should be said that the VÚME and VÚPE data provide data beyond the scope of the CSO survey. The main reason for setting the 2018–2021 reporting period was the fact that electronically traceable data on water and sewerage charge rates have only been recorded from 2018 onwards. Table 3 shows the selected representatives/operators for each region of the Czech Republic and the distribution of the selected water supply and sewerage operators according to the size of the company – a summary of the operators and whether they are large or small companies. The assessment is based on the 2021 financial statements.

TABLE 3. Selected representatives of water supply and sewerage operators in the Czech Republic and the size of their accounting units

Region	Operator	Water supply location	Type of company
Capital city of Prague	Letiště Praha, a.s.	Letiště Praha	large account unit
Central Bohemia	Středočeské vodárny, a.s.	Kladno – Mělník	large account unit
South Bohemia	Městská Vodohospodářská s.r.o.	Třeboň	small account unit
Plzeň	Vodovody a kanalizace města Kdyně spol. s.r.o.	Kdyně	micro account unit
Karlovy Vary	CHEVAK Cheb, a.s.	Chebsko – regional price	medium-size account unit
Ústí nad Labem	Ludvíkovice municipality	Ludvíkovice	municipality
Liberec	Zásadská vodárenská společnost, s.r.o.	Zásada	micro account unit
Hradec Králové	VODA-RA s.r.o.	Radvanice	micro account unit
Pardubice	Vodovody a kanalizace Pardubice, a.s.	Pardubice	large account unit
Vysočina	Technické služby Třešť, spol. s r.o.	Třešť	small account unit
South Moravia	Vodovody a kanalizace Vyškov, a.s.	Vyškov	medium-size account unit
Olomouc	Town of Štíty	Štíty, Heroltice	city
Zlín	Slovácké vodárny a kanalizace, a.s.	Uherskohradišťsko, Uherskobrodsko – regional price	medium-size account unit
Moravia – Silesia	Vodovody a kanalizace Hlučín, s.r.o.	Hlučín	small account unit

Source: own elaboration based on www.eagri.cz, www.justice.cz.

Results and discussion

As already mentioned above, prices for water and sewerage fall among the prices that are subject to substantive regulation, i.e. prices for which the method of determination is regulated by law and other legal regulations. These are pursuant to the provisions of Sections 8 and 20 of Act No. 274/2001 Coll., on water supply and sewerage for public use, as amended, and Act No. 526/1990 Coll., on prices, as amended. The method of determination in this case means the binding procedure for calculating the price and calculating the amount of reasonable profit included in the price. Nearly 11 million people in the Czech Republic are supplied with water. The Czech Republic is made up of 14 regions, each of which differs in its performance.

Based on the above-stated data for the cost analysis of the Czech Republic's water rates included in the research, the following conclusions were drawn. It is necessary to point out that the research is still in its early stages, i.e. the input data, on the basis of which the analyzes and conclusions on this issue are compiled, can be considered as so-called pilot (initial) research, which provides insight into the given issue. All the outputs given below have been developed based on each step namely data collection, data processing and data evaluation using Microsoft Excel.

After conducting a complex analysis of the operators of the Czech Republic, finding representatives of the operators of each region of the Czech Republic so that they meet the predefined condition that the selected operator must supply water to only one location (maximum two), an analysis was carried out in which the size of the entity/company was traced to the selected operator. In this case, the selected operators were classified according to the criteria described above into large companies, medium-sized companies, small companies, micro companies, cities, and municipalities (Table 3). The next step led to the actual cost analysis of water charge rates for the identified operators in the regions of the Czech Republic. The case study was conducted to confirm or refute the assumption that there is a connection between the percentage of costs and the size of the company in the pricing of water charge rates. Vertical analyses were compiled from the calculation formulas of individual operators for the years 2018–2021, i.e. research was carried out into the representation of individual cost components entering the price of water charge rates over a four-year horizon. For illustrative purposes, one operator for which the complete calculating formula was shown and the percentage representation of each cost to all items in the water charge rates pricing formula was determined, was selected (Table 4).

Similarly to Table 4, the same process has been carried out for all 14 operators, i.e., 14 costing analyses in terms of vertical analysis have been created for the 2018–2021 period. Table 5 shows the average representation of the type of cost-material items for all 14 operators.

The most common value is a percentage representation of material ranging around 20%. For accuracy, the median was determined, which in this case was 21.58%. Thus, in this case, it can be said that the material item ranges from 16.13% to 27.19%. This methodology was applied to all the above types of cost items (Table 6).

There is no obvious connection between the size of the company and the percentage allocation of individual cost items in water charge rate determination. This means that different water management companies have different percentage representation of material, energy, wages, other direct costs, and operating costs, regardless of whether they are a micro company, a small company, a medium-sized company, a large company or a specific municipality or city. Selecting and mapping

TABLE 4. Percentage representation of individual cost items and other items constituting the price of water charge rates in Pardubice – Vodovody a kanalizace Pardubice, a.s.

No.	Cost items	2018	2019	2020	2021
		%			
1	material	22.12	21.05	20.26	22.20
1.1	- raw groundwater + surface water	7.41	6.53	5.93	5.86
1.2	- drinking water collected	8.40	8.61	9.46	11.40
1.2	- chemicals	0.29	0.28	0.32	0.47
1.4	- other material	6.02	5.62	4.56	4.48
2	energy	3.23	3.66	3.26	2.92
2.1	- electric energy	3.07	3.44	3.10	2.83
2.2	- other types of energy (gas)	0.16	0.22	0.16	0.09
3	wages	6.29	6.92	6.68	7.37
3.1	- direct wages	4.69	5.17	5.00	5.52
3.2	- other personal costs	1.59	1.74	1.68	1.85
4	other direct costs	50.75	48.28	51.90	48.05
4.1	- depreciation	23.97	22.11	20.75	18.31
4.2	- repairs	26.70	26.12	31.11	29.72
4.3	- rental of infrastructure assets	0.08	0.06	0.05	0.02
4.4	- water delivered	0.00	0.00	0.00	000
5	operating costs	4.07	3.11	3.73	3.67
5.1	- wastewater discharge charges	0.00	0.00	0.00	0.00
5.2	- other external operating costs	2.72	2.33	3.05	2.91
5.3	- other own costs	1.35	0.78	0.68	0.76
6–9	financial income and expenses, production and administrative overhead	10.46	11.49	12.03	12.90
10	full own costs	96.91	94.51	97.87	97.11
11–12	calculation profit	3.09	5.49	2.13	2.89
13	total	100.00	100.00	100.00	100.00

Source: own elaboration.

the calculation formula of each water management company to meet the set criteria was lengthy and tens of thousands of data items need to be reviewed to compare companies among themselves and to determine average values of the representation of each cost item.

However, the analysis carried out allows for the determination of an interval for each cost component, within which it is clear what percentage level the individual cost enters. The following procedure was therefore set out. For all 14 operators,

TABLE 5. Average percentage representation of material in the calculation formula for selected operators over the 2018–2021 horizon

Company size	Operator	Region	Material [%]
Large account unit	Vodovody a kanalizace Pardubice, a.s.	Pardubice	21.41
Large account unit	Středočeské vodárny, a.s.	Central Bohemia	10.40
Large account unit	Letiště Praha, a.s.	Capital City of Prague	79.51
Medium-size account unit	Slovácké vodárny a kanalizace, a. s.	Zlín	16.13
Medium-size account unit	Vodovody a kanalizace Vyškov, a.s.	South Moravia	13.83
Medium-size account unit	CHEVAK Cheb, a.s.	Karlovy Vary	9.30
Small account unit	Technické služby Třešť, spol. s.r.o.	Vysočina	22.35
Small account unit	Městská Vodohospodářská, s.r.o.	South Bohemia	82.93
Small account unit	Vodovody a kanalizace Hlučín, s.r.o.	Moravia – Silesia	27.19
Micro account unit	Vodovody a kanalizace města Kdyně spol. s r.o.	Plzeň	21.76
Micro account unit	Zásadská vodárenská společnost, s.r.o.	Liberec	19.86
Micro account unit	VODA-RA s.r.o.	Hradec Kálové	22.84
Town	Town of Štíty	Olomouc	20.11
Municipality	Ludvíkovice municipality	Ústí nad Labem	96.83

Source: own elaboration.

the main cost items have been examined and the percentage of the individual costs in relation to the total has been calculated. Subsequently, the averages of the percentage values of the individual cost items were determined from four years under review. These averages of the percentage representation of each cost item have been compared among all operators in the analysis. Subsequently, for each major cost component, their most frequent intervals for the respective operators were created. For each cost item, abnormalities were excluded from the analysis.

It can be concluded from the research carried out that it is not possible to determine an average percentage value of the main cost items that would represent companies according to their size. No similarity was found in the data. However, it was possible to determine the range of most frequently occurring values for each major cost item determined regardless of the company size. After separating the most frequently occurring values from the less frequent or exceptional ones, it can be said that in the frame of this case study:

- material ranges from 16.13% to 27.19% of the total cost and profit of the companies; it is represented by the cost of raw groundwater and surface water, potable water collected, chemicals and other materials;

TABLE 6. Average percentage representation of the main cost items in the calculation formula for selected operators over the 2018–2021 horizon, median, min and max, average of min and max

Region	Material	Energy	Wages	Other direct costs	Operating costs
			%		
Pardubice	21.41	3.27	6.81	49.75	3.65
Central Bohemia	10.40	5.57	6.45	44.02	14.47
Capital City of Prague	79.51	1.39	33.78	15.48	1.82
Zlín	16.13	5.01	30.17	25.17	7.77
South Moravia	13.83	3.61	19.17	35.83	6.98
Karlovy Vary	9.30	5.62	5.44	47.34	6.46
Vysočina	22.35	5.70	29.44	11.97	8.81
South Bohemia	82.93	4.36	3.80	8.71	4.88
Moravia – Silesia	27.19	1.53	19.91	31.83	3.04
Plzeň	21.76	10.82	33.60	6.89	12.85
Liberec	19.86	0.63	30.37	34.09	7.99
Hradec Králové	22.84	21.15	31.35	10.51	12.36
Olomouc	20.11	1.73	6.45	123.84	14.05
Ústí nad Labem	96.83	0.21	22.00	37.46	14.65
Median	21.58	3.99	20.96	32.96	7.88
Lowest interval value considered	16.13	1.39	19.17	25.17	3.04
Maximum interval value	27.19	5.70	33.78	49.75	14.65
Min and max average	21.46	3.78	27.76	38.19	9.07

Source: own elaboration.

- energy is the lowest cost item, consisting of electricity and other energy and ranging from 1.39% to 5.70%;
- wages range around 19.17–33.78%;
- other direct costs range from 25.17% to 49.75% and are represented by depreciation, repairs, rent of infrastructure assets and water supplied;
- operating costs, which include sewage discharge charge rates, external operating costs and own overheads, range from 3.04% to 14.65%.

As explained above, it was not possible to include all the data in the average, so intervals of values were set, however, it was possible to determine the average of the values taken in the interval:

- material 21.46%;
- energy 3.78%;
- wages 27.79%;

- other direct costs 38.19%;
- operating costs 9.07%.

It should therefore be noted that the median was always taken from all observed values in the case study:

- material 21.58%;
- energy 3.99%;
- wages 20.96%;
- other direct costs 32.96%;
- operating costs 7.88%.

The research described in the article aims to assess or challenge the conclusion of whether any dependence can be found between the size of the company within the representation of each price cost of water charge rates. However, the analysis shows that there is no obvious connection between the size of the company and the percentage allocation of individual cost items in water charge rate determination.

The aim of the research is also about finding out which costs have the biggest impact on the price of water. The research shows that the highest percentage representation of costs is found in other direct costs, the second highest percentage representation of costs is found in wages, the third highest representation of costs occurs in the material and the lowest intervals of percentage representation include operating costs and energy.

Conclusions

The research described in the paper aimed to determine the percentage representation of the types of costs in the unit price of water charge rates in the Czech Republic using vertical analysis, with a focus on demonstrating the dependence between the percentage representation of costs in the unit price and the size of the analyzed company. As already mentioned above, the research can be considered for the time being as pilot (initial) research, which provides an initial insight into the given issue. The conclusions drawn from the analyzes cannot be considered statistically relevant in the initial phase of the research, nor can they be understood as a representative sample for the entire Czech Republic and its individual regions. These are initial cost analyzes of the price of water, which will subsequently be confirmed by analyzing additional input data in the next step of the research. In total, 14 operators were taken into the research in the case study and had to meet certain factors in their selection, namely the selection of one operator per region of the Czech Republic.

The selection of the operator had to meet the condition of delivery to only one point of consumption (or maximum two) within the given region of the Czech Republic, the selection of the operator based on the above-stated factors must not interfere with other regions of the Czech Republic. The selection of the operator was limited by the size of the company (micro, small, medium-sized, and large companies) in the ratio 3 : 3 : 3 : 3, the selection of the operator was limited by the representation of at least one representative of the public sector, i.e. a city or a municipality (in the case study two such representatives were considered). A sample selection of 14 representatives for each region of the country was based on processing 26,000 data pieces where the years 2018–2021 were taken as the reference period, which was subsequently narrowed down to 1,736 values that entered the cost analysis. The sewerage charge rate was not addressed because not all water users are connected to the sewer system and use, for example, septic tanks.

Thus, the analysis was developed for 14 representatives/operators for which the types of costs were monitored and analysed for the 2018–2021 period. For these costs, which were narrowed down to the main item costs such as material, energy, wages, and other direct and operating costs, an interval within which the given value range was set at the very end. This interval was determined based on the minimum and maximum values that occurred in the vertical analysis. This analysis shows that there is no dependence between the size of the operator and the percentage share of the types of costs in the unit price of water charge rates. The ranges for each type of cost are shown in Table 6, where a conclusion was drawn in terms of the most frequently represented cost items from the water charge rate calculation formula, namely:

- the highest percentage representation of costs is found in other direct costs, where the largest burden is in the depreciation of infrastructure assets, whose absolute amount is in millions of CZK (1 EUR = 25.00 CZK) and ranges from 25.17% to 49.75%;
- the second highest percentage representation of costs appears in wages and salaries, ranging from 19.17% to 33.78%;
- the third highest percentage of costs occurs in materials, ranging from 16.13% to 27.19%;
- the lowest intervals of percentage representation include operating costs and energy, which range in the order of ten per cent.

It can be stated from the above-stated facts that further analysis in the ongoing research will focus on the highest percentage of costs, namely other direct costs, wages, and materials.

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Zákon č. 563/1991 Sb., o účetnictví [Act No. 563/1991 Coll., on Accounting].

Summary

Cost analysis of water charge rates in the Czech Republic – Case study. The article was conceived as an initial insight into the issues related to the representation of individual type costs (e.g. material, labor costs, property depreciation, etc.) in the price of water in the Czech Republic. The aim of the article was to point out the possibility of dependence between the size of the company operating the infrastructural property of water supply and sewerage and the representation of individual costs in the water price within the framework of the case study. As a sample that formed the outputs of the case study, 14 companies were

taken, which were selected according to the unified regions of the Czech Republic. Both basic mathematical methods and elementary methods used in financial analysis were used in the analysis. Within the scope of the case study, it can be stated that there is no dependence between the size of the companies and the representation of costs. Among the largest costs from the point of view of financial representation are other direct costs, where the costs of depreciation, property repairs, rental property, as well as wage costs and material costs are mainly represented. Insignificant costs include, for example, energy costs, which are only represented in the range of 1.39–5.70% of the total costs. Therefore, in order for the results included in the case study to be considered statistically relevant, it is necessary to expand the sample and confirm or refute the initial findings published in this article.