

An exploratory approach for evaluating the energy and personnel share of operation and maintenance costs for water utilities in selected emerging economies of Europe

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ABSTRACT

This study provides an analysis of specific performance indicators for water utilities in four countries, Albania, Hungary, Poland and Romania. The annual operational and staff cost indicators from records of the IBNET database have been analysed. Statistical analysis indicates significant differences between the fraction of energy and labour operational costs among the countries studied. Some statistically significant correlations of performance within financial indicators are also revealed. The results can provide input for more in-depth technical and economic analysis for water utilities.

Key words | energy cost, financial performance, IBNET, labour cost, sustainability, water utilities

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INTRODUCTION

Restructuring the water sector has been at the top of the agenda of most Balkan, Central and East European ex-communist countries during the last two decades (Beggoli & Lajçi 2013; Bogdanović *et al.* 2013; Ciomoş & Zaharia 2013; Gjinali & Minarolli 2013; Zulic 2013). Certain practices have been (or should be) undertaken in order to address the goals outlined in the policy agendas of these countries, such as corporatisation and privatisation of water utilities. These practices are a result of the economic reforms adopted after the fall of communist

regimes and the desire of the emerging economies to engage in the European Union (EU) (Trybus 2006). Emerging European economies are therefore trying to harmonise their regulation regimes, infrastructures and economic performance with other members of the EU. As in-depth analysis can provide insights into the performance of water utilities and lessons for other countries, data from four countries were analysed. A brief outline of the status of water policy in each of these countries is also presented.

Water sector reform in Albania

Major reform in the Albanian water sector came about with the enforcement of Law 8102, dated 28.03.1996, as amended (Republic of Albania 1996). Among the major outcomes of this law was the establishment of the Water Regulatory Authority (WRA) of Albania, in 1998. It is a public body in charge of the regulation of the water and sewerage service in the country (WRA 2013). Today there are 57 water operators, of which 50 operators are licensed and 44 apply tariffs approved by WRA. Not all the operators that provide the water supply perform the wastewater treatment as well; only 30 of them perform both kinds of service and just five of them are licensed for wastewater treatment. The registered operators with WRA supply water for 80% of the country's population. The remaining population is supplied with water by other departments of local governments not affiliated with WRA.

As a precondition of the water supply service, the operators should fulfil all required documentation, in accordance with the Licensing Regulations approved by the decision of the National Registration Center No. 29 dated 08.12.2009, for submitting a licence to WRA. Once the licence is submitted, based on the law, every year (until 30th June) the operators are allowed to apply for tariff setting. The approval for tariff adjustments is only given to the utilities that meet the Key Performance Indicators targets for technical and financial performance as set by the WRA. Concerning the performance of water utilities, WRA published reports in 2011 and 2012 on the performance of water utilities (WRA 2012).

Water sector reform in Hungary

Major reform in the Hungarian water sector took place after the 1990s with the change in the political situation of the country. The reform was towards governance of water utilities and this also resulted in new tariff policies. For example, one cubic meter of water was charged at 0.03 € (10 HUF) in 1989, 0.12 € (40 HUF) in 1994 and 0.72 € (240 HUF) in 2013 in the city of Kaposvar. Until recently, water tariffs were a matter of political decision and were not based on financial returns. The most recent reform in tariffs was introduced by the CCIX law in 2011 which came into force on

1st March 2013 (Parliament of Hungary 2011). This applies to unregulated utilities with some key rules. The most important are presented as follows:

- The owner of water utility is the government or the local municipality (private owners had to give back assets free of charge).
- The government will determine the charges of water after 31.12.2014 (so far this has been a local decision) and tariffs cannot be raised until this deadline (in 2012 the charges were set to increase 4.2, and 0% in 2013 and 2014).
- All water utilities had to apply to the Hungarian Energy and Public Regulatory Authority by 31st May 2013 to get permission to operate utility systems.
- Utilities (favoured for regional coverage by this law) have to serve a minimum 150,000 consumer-equivalent.
- Utilities should be financially robust, in terms of capital strength, to avoid running into debt and ensure liquidity.
- Utilities should hire at least a full-time civil engineer, mechanical engineer, electrical engineer, hydrogeologist, biologist, treatment technologist and economist all with at least 2 years' experience.
- All technical, financial and human resources data should be reported on the web (monthly, 6-monthly and yearly).

To date 68 companies have requested permission to operate under this law, compared to the 400 which existed before. The governing body of the water sector is the Hungarian Water Association (HWA) called MAVÍZ in Hungarian. So far, around 100 water utilities have been associated with HWA. These utilities provide water to 8.9 million people (533 million m³/yr) and sewerage treatment for 6.6 million people (MAVÍZ 2010). Another available source of information is the Hungarian Energy and Public Utility Regulatory Authority (MEKH 2013).

Water sector reform in Poland

The reforms of the water sector in Poland began on 25th October 1990, when the new Act on Territorial Self Government introduced a new administrative organisation for the country. This Act imposed on the municipalities an obligation of collective water supply and sewage disposal. Furthermore, on 7th July 2001, the Act on Collective

Water Supply and Sewage Disposal was introduced. This precisely defines the terms and conditions of the collective water supply intended for human consumption and sewage disposal to ensure an adequate quality of water and reliable sewage disposal, as well as to protect the interests of consumers, taking into account the requirements of environmental protection and the cost of the service. On the basis of the above regulations, the municipalities have two main obligations: (i) to perform the services and (ii) to regulate the system (quality of service, tariffs). The municipalities may delegate the obligations to perform the services to another party, however, they may not delegate the responsibility for setting the tariffs (regulatory function).

On 1st May 2004, Poland became an EU member country. Having access to the EU Cohesion Fund, the country was able to modernise the water and sewage infrastructure, which after almost five decades in a socialist economy framework, was in a rather poor condition. The National Fund for Environmental Protection and Water Management (Narodowy Fundusz Ochrony Środowiska I Gospodarki Wodnej), established in 1989, also plays a significant role in financing and coordinating infrastructural projects. General statistical data for the water and wastewater sector in Poland are presented as follows (Central Statistical Office of Poland 2013a):

- At the end of 2012, there were 1,793 (1,150 public, 643 private) entities registered under section 'Intake and supply of water' and 2,698 (253 public, 2,445 private) entities registered under section 'Wastewater collection' in the Registry of the Economic Activity.
- 33.78 million people (87.6% of the population) are connected to the water supply system, mostly in the cities (95.4%).
- Total length of the water supply network at the end of 2011 was 278,000 km.
- 24.49 million people (63.5% of the population) are connected to the wastewater treatment facilities, mostly in the cities (86.7%).
- Total length of the wastewater removal network at the end of 2011 was 118,000 km.

Current (July 2013) tariffs in Poland vary, depending on the region and the size of the community: from 0.90 to 11.82 €/m³ (3.78 to 49.90 PLN), whereas the average tariff

in Poland is 2.44 €/m³ (10.31 PLN) and median tariff is 2.18 €/m³ (9.19 PLN). These figures represent the total price for water supply and wastewater treatment. Prices include 8% of Value Added Tax (Water Tariffs in Poland 2013).

Water sector reform in Romania

The first Romanian public services reform appeared in 2001 after a very long period with little legislation reform (the previous laws had been issued in 1977). The Water Services Law was passed in the following year, in 2002, and refers to the responsibility of public authorities to organise the water. The Water Quality Law, passed in the same year, is concerned with ensuring that the water provided to consumers falls within particular health and safety parameters for the population. Starting in 2003, the tertiary legislation was developed in order to make a unitary framework regarding: licencing of the operators, delegation of the water services, the water supply standard contract and the mechanism of the establishment and adjustment of the tariffs.

After Romania joined the EU in 2004, the legislation was updated with the introduction of two new Public Service and Water Service Laws, and new indicators for the service quality were introduced. These two laws were amended again in 2006. In 2008, the water utilities were asked to corporatise into commercial companies and to extend their service area to be able to implement large scale projects financed by the EU. This regionalisation/aggregation process requires strong companies and a new structure for the local authorities which have the legal opportunity to form Inter-communal Development Associations (IDA) and the possibility to delegate some of their rights, such as the approval of the investment and tariff policy. This allows decisions to be taken over a realistic period of time and protects the rights of all the members. The IDAs supervise the water company activity according to the provision of the delegation contract, which includes the rights and the obligations of the parties such as level of services and tariffs. The Government of Romania has published a guide to the regionalisation of drinking water and wastewater services, with references to the water sector transformation and details on reform history (Government of Romania 2008). For more about inter-communal

cooperation in Romania see Săgeată (2012) and with reference to water and water resources management, see Vinke-de Kruijf et al. (2009).

The Romanian utilities are responsible for the whole water cycle: water treatment (and distribution), sewerage and wastewater treatment. The Romanian Water Employers' Report which was presented in June 2013 at Danube-Black Sea Water Forum in Bucharest states that at the end of 2011, 56.5% of the population had access to centralised water supply systems and 43.5% was connected to sewerage networks. The 40 county-level water companies plus Bucharest water operator account for 86.3% of the water supply and 89.03% of the sewerage market. Despite the aggregation process, which refers to all 40 Romanian counties, there are still another 1000 small and very small companies and public services which are organised inside small communities or small towns.

Benchmarking in water utilities

Water utilities aim to improve their service quality and their financial position (Pollard et al. 2004; Saal et al. 2007). One way to monitor the financial performance of water utilities is to statistically compare financial indicators (Tsagarakis 2013). Overall operation and maintenance (O&M) cost of water utilities consist of three major components, including energy, employment and other costs. Indeed, energy consumption is a major factor in water and wastewater facilities that can be optimised through appropriate operation and asset management (Costanzo & Jentgen 2009; Mizuta & Shimada 2010; Venkatesh & Brattebø 2011). Personnel also constitute a major share of O&M costs (Tsagarakis et al. 2003). Chemicals are a major component of the remaining costs (Venkatesh & Brattebø 2011). The management of these costs in emerging economies is a major challenge due to the continuously changing legal and governmental framework. On the other hand, the reduction of energy and employee expenditures is a vital factor for the viability of water utilities (Fankhauser & Tepic 2007). One way to monitor and manage these costs is through benchmarking. This is the systematic recording and analysis of the performance indicators that utilities officially report to their governing bodies. Qualified organisations exist that collect indicators

with national or international coverage like IBNET (IBNET 2013), IWA (2013) and EUREAU (2009). The most user friendly, up to date and easily accessed of these is the IBNET database. It is also frequently updated with data from more years and newly entered countries. As a result, in recent years scholars have used this source of data for their research (see Nauges & Berg 2008; Bisztray et al. 2010; Tsagarakis 2013).

The objective of this work is twofold. First, the study of specific financial indicators for water utilities over time and the comparison of figures within four selected countries and the comparison of descriptive statistics among countries. Secondly, the identification of any correlations between the financial indicators and the other indicators.

RESEARCH METHODOLOGY

For this paper, the IBNET database was used (IBNET 2013). The most recent data from 162 water utilities in four countries were explored. These countries were selected based on data availability. Data were retrieved from the webpage of IBNET. The latest year with data was selected. Three of the indicators of the database plus one created from these indicators were studied. The first indicator is the operating cost coverage (I_{OCC}), a financial performance indicator as described in Equation (1)

$$I_{OCC} = \frac{\text{Total annual operational revenues}}{\text{Total annual operating costs}} \quad (1)$$

The next two are energy costs and staff indicators, Equations (2) and (3). The former gives the portion of labour costs over operational costs (I_L) and the latter gives the portion of energy costs over operational costs (I_E).

$$I_L = \frac{\text{Total annual labour cost}}{\text{Total annual operating costs}} \quad (2)$$

$$I_E = \frac{\text{Total annual energy costs}}{\text{Total annual operating costs}} \quad (3)$$

For the purpose of this study, a new indicator was created (I_O) which includes the percentage of non-labour or

energy costs as calculated by subtracting I_L and I_E from 100%, Equation (4)

$$I_o = \frac{\text{Total annual operating (other) costs except labour and energy}}{\text{Total annual operating costs}} \quad (4)$$

To fulfil the first objective of this paper, descriptive statistics from each country for the indicators mentioned above are presented for comparison on the same table. This provides the opportunity to: (i) locate extreme values within the country and (ii) compare basic statistics among countries. For the second objective, a high number of utilities are necessary in the dataset per country. Correlations of indicators and modelling provide insights into drivers of good/bad performance. Time series analysis is essential to study diachronic effects on indicators and to forecast future performance. Such analysis requires continuous data for many years; however, no such data was available for the study in this paper. The interactions studied are depicted in the right part of Figure 1 with continuous lines. It is essential that benchmarking indicators are studied in their dynamic dimension as depicted with dashed lines in Figure 1. For this reason, long-term

monitoring is essential, which was not the case with the data available in this paper.

RESULTS AND DISCUSSION

Descriptive analysis

Descriptive statistics of the I_E (ratio of annual energy to operating costs) for the studied countries are presented in Table 1. The year reported in the first row indicates the most recent available data at hand. Albanian water utilities report on average at least double I_E compared with the other countries (28.4%). However, the high standard deviation (15%), 75% percentile (39%) and maximum value (67%), indicate some extreme values. This high energy portion of the cost is recognised nowadays and is addressed by renewing pumps and other heavy consuming electrical equipment. Utilities from the other three countries report a similar distribution of the I_E indicator.

On the other hand, mean value of the I_L (ratio of annual labour to operating costs) indicator (Table 2) is lower for utilities from Albania (38%) compared with those from

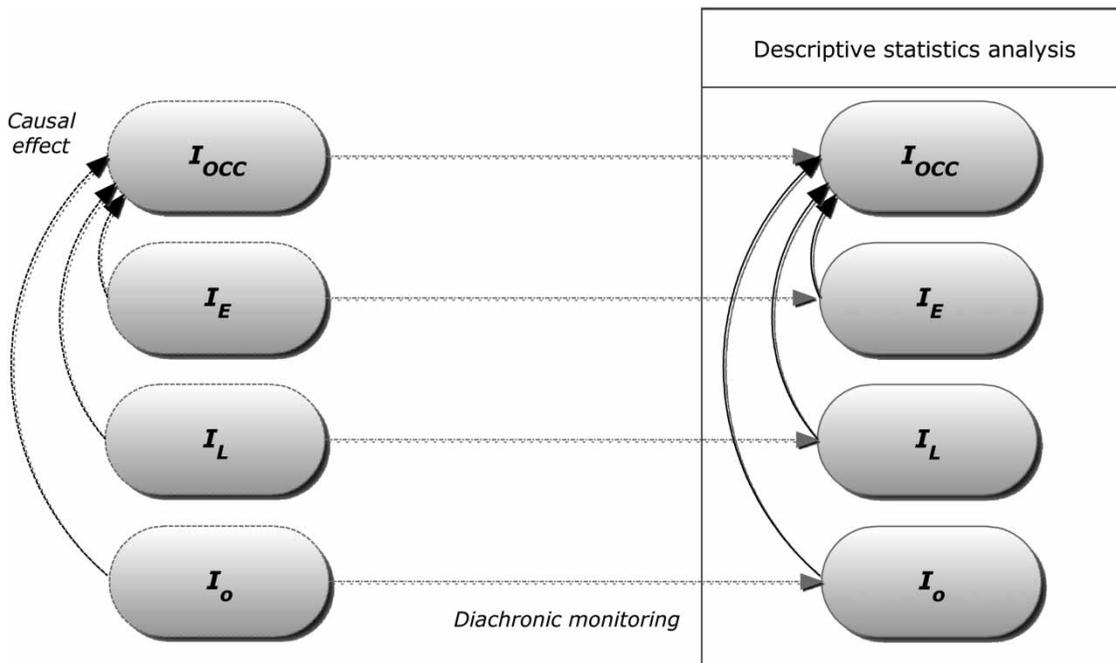


Figure 1 | Methodological approach of this paper in continuous lines, and with the proposed dynamic analysis (dashed lines).

Table 1 | Statistics for the indicator I_E (%) per country

Statistics	Hungary (2007)	Poland (2010)	Romania (2010)	Albania (2011)
N	19	30	17	46
Mean	11.8	11.6	10.8	28.4
STDEV	2.4	3.5	3.6	15.0
Min	8.0	5.0	5.0	5.0
25% percentile	10.0	8.0	8.0	17.7
Median	12.0	11.5	11.0	26.0
75% percentile	14.0	15.2	12.5	39.0
Max	16.0	17.0	19.0	67.0

Table 2 | Statistics for the indicator I_L (%) per country

Statistics	Hungary (2007)	Poland (2010)	Romania (2010)	Albania (2011)
N	20	31	19	62
Mean	44.3	28.3	46.5	38.0
STDEV	8.6	12.5	10.8	13.2
Min	28.0	6.0	19.0	16.0
25% percentile	38.7	20.0	42.0	27.7
Median	45.0	29.0	47.0	36.5
75% percentile	49.0	37.0	52.0	47.5
Max	63.0	51.0	68.0	71.0

Hungary (44.3%) and Romania (46.5%), but Poland reports even lower values (28.3%).

Descriptive statistics for the indicator I_O , which is the remaining part of the annual operating cost after subtracting I_E and I_L , are presented in Table 3. As expected, high values for Polish water utilities were revealed and lower for the other countries. The water–sewage infrastructure in Poland has been in a very poor condition since the years of the socialist economy. To improve the quality of service, the water utilities introduced large, EU co-funded investment programmes. During the years analysed, 2003–2010, the total water-sewage network length in Poland increased by 26.3% (Central Statistical Office of Poland 2013b). The increase seen in the group with costs other than energy and labour costs results from higher asset related costs. Albanian water utilities supervised by WRA have increased their I_{occ} indicators from 2008 to 2012 (WRA 2012), which is

Table 3 | Statistics for the indicator I_O (%) per country

Statistics	Hungary (2007)	Poland (2010)	Romania (2010)	Albania (2011)
N	19	30	17	44
Mean	44.1	60.3	44.0	46.0
STDEV	10.0	13.9	10.7	20.6
Min	23.0	33.0	25.0	12.0
25% percentile	37.0	48.5	37.5	30.2
Median	45.0	61.5	43.0	47.5
75% percentile	51.0	69.5	46.0	58.0
Max	60.0	86.0	74.0	90.0

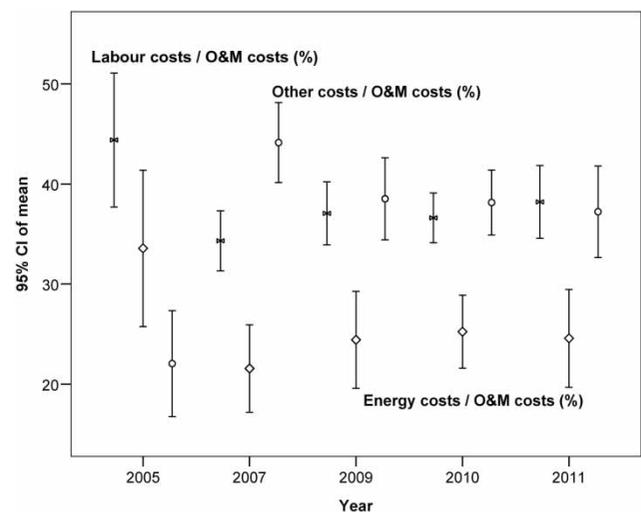
also related to assets and the use of chemicals for better treatment.

Comparison of the operating cost components

Figures 2–5 show the fluctuations over time of the three indicators related to the portion of the annual operating cost in categories for Albania, Hungary, Romania and Poland, respectively.

Albania

Data from Albanian utilities (Figure 2) indicate a constant mean value for labour and energy portions, apart from 2005, as compared with later years. This increase in the portion of other costs can be attributed to the increased need to

**Figure 2** | Fluctuations of I_O , I_E and I_L for Albania.

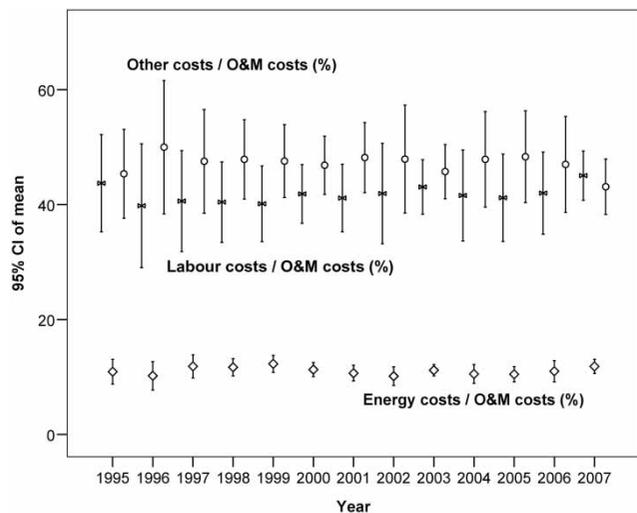


Figure 3 | Fluctuations of I_O , I_E and I_L for Hungary.

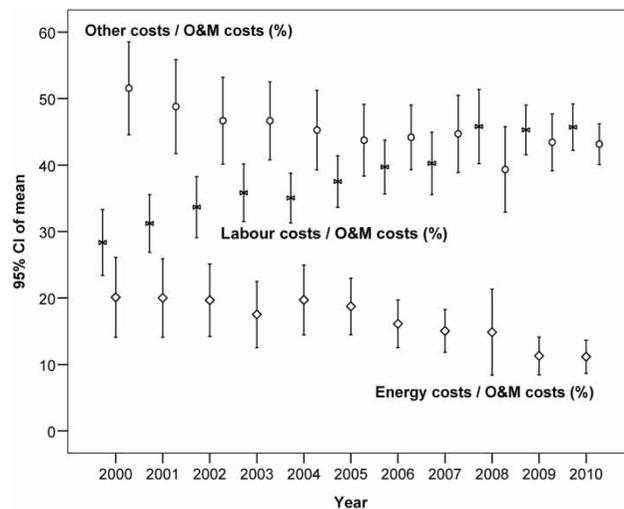


Figure 5 | Fluctuations of the I_O , I_E and I_L for Romania.

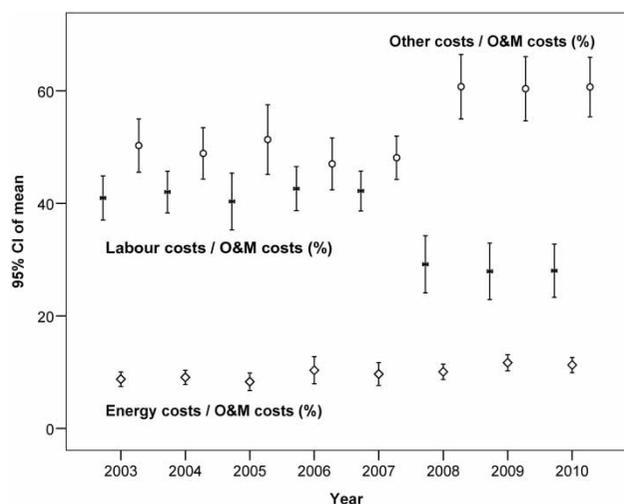


Figure 4 | Fluctuations of I_O , I_E and I_L for Poland.

improve services through better maintenance and to the cost of chemicals for water and wastewater treatment. Furthermore, in recent years efficient energy management has been achieved through investment in new pumping systems and improved electromechanical equipment. The metering system has also been upgraded.

Hungary

Data from Hungarian utilities (Figure 3) present no statistically significant change for any of the indicators during

the years under consideration. Water tariffs are under strict political control from the government and local municipalities. Charges bear little or no dependence on economic criteria. This affects financial performance. As a result, to compensate for the financial deficits, salaries are pushed down. On the other hand, utilities are saving money by cooperating with common tenders and investing in new efficient technologies (pumps, etc.).

Poland

Analysis of data from Polish utilities (Figure 4) shows major differences among the share of the labour cost when the early years are compared to the last years of the database. However, the energy cost has no statistically significant difference among the years.

These results may suggest that there was a significant decrease in the share of labour expenses among the water utilities in the period analysed, compared with the other costs. However, data from the Central Statistical Office of Poland do not reveal any information that may support this supposition. The average annual number of employees in water utilities increased from 71,100 in 2005 to 79,700 in 2010, while the average annual salary also increased from 564 € (2,380 Zloty) in 2005 to 765 € (3,228 Zloty) in 2010 (Central Statistical Office of Poland 2013a). Having analysed financial data of the water utilities reporting to the Polish Waterworks Chamber of Commerce, it was

Table 4 | Statistics of the indices calculated for a larger sample of data (Polish Waterworks Chamber of Commerce 2013)

Indicator (%)	2006	2007	2008	2009	2010	2011
I_L	26.64	18.63	20.31	20.57	21.24	26.01
I_E	7.75	6.97	10.56	8.33	7.69	8.45
I_{occ}	65.61	74.41	69.12	71.10	71.07	65.54

revealed that the I_L indicator had been lower for the years 2007–2010 than in 2006 and 2011 as reported in Table 4 (Polish Waterworks Chamber of Commerce 2013).

Detailed analysis of the I_L indicator shows ambiguous conclusions depending on the source of data. To a lesser degree, mainly larger utilities use the IBNET database mostly for benchmarking purposes. Among the 40 water utilities reporting to IBNET, only 16 have a decreasing tendency of the I_L indicator. Ten out of these 16 utilities carried out EU co-funded investment programmes. Therefore, it can be concluded that some part of the labour-related expenses had been allocated as ‘investment expenses’ instead of ‘operating activity expenses’ by those utilities, reporting to IBNET.

Regarding the energy cost portion, it remains statistically at the same level. However, the total increase in energy price from 2003 to 2010 was 38.11%. The minimum annual increase was 2.27% in 2007 while the maximum was 11.11% in 2008 (Cena Pradu 2013).

Romania

The Romanian data for IBNET is provided by 25 water utilities covering only half of the water sector in reference to the population served. There is a statistically significant difference in the labour share of the cost in the early years compared with the last years of the database (Figure 5). The energy indicators decrease, but only the first against the last 2 years of the data range has a statistically significant difference ($p < 0.05$).

The evolution of I_O , I_E and I_L indicators for Romania in the period 2000–2010 is related to the major changes that occurred both in the water sector and in the country itself. Thus, the water sector has experienced significant improvements in infrastructure due to the investment programs started in 1995 and continued until today. As a candidate state for accession to the EU, Romania benefited from

major investments from the Instrument Structural for Pre-accession (ISPA) Measure and after its accession (2007) it received support from Cohesion Funds. The investment in the water and wastewater infrastructure consisted of replacing the old network and pumping systems. The water and wastewater treatment plants were modernised and new equipment and technology was installed (e.g. using biogas for cogeneration). As a direct consequence, the specific energy consumption has decreased by 1% in each of the last 10 years. The water network improvement led to less network failures and water losses with impact on operating and maintenance costs.

Apart from the modernisation of infrastructure, an improvement in the management of water companies has also occurred, thus exerting a stronger control on the costs. The increase of the labour cost share in the total operating and maintenance costs is mainly due to wage increases for all categories of employees in Romania during the economic growth from 2000–2007. Another factor that had an influence on the I_L evolution was the change of the personnel structure, leading to an increase in the highly qualified staff required for the new infrastructure operation and for complying with the increasing legal requirements for quality insurance management and environmental reporting systems, for the customer support activities, for project management and IT development.

For a full analysis of the labour usage, a survey of third party costs is also necessary in order to identify the costs related to some activities which were outsourced. In this respect, it should be mentioned that in Romania no large scale publication on outsourcing could be found. The utilities keep all the activities in their jurisdiction. The most commonly outsourced services are for security and car repairs. It is evident that the efficient energy use and the decrease of the O&M costs provided the resources necessary to cover the increase in the labour costs. This had a positive impact on the utilities and the motivation of employees for continuing the water sector modernisation and it did not put pressure on the tariffs.

Correlations among indicators

Statistical significant correlations of I_{OCC} with I_E , I_L and I_O are presented in Table 5 for each selected country. Only comparisons from Albanian water utilities led to statistically

Table 5 | Correlations among I_{OCC} , I_E , I_L and I_O indicators

Country	I_{OCC}		
	I_L	I_E	I_O
Poland	$r_s = -0.014, p = 0.941, N = 30$	$r_s = 0.114, p = 0.547, N = 30$	$r_s = -0.017, p = 0.930, N = 30$
Hungary	$r_s = -0.263, p = 0.291, N = 18$	$r_s = -0.347, p = 0.159, N = 18$	$r_s = 0.323, p = 0.192, N = 18$
Albania	$r_s = 0.393^b, p = 0.005, N = 46$	$r_s = -0.302^a, p = 0.035, N = 49$	$r_s = 0.011, p = 0.941, N = 49$
Romania	$r_s = -0.181, p = 0.555, N = 13$	$r_s = 0.178, p = 0.560, N = 13$	$r_s = 0.060, p = 0.847, N = 13$

^a $p < 0.05$.^b $p < 0.01$.

significant correlations. It can be said that OCC is positively related to the high portion of personnel cost ($p < 0.01$) and consequently low portion of energy cost ($p < 0.05$). This means that water utilities with a high share of personnel costs are more likely to perform financially better compared to those with low share *ceteris paribus*. This indication is provided by simple statistical analysis. Validation is needed in case there is a correlation of I_L with another variable that affects I_{OCC} .

CONCLUSION

The water/wastewater sectors in the emerging countries of Europe has improved greatly, mainly because of the modernisation of water utility governance and major national and external funding. Many of these economies have shown interest in participating in international organisations and monetary unions (e.g. EU) and, therefore, some specific initiatives have been undertaken in order to harmonise their market structure and governance. Monitoring of performance and intercomparison of indicators is essential for optimising this water reform.

The study of staff, energy and financial indicators can provide a tool for effectively monitoring the performance of water utilities. In fact, these indicators constitute the majority of the operational costs of water utilities and provide sufficient ground to achieve significant cost savings. In this study, indicators from four selected European emerging economies were analysed. First, the performance of

water utilities can be accessed based on the country mean figures. Second, a comparison of measures of central tendency and dispersion among countries has provided a deeper understanding. Third, the investigation of possible correlations can lead to factors that positively affect financial performance of water utilities. The study of these indicators with time, using a time series analysis is also necessary, however, this was not feasible with the data in this study due to the short time span.

The IBNET database and other such databases are a useful source for benchmarking. Nevertheless, before reaching conclusions from such analysis, reference should be made to the number of utilities per country represented and to the representation of the sample. Cross validation with data from other national bodies is essential. This is an exploratory first approach and more in-depth analysis also including macroeconomic figures and governance effects are needed.

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