PERFORMANCE INDICATORS AND BUSINESS INTELLIGENCE TOOLS APPLIED TO DRINKING WATER QUALITY IN THE FIELD OF REGULATION

INDICADORES DE DESEMPENHO E FERRAMENTAS DE BUSINESS INTELLIGENCE APLICADA À QUALIDADE DA ÁGUA PARA CONSUMO HUMANO NO CAMPO DA REGULAÇÃO

INDICADORES DE DESEMPEÑO Y HERRAMIENTAS DE INTELIGENCIA DE NEGOCIOS APLICADOS A LA CALIDAD DEL AGUA POTABLE EN EL ÁMBITO DE LA REGULACIÓN

https://doi.org/10.56238/sevened2026.008-026

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ABSTRACT

In the context of exposure regulation, a system of performance indicators combined with Extraction, Transformation, and Loading (ETL) methods, coupled with dashboard analysis, is an important tool for evaluating the performance of a product's quality. Therefore, this work aims to present the functionalities and applications of a performance indicator system implemented for evaluating the quality of drinking water, considering parameters that demonstrate the effectiveness of the product's quality. The indicator evaluation system was built using an ETL process of the data, executed by Microsoft Power BI®, as it offers excellent functionalities for developing dashboards and devices that promote transparency and interaction mechanisms. It was possible to evaluate and analyze the quality of drinking water at production points and in the distribution network with the aid of graphic elements related to effectiveness and efficiency. Tools such as performance papers and data download options were made available on the dashboard, promoting transparency and joint participation by users and key stakeholders in basic sanitation management. Finally, the tool allowed for a comparison of the water quality performance produced at Water Treatment Plants (WTPs)

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with the targets established in Municipal Basic Sanitation Contracts or Plans (PMSB), and for directing inspections when the result was unsatisfactory.

Keywords: Quality. Performance Indicators. Drinking Water. Exposure Regulation.

RESUMO

No contexto da regulação por exposição, um sistema de indicadores de desempenho aliados a métodos de Extração, Transformação e Carga (ETL) somado à análise através de Painéis (Dashboards) é ferramenta importante na avaliação do desempenho da qualidade de um produto ofertado. Assim, este trabalho tem por objetivo apresentar as funcionalidades e aplicações de um sistema de indicadores de desempenho implementado para avaliação da qualidade da água para consumo humano, no qual foram considerados parâmetros que comprovassem a eficácia da qualidade do produto. O sistema de avaliação dos indicadores foi construído por um processo de ETL dos dados, que foi executado pela ferramenta Microsoft Power BI®, visto que oferece ótimas funcionalidades para desenvolvimento de painéis (Dashboards) e dispositivos que possibilitam promover mecanismos de transparência e interação. Foi possível avaliar e analisar a qualidade da água para consumo humano nos pontos de produção e rede de distribuição com o auxílio de elementos gráficos que estavam relacionados a eficácia e eficiência. Ferramentas como Paper de desempenho e a opção de downloads de dados foram disponibilizadas no Painel, promovendo mecanismo de transparência e participação conjunta por parte de usuários e principais stakeholders da gestão do saneamento básico. Finalmente, a ferramenta permitiu comparar o desempenho da qualidade da água produzida nas Estações de Tratamento de Água (ETAs) com as metas existentes em Contratos ou Planos Municipais de Saneamento Básico (PMSB) e direcionar as fiscalizações diretas quando o resultado foi insatisfatório.

Palavras-chave: Qualidade. Indicadores de Desempenho. Água Potável. Regulação por Exposição.

RESUMEN

En el contexto de la regulación de la exposición, un sistema de indicadores de desempeño combinado con métodos de Extracción, Transformación y Carga (ETL), junto con el análisis de tableros de control, constituye una herramienta importante para evaluar el desempeño de la calidad de un producto. Por lo tanto, este trabajo busca presentar las funcionalidades y aplicaciones de un sistema de indicadores de desempeño implementado para evaluar la calidad del agua potable, considerando parámetros que demuestran la efectividad de la calidad del producto. El sistema de evaluación de indicadores se construyó mediante un proceso ETL de datos, ejecutado por Microsoft Power BI®, ya que ofrece excelentes funcionalidades para el desarrollo de tableros de control y dispositivos que promueven la transparencia y los mecanismos de interacción. Fue posible evaluar y analizar la calidad del agua potable en los puntos de producción y en la red de distribución con la ayuda de elementos gráficos relacionados con la efectividad y la eficiencia. Herramientas como informes de desempeño y opciones de descarga de datos se pusieron a disposición en el tablero de control, promoviendo la transparencia y la participación conjunta de los usuarios y los actores clave en la gestión del saneamiento básico. Finalmente, la herramienta permitió comparar el desempeño de la calidad del agua producida en las Plantas de Tratamiento de Agua (PTA) con los objetivos establecidos en los Contratos o Planes Municipales de Saneamiento Básico (PMSB), y dirigir inspecciones cuando el resultado fue insatisfactorio.

Palabras clave: Calidad. Indicadores de Desempeño. Agua Potable. Regulación de la Exposición.

1 INTRODUCTION/OBJECTIVES

One of the main ways in which regulatory agencies act is related to the mechanism involving data transparency and regulation by exposure, being a very interesting way of regulating because it brings elements that offer integration and joint management action.

In the Concept of Water Quality for human consumption, Annex XX of the Consolidation Ordinance GM/MS No. 5, of September 28, 2017, of the Ministry of Health, establishes the maximum and minimum parameters and values allowed for them, in addition to establishing the two basic activities that aim to ensure the quality of drinking water, namely, control and surveillance, exercised by the system operator and public health entities, respectively. The Infranational Regulation Agencies act in relation to the quality of water for human consumption according to the National Guidelines for Basic Sanitation outlined through Law No. 11,445, of January 5, 2007, amended by Law No. 14,026, of July 15, 2020. His expertise is mainly the performance through indicators to verify the performance and quality of service provision and the fulfillment of contractual goals and the Municipal Basic Sanitation Plan (PMSB).

In this context, the use of performance indicators to assess the quality of water for human consumption together with tools that maximize its usefulness in the field of regulation is a key part of the analysis of data from Water Treatment Plants (WTPs) carried out by the Agencies. In view of this importance, it is necessary that more studies of the methodologies applied by the Regulatory Agencies be carried out.

Thus, this work aims to present the functionalities and applications of a system of performance indicators aimed at the evaluation of the quality of water for human consumption in the Pernambuco Regulation Agency, in which parameters that prove the effectiveness of the quality of the product were considered.

2 METHODOLOGY

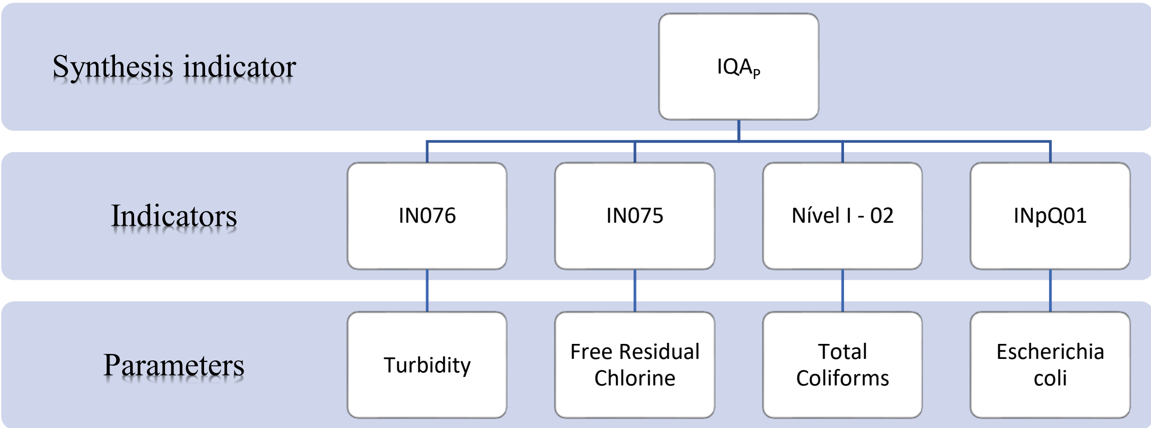
This work adopts a quantitative and qualitative approach, employing a case study as a research strategy. The object of analysis is the system of performance indicators used by the Pernambuco Regulation Agency to evaluate the quality of water for human consumption.

Data collection was carried out through documentary analysis of the agency's internal files, including technical reports, procedure manuals and regulations. The main source of data was the historical series obtained from the service provider in relation to the control of the quality of water for human consumption. The analysis consisted of a detailed description of the methodology adopted, the selected indicators, their relevance in the regulatory context and the way they are used to identify trends and challenges in ensuring potability.

The selection of 4 parameters was proposed to obtain a systemic view of water quality: Turbidity, Free Residual Chlorine, Total Coliforms and Escherichia coli. The incidence indicator of the analyses within the standard is applied to each specific parameter, totaling four indicators for evaluating the quality of drinking water. To add managerial value to the indicators, a Drinking Water Quality Index was proposed to summarize the result of the four indicators in just one, allowing better analysis in the decision-making of an inspection. Figure 1 illustrates the composition of the indicators.

Figure 1

Composition of indicators through water quality parameters



Source: Prepared by the authors (2025)

Table 1 describes the calculation formulation of the indicators and their respective references and nomenclatures.

Table 1

Description of the calculation and reference formulas of the indicators

Indicator	Description	References	Calculation formula
IN075	Incidence of residual chlorine analyses within the standard	SNIS	$\text{IN075} = \left(\frac{QD007}{QD006}\right) \times 100$ QD007 - Quantity of samples for residual chlorine within the standard (analyzed) QD006 - Quantity of Residual Chlorine Samples Analyzed
IN076	Incidence of turbidity analyses within the standard	SNIS	$\text{IN076} = \left(\frac{QD009}{QD008}\right) \times 100$ QD009 - Number of Samples for In-Standard Turbidity (Analyzed) QD008 - Number of Samples for Turbidity Analyzed
Nível I – 02	Incidence of total coliform analyses within the standard	ANA	$\text{Nível I} - 02 = \left(\frac{QD027}{QD026}\right) \times 100$ QD027 - Number of samples for total coliforms within the standard (analyzed) QD026 - Amount of samples for total coliforms analyzed
$\mathbf{IN_PQ01}$	Incidence of E.coli analyses within the standard	Arpe	$\text{IN}_\text{P}\text{Q01} = \left(\frac{QD017}{\text{QD016}}\right) \times 100$ QD017 - Number of samples for E.coli within the standard (analyzed) QD016 - Number of samples for E.coli analyzed

Source: Prepared by the authors (2025)

The calculation of the weight w, related to the portion of influence of the indicators in the formulation of the IQAp, is carried out through a quantitative and qualitative evaluation of the risks that non-conformities of the quality parameters entail for the supply system. To characterize the risk of each parameter, we used scores for the following aspects: severity (S), occurrence (O) and detection (D) of the hazard. The scores given to the aspects range from 1 to 3, with 1 for low, 2 for moderate, and 3 for high. A better description of this type of methodology can be seen in Rodrigues (2014). Table 2 illustrates the calculation formulation for the Drinking Water Quality Index (IQAp).

Table 2

Methodology for calculating the Drinking Water Quality Index (IQAp)

Indicator	Description	Origin	Calculation formula
$\boldsymbol{IQA_p}$	Drinking Water Quality Index	Arpe	$IQA_p = \sum_{i=1}^{n} [q_i * w_i]$ $\sum_{i=1}^{n} w_i = 1$ $w_i = \frac{R_i}{R_{total}}$ $R_i = severidade(S)\ x\ ocorrência(O)\ x\ detecção(D) = S\ x\ O\ x\ D$ $R_{total} = R_{CRL} + R_{turbidez} + R_{C.T} + R_{E.coli}$ Where: n - number of water quality parameters assessed locally in the SAA I - Evaluated parameter qi - Incidence of analyses within the standard of parameter i wi - Weight assigned to parameter i

Source: Prepared by the authors (2025)

Table 3 below reports the scores and justifications given to the severity (S) aspect.

Table 3

Score for the severity aspect

Severity Score		
Classification	Justification	Score
High	Substance very harmful to the environment, causes serious effects on human health, has characteristics of toxicity and pathogenicity.	3
Moderate	Substances that are harmful to the environment, cause mild effects on human health (irritations or allergies)	2
Low	Substances that are not harmful to the environment, cause negative effects on human health	1

Source (adapted): (Rodrigues, 2014)

Tables 4, 5, 6 and 7 below report the scores and justifications that are given to the occurrence (O) aspect according to the frequency of non-compliance for the parameters Free Residual Chlorine, Turbidity, Total Coliforms and Escherichia coli.

Table 4

Score for the occurrence aspect for the Free Residual Chlorine parameter

Score for Occurrence (Free Residual Chlorine)		
Classification	Justification	Score
High	The environmental impact or health risk occurs at a high frequency for the parameter (13 or more non-conformities per year)	3
Moderate	The environmental impact or health risk occurs at a moderate frequency for the parameter (7 to 12 non-conformities per year)	2
Low	The environmental impact or health risk occurs at a low frequency for the parameter (up to 6 non-conformities per year)	1

Source (adapted): (Rodrigues, 2014)

Table 5

Score for the occurrence aspect for the Turbidity parameter

Score for Occurrence (Turbidity)		
Classification	Justification	Score
High	The environmental impact occurs at a high frequency for the parameter (above 30 non-conformities per year)	3
Moderate	The environmental impact occurs at a moderate frequency for the parameter (11 to 30 non-conformities per year)	2
Low	The environmental impact occurs at a low frequency for the parameter (up to 10 non-conformities per year)	1

Source (adapted): (Rodrigues, 2014)

Table 6

Score for the occurrence aspect for the Total Coliforms parameter

Score for Occurrence (Total Coliforms)		
Classification	Justification	Score
High	The environmental impact occurs at a high frequency for the parameter (above 6 non-conformities per year)	3
Moderate	The environmental impact occurs at a moderate frequency for the parameter (3 to 6 non-conformities per year)	2
Low	The environmental impact occurs at a low frequency for the parameter (up to 2 non-conformities per year)	1

Source (adapted): (Rodrigues, 2014)

Table 7

Score for the occurrence aspect for the Escherichia coli parameter

Score for Occurrence (Escherichia coli)		
Classification	Justification	Score
High	The environmental impact and the health risk occur at a high frequency for the parameter (above 3 non-conformities per year)	3

Moderate	The environmental impact occurs at a moderate frequency for the parameter (1 to 3 non-conformities per year)	2
Low	The environmental impact occurs at a low frequency for the parameter (up to 1 non-compliance per year)	1

Source (adapted): (Rodrigues, 2014)

Table 8 reports the scores and justifications given to the detection aspect (D).

Table 8

Score for the detection aspect

Detection Score		
Classification	Justification	Score
High	To detect non-conformity, medium to high complexity methods are used, requiring several steps for the success of the method, causing an execution time usually greater than 1 day.	3
Moderate	Non-compliance is perceived with the use of simple meters, with a measurement time generally less than 30 minutes (turbidimeters, photocolorimeters, titrations, etc.)	2
Low	Non-compliance can be perceived visually	1

Source (adapted): (Rodrigues, 2014)

Tables 9 and 10 describe the reasons why the non-conformities received their scores for each aspect in the positions of the treatment outlet and the distribution network, respectively.

Table 9

Explanation form of severities, occurrences and detections for treatment exit

Parameter	Severity (S)	Occurrence (O)	Detection (D)	Risk
Free Residual Chlorine	It can cause significant problems to human health due to its exposure in high concentrations May increase the likelihood of the presence of pathogenic microorganisms due to the absence of residues in the water Score: 3	Depends on the frequency of non-compliance	CRL analysis is done using simple equipment. (Photocolorimeter) On average, the full test takes about 10 minutes or less. Score: 2	R = S x D x O R = 3 x 2 x O R = 6 x O
Turbidity	Considered an indicator of efficiency of the water clarification process.	Depends on the frequency of non-compliance	Turbidity analysis is done using simple equipment. (Turbidity meter).	R = S x D x O R = 3 x 2 x O R = 6 x O

Parameter	Severity (S)	Occurrence (O)	Detection (D)	Risk
	May interfere with disinfection efficiency Indicator of efficiency in the process of removing oocysts from Protozoa. Its positivity in relation to the current norm has the effect of indirectly pointing to the increase in the probability of the presence of Protozoa. Score: 3		On average, the full test takes about 10 minutes or less. Score: 2	
Total Coliforms	Parameter used as a counter-test for the sentinel parameters Turbidity and Free Residual Chlorine Bacteriological removal efficiency indicator Its positivity in relation to the current norm has the effect of pointing to an increase in the probability of the presence of pathogenic microorganisms Score: 3	Depends on the frequency of non-compliance	Complex test, requires specialized personnel, takes more than a day to complete execution Score: 3	R = S x D x O R = 3 x 3 x O R = 9 x O
Fecal Coliforms (Escherichia coli)	It can cause significant problem to human health. Proves the compromise of the quality of water for human consumption Faecal contamination indicator Score: 3	Depends on the frequency of non-compliance	Complex test, requires specialized personnel, takes more than a day to complete execution Score: 3	R = S x D x O R = 3 x 3 x O R = 9 x O

Source (adapted): (Ogata, 2011)

Table 10

Explanation form of severities, occurrences and detections for treatment exit

Parameter	Severity (S)	Occurrence (O)	Detection (D)	Risk
Free Residual Chlorine	It can cause significant problems to human health due to its exposure in high concentrations May increase the likelihood of the presence of pathogenic microorganisms due to the absence of residues in the water Score: 3	Depends on the frequency of non-compliance	CRL analysis is done using simple equipment. (Photocolorimeter) On average, the full test takes about 10 minutes or less. Score: 2	R = S x D x O R = 3 x 2 x O R = 6 x O

Parameter	Severity (S)	Occurrence (O)	Detection (D)	Risk
Turbidity	May interfere with the efficiency of residual chlorine Non-compliance is related to measuring only organoleptic aspects Score: 1	Depends on the frequency of non-compliance	Turbidity analysis is done using simple equipment. (Turbidity meter). On average, the full test takes about 10 minutes or less. Score: 2	R = S x D x O R = 2 x 2 x O R = 4 x O
Total Coliforms	Parameter used as a counter-test for the sentinel parameters Turbidity and Free Residual Chlorine Bacteriological removal efficiency indicator Its positivity in relation to the current norm has the effect of pointing to an increase in the probability of the presence of pathogenic microorganisms Score; 3	Depends on the frequency of non-compliance	Complex test, requires specialized personnel, takes more than a day to complete execution Score: 3	R = S x D x O R = 2 x 3 x O R = 9 x O
Fecal Coliforms (Escherichia coli)	It can cause significant problem to human health. Proves the compromise of the quality of water for human consumption Faecal contamination indicator Score: 3	Depends on the frequency of non-compliance	Complex test, requires specialized personnel, takes more than a day to complete execution Score: 3	R = S x D x O R = 3 x 3 x O R = 9 x O

Source (adapted): (Ogata, 2011)

Table 11 below summarizes the reference values adopted for the qualitative evaluation of the performance indicators.

Table 11

Benchmarks for performance indicators

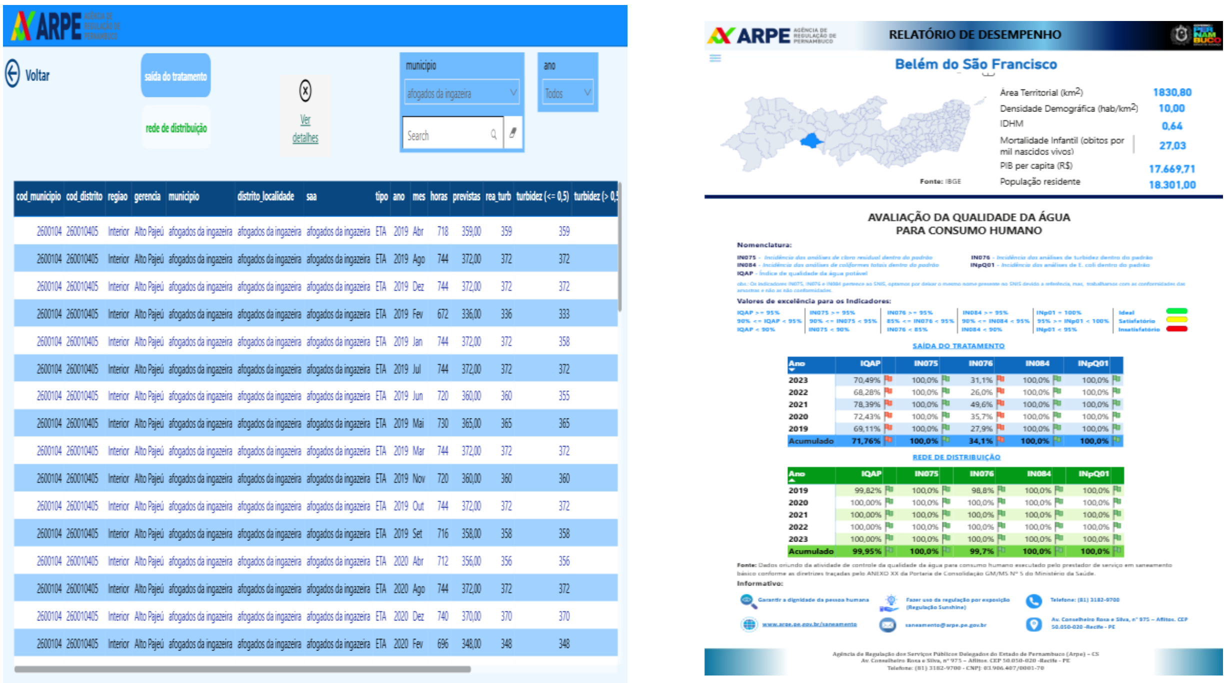
	Reference values		
Performance indicators	Ideal	Satisfactory	Unsatisfactory
IQAp	IQAp >= 95%	90% <= IQAp < 95%	IQAp < 90%
IN075	IN075 = 100%	-	IN075 < 100%
IN076	IN076 >= 95%	85% <= IN076 < 95%	IN076 < 85%
Level I - 02	Level I – 02 >= 95%	-	Level I – 02 < 95%
INpQ01	INpQ01= 100%	-	INpQ01< 100%

Source: Prepared by the authors (2025)

In the evaluation stage, an ETL (Extraction, Transformation and Loading) process of the data was used in order to obtain a better fit of the data. The interaction with users and managers is carried out through a performance panel, which allows, in addition to the visualization of indicators in tables and graphs with pictorial elements, the printing of *performance papers* by municipality. Figure 2 shows the data *download* page and the performance report of the indicators. The user can access and print the results of the municipal indicators in a historical series of the last five years, accompanied by a qualitative evaluation based on the classification by reference value ranges.

Figure 2

a) Page for data downloads; b) Performance paper for printing



(a) (b)

Source: Prepared by the authors (2025)

This methodology allowed an in-depth understanding of the practical application of the evaluation system and its effectiveness in detecting problems and promoting improvements in water quality, contributing to the improvement of regulatory practices. Regarding the objectives of this methodology, three were identified as essential: (a) Evaluate the quality of water for human consumption from Water Treatment Plants (WTPs) through a system of performance indicators, (b) Provide a means of aid in decision making and (c) Apply *a business intelligence* tool for use in exposure regulation.

3 RESULTS AND DISCUSSION

The analysis of the agency's files allowed us to identify that the system's data sources come from the control function of water for human consumption, which is defined by Annex XX of the Consolidation Ordinance GM/MS No. 5, of September 28, 2017, of the Ministry of Health, and which is executed by the operator of the water supply system. Statistical data is received that is passed through a process of extraction, transformation and loading for subsequent calculation of the indicators. In the performance panels, the indicators are visualized with quantitative values and with qualitative elements classified according to range or reference values.

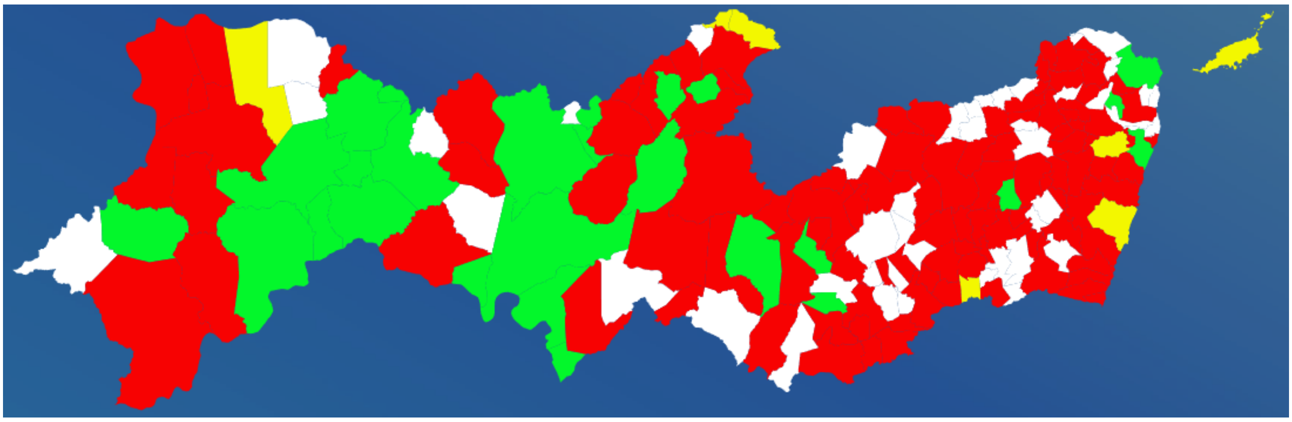
To exemplify the result of the performance evaluation of the quality of water for human consumption in relation to the provision of basic sanitation service in the state of Pernambuco, the base year of 2024 was considered and the data extracted come from the Performance Panel of the Pernambuco Regulation Agency – Arpe on drinking water quality.

We chose to show and analyze the result of the indicators in qualitative maps of the state of Pernambuco for technical reasons of visualization and spatial understanding of non-conformities. It should be noted that the absence of data, represented by the white color on the maps for certain municipalities, is justified by three factors: technical issues, municipalities that were not part of the agency's regulatory framework in the base year, or by the methodology of the indicators, in which municipalities that do not have Water Treatment Plants do not generate data at the treatment output.

At first, we present the results of the IQAp indicator, which has the function of summarizing the results of the other four indicators in a single piece of information for decision making. As seen in Figure 3, which reports the PQI at the end of treatment, it is observed that most municipalities have their PQI classification as unsatisfactory (red), which may probably evidence some systemic problem in ensuring the standard established by Annex XX of Consolidation Ordinance No. 5 GM/MS in relation to one of the four indicators that compose it.

Figure 3

IQAp at treatment discharge (base year 2024)



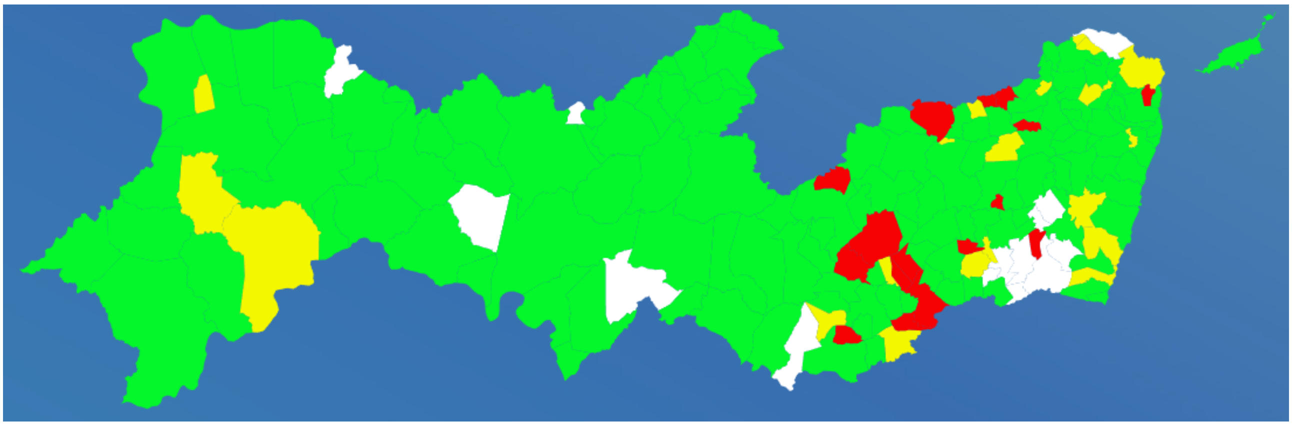
Source: Water Quality Dashboard - Arpe (2025)

Figure 4 shows the result of the aqi for the distribution network, showing a very different contrast in relation to the treatment output. Most municipalities have the IQAp classified as ideal (green), reporting only a few cases in isolation with the classification of unsatisfactory.

Detailing the analysis for the indicators that make up the IQAp, the first being IN075, an indicator of residual chlorine compliance according to the standard of Annex XX of Consolidation Ordinance No. 5 GM/MS.

Figure 4

IQAp in the distribution network (base year 2024)

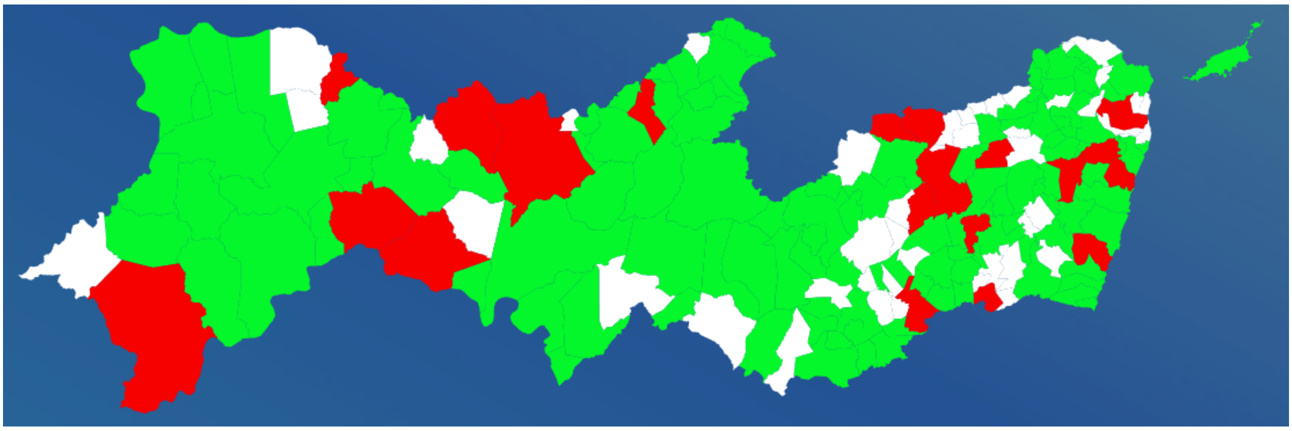


Source: Water Quality Dashboard - Arpe (2025)

Figure 5 shows that for this indicator its qualitative classification was ideal (green) at the end of treatment for most of the municipalities operated by the basic sanitation service provider. While in the network, Figure 6, most municipalities also obtained the qualitative classification of ideal, but with more clustered points of municipalities with an unsatisfactory classification. Depending on the quantitative value of the indicator, these municipalities may be subject to a direct inspection (*in loco*) to verify the chlorination system of the WTPs and guarantee the quality of the product in relation to the Contractual and PMSB goals.

Figure 5

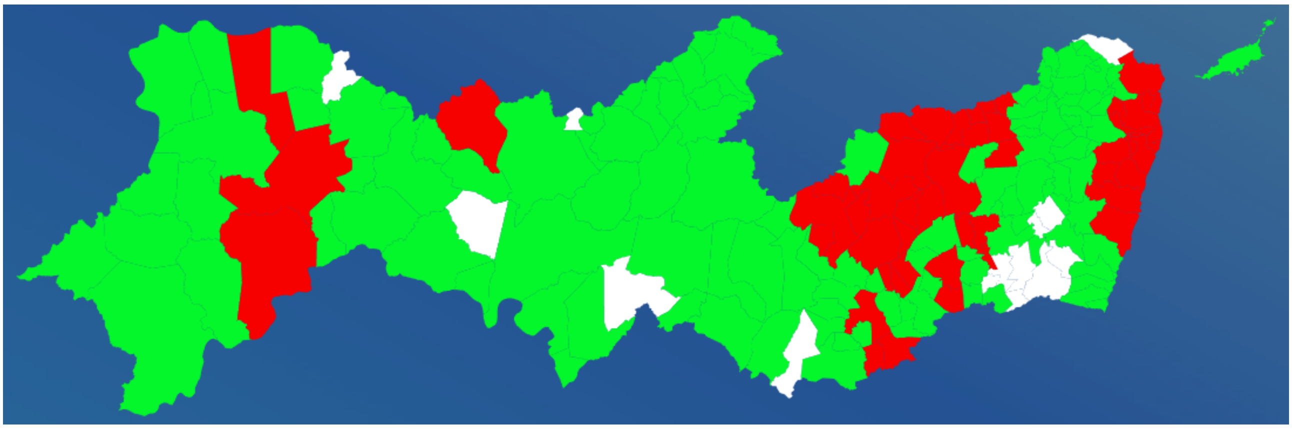
IN075 at treatment exit (base year 2024)



Source: Water Quality Dashboard - Arpe (2025)

Figure 6

IN075 in the distribution network (base year 2024)



Source: Water Quality Dashboard - Arpe (2025)

Analyzing the indicator IN076 for turbidity compliance according to Annex XX of Consolidation Ordinance No. 5 GM/MS, it is verified that at the end of the treatment, Figure 7, most municipalities have their classification as unsatisfactory and that the colorimetric map is very similar to the graph in Figure 3. It is notable that the deficiency of the IQAp comes from most of the IN076 indicator, which has low compliance yields in the municipalities of the state. Achieving the potability standard for water turbidity after filtration, 0.5 NTU in 95% of samples and the remaining 5% up to 1 NTU, is a major challenge.

Figure 7

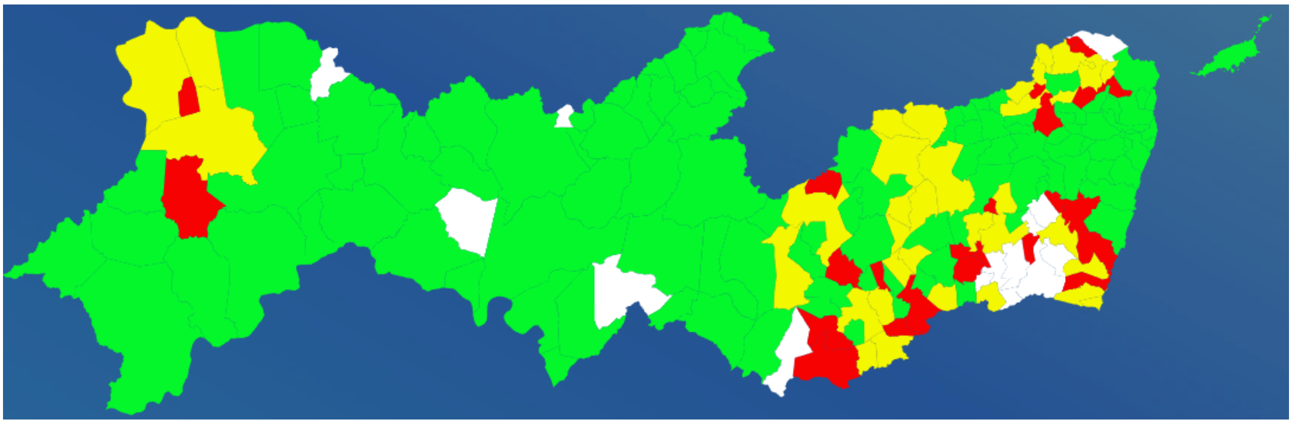
IN076 at treatment exit (base year 2024)

Source: Water Quality Dashboard - Arpe (2025)

Figure 8 illustrates the indicator IN076 in the distribution network, where it is possible to see a very different panorama of the treatment output, most municipalities have an IN076 classification as ideal, which is justifiable due to the potability standard being organoleptic, maximum value allowed up to 5 NTU, while at the treatment output it is much more restrictive because it is linked to efficiency issues in the elimination of cysts and oocysts of Protozoa in the filtration process.

Figure 8

IN076 in the distribution network (base year 2024)



Source: Water Quality Dashboard - Arpe (2025)

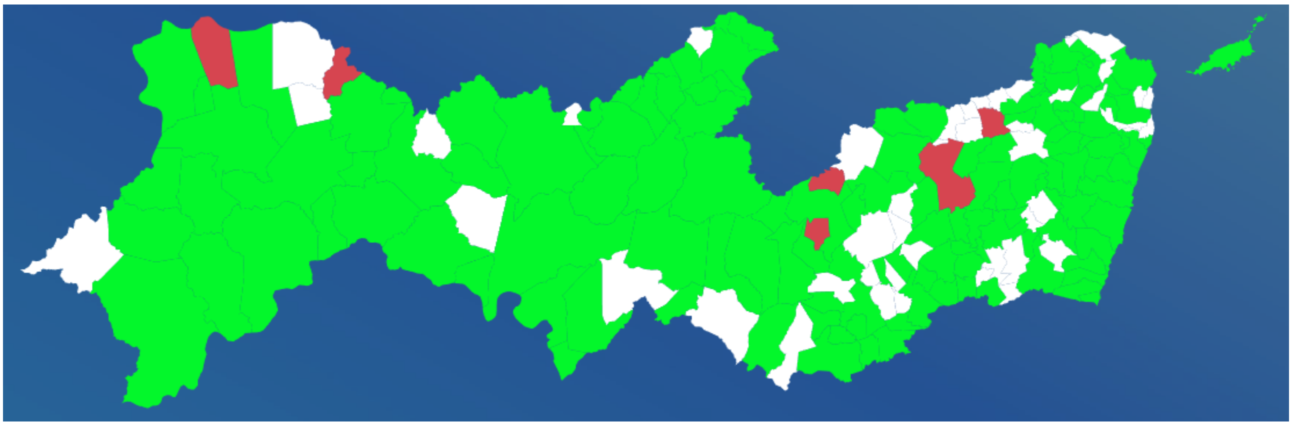
The yield of this indicator is often impacted by a series of challenges, such as the degradation of water quality in water sources and the water crisis, which causes the depletion and collapse of these sources. Added to this is the problem of undersized Water Treatment Plants (WTPs), either due to inadequate design or the inability to keep up with the increase in population demand, the consequence is the prioritization of the amount of water produced, to the detriment of the quality and efficiency of treatment. All these aspects have contributed to the performance of this indicator being often compromised.

Reaching the potability standard for the IN076 indicator at the filtration outlet is a systemic deficiency for most WTPs in the municipalities of Pernambuco, with the exception of those that have their abstraction from springs with good water quality, such as the São Francisco River, or those that have a very robust treatment system.

The Level I-2 indicator is found in ANA reference standard No. 09 and measures the compliance of total coliform samples in relation to the standards established in Annex XX of Consolidation Ordinance No. 5 GM/MS, being related to treatment efficiency and is used to verify it.

Figure 9

Level I – 2 at treatment exit (base year 2024)



Source: Water Quality Dashboard - Arpe (2025)

Figure 10

Level I – 2 in the distribution network (base year 2024)

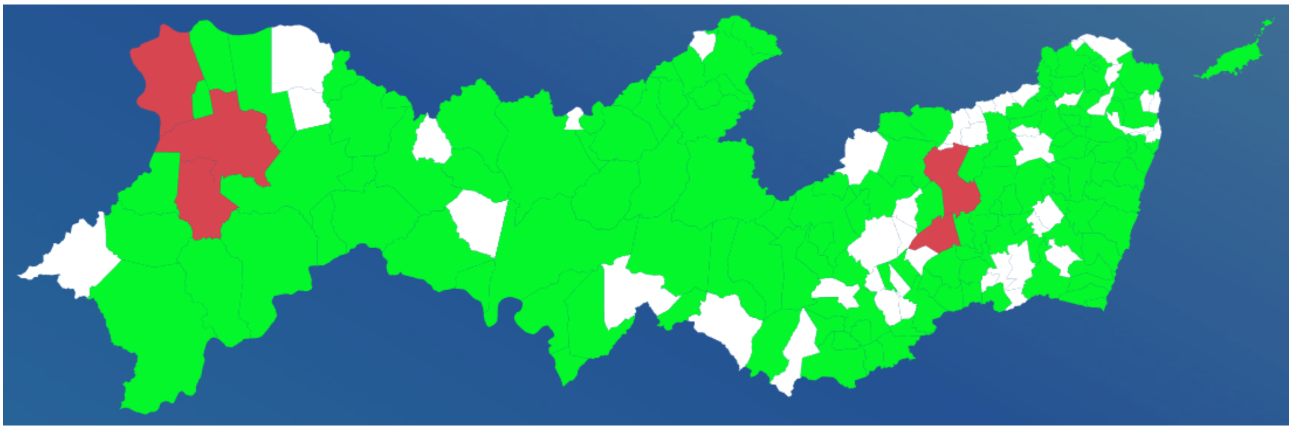
Source: Water Quality Dashboard - Arpe (2025)

Figure 9 above shows the positivities of this indicator in the base year, which implies a deficiency in water treatment for few municipalities in the state in relation to the treatment output and should also be analyzed quantitatively for planning direct inspections. For the distribution network, Figure 10 also shows few municipalities classified as unsatisfactory, which leads us to infer that for the year 2024 most municipalities presented good yields in their treatment system and microbiological protection of the network.

The INpQ01 indicator points to fecal contamination of the water, and should not present positivity in any way in the treatment system, but even so, we find it in our state, mainly due to three factors that reflect on the inefficiency of the treatment system: poor water quality source, undersized Water Treatment Plants and old distribution networks. As can be seen in Figures 11 and 12, some municipalities were positive for Escherichia coli at the end of the treatment and in the distribution network. Both the Level I - 2 indicator and the INpQ01 are the main pointers used by the Agency in relation to product quality to direct direct inspection.

Figure 11

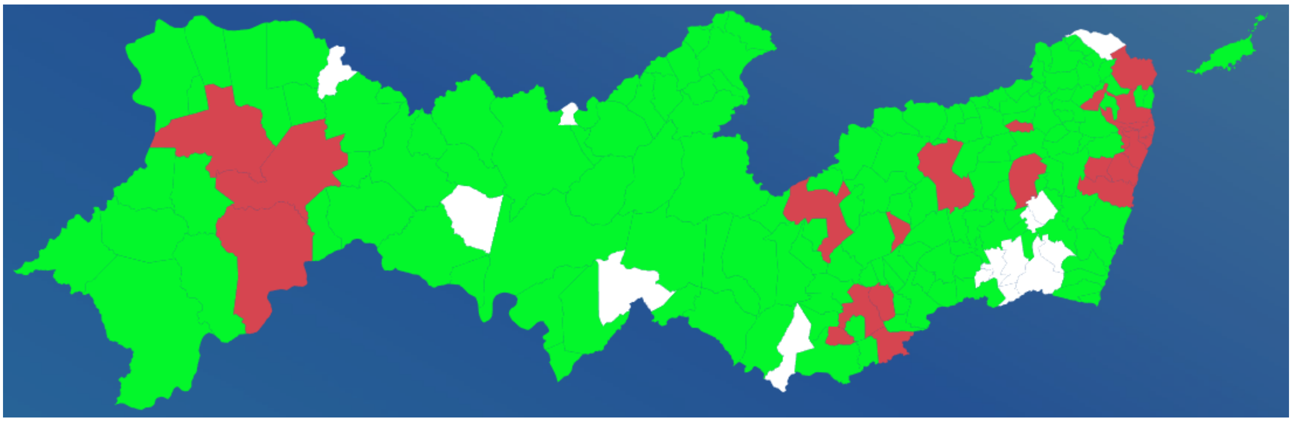
INpQ01 at treatment exit (base year 2024)



Source: Water Quality Dashboard - Arpe (2025)

Figure 12

INpQ01 in the distribution network (base year 2024)



Source: Water Quality Dashboard - Arpe (2025)

The analysis carried out was explained qualitatively in order to show its ease of interpretation, being subject to analysis by service users and main *stakeholders* of the management of the basic sanitation sector. It was possible to understand how the application of *business intelligence* techniques used in the evaluation and analysis of water quality is a useful tool, especially with regard to regulation by exposure, and not just a tool that would point out the problem and direct decision-making.

4 CONCLUSION

The model showed good results both to point out specific problems related to water quality and to more generalized problems, always related to the systemic formulation of the indicators.

The system of performance indicators for evaluating the quality of water for human consumption combined with *business intelligence* tools proved to be an interesting resource in the work developed by Arpe, allowing not only the evaluation of performance for decision making, but also offering instruments that allow a better dissemination of the indicators. The availability of a performance *paper* that allowed the user to print the data of the indicators by municipality, in an accessible way, was a positive aspect in favor of active transparency.

The mechanisms of regulation by exposure provided by the model presented in this work, favoring the dissemination of performance indicators to the user or managers of basic sanitation, direct the regulator's action towards effectiveness in monitoring the quality of the water offered to the population.

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