Modern Environmental Science and Engineering (ISSN 2333-2581)
July 2018, Volume 4, No. 7, pp. 658-664
Doi: 10.15341/mese(2333-2581)/07.04.2018/009
Academic Star Publishing Company, 2018
www.academicstar.us

Management-Indicators Consulting System for Potable Water Utilities

Martha Patricia Hansen Rodríguez [1], Rodríguez Varela J. M.[1], Laurel Varela Y.[1], Fernández García H.[2], Martínez Ocampo G. A.[1], Antúnez Leyva E.[1], Gómez Lugo L.[1], and Casados Prior J.[1]

1. Instituto Mexicano de Tecnología del Agua (IMTA), México

2. Universidad Tecnológica Emiliano Zapata (UTEZ), México

Abstract: The service-quality performance that a water utility offers any city can be measured according to the efficiency and effectiveness with which it provides water, gathers it and treats it once it becomes wastewater. Other important aspects are, user satisfaction, the continuous provision of water with quality and quantity, knowledge of the elements that make up the infrastructure, having a reliable users' register; knowledge of production and delivery of water to consumers, use of all treatment units' full capacity. Not to mention, attention to users' complaints in a reasonable time and timely payment for the service as well as the repayment of operation costs, maintenance and administration.

This is why it is important to create a system of indicators that permits the evaluation of the evolution of the development and modernization process of water utilities for potable water, sewerage and treatment, set goals to be reached, and contribute to the transparency of national information.

The Mexican Water Technology Institute (IMTA, 2017), created an indicator program for the management of water utilities (PIGOO, based on its initials in Spanish) which have gone up from 50 to 189 since 2005 to 2016, they provide service to 49% of the population in Mexico. At the same time, the number of management indicators has gone from 12 to 29. Information is available for the 245 participating organisms on the web site, http://www.pigoo.gob.mx/, which has an option for consulting a mobile app for the Android operating system.

The battery of 29 management indicators permits the measurement of the performance and efficiency of potable water systems in technical-operative, commercial and financial aspects. Ideally, performance indicators for water utilities would be linked to an objective or a strategy that the same entity sets. These are calculated through data gathered from annual reports of variables such as water volume produced, number of employees, total revenue and costs, occurrence of leaks, complaints etc.

The website has, among other things, the possibility of comparing these indicators, geographic consulting, and search filters for different demographic and geographic ranges of value for different management-performance indicators. This work presents the diverse topics and options that the program offers as well as the analysis of its results.

Key words: performance indicators, water operating systems, PIGOO, México

1. Introduction

In the United States of Mexico, the Political Constitution of 1917 is the *Magna Carta* that legally governs the country; it sets limits and defines relations between the legislative, executive and judicial powers of the Federation for the three levels of government: federal, state and municipal as well as for its citizens. It sets the bases for the government and the organization of its institutions in which its power is settled and established as a supreme social pact for Mexican society, the rights and duties of the Mexican people.

Article 27 of the Constitution states that national waters are sole-property of the state, Article 115 assigns municipal governments the responsibility of

Corresponding author: Martha Patricia Hansen Rodríguez, Master of Engineering; research areas/interests: efficiency in water operators systems, leakage control, sectorization. E-mail: phansen@tlaloc.imta.mx.

delivering potable water, sewerage, treatment and disposition of wastewater services.

The Law for National Waters regulates the exploitation, use, distribution and control of water, and is official practice throughout the country. Additionally, there are state water laws. This grouping of legal instruments establishes the guidelines for the use and conservation of this resource, as well as rights and obligations that the water utility or private company contracted for said services must abide by.

According to economic censuses of the National Institute of Statistics and Geography [1], 2,517 water utilities carry out the abstraction, treatment and provision of water in Mexico; of which, 44 were identified as being from the private sector and the rest as being from the public sector.

In terms of geographical coverage, 1,302 water utilities worked solely in urban zones, where population concentration and economic activities generate a greater demand for water-services infrastructure, while 1,215 organisms provided their services in urban as well as rural areas.

It is important then, to create a system of indicators that permits the evaluation of the evolution of this developmental and modernization process for the water utilities in charge of potable water, sewerage and treatment, additionally; it must set target standards and contribute to the transparency of national information. Moreover, it is important for users interested in said topic to have reliable and effective communication tools. In this case the IMTA developed a web site that permits users to find out the behavior of the indicators for different water utilities participating in the program in a fast and easy way.

This work shows the tools developed as well as some results achieved in the program, more detailed information can be consulted on the PIGOO program website pertaining to the 2002-2016 period.

1.1 Objective

The principal objective of the program is: "To evaluate and track the performance as well as the evolution of the primary potable-water water utilities of the country".

2. Methodology

To define the strategic indicators with which to evaluate water utilities, an analysis was conducted on the technical literature, which served to define 12 such indicators, the remaining 29 were added during the development of this project 19 of which evaluate the area of operation, another 5 evaluate the financial area and the remaining 5 evaluate for general efficiency of the system.

2.1 Operational Indicators

1) Networks and installations
2) Piping repair
3) Repair of domestic connections
4) Intakes with continuous service
5) Macromeasurement
6) Micromeasurement
7) Losses due to network longitude
8) Losses per intake
9) Delivery
10) Consumption
11) Users log
12) Service hours in zones with a system of turns
13) Users that are provided water through water trucks
14) Complaints
15) Employees per every thousand intakes
16) Employees assigned to leak control
17) Treated volume
18) *Reported* potable water coverage
19) *Reported* sewerage coverage

2.2 Financial Indicators

1) Cost divided by volume produced
2) Work relation
3) Investment relation GDP
4) Cost relation – tariff

5) Users that pay on time

2.3 Efficiency Indicators

1) Commercial efficiency
2) Collections efficiency
3) Physical efficiency 1
4) Physical efficiency 2
5) Global efficiency

Afterward, water utilities pertaining to cities with more than 20,000 inhabitants were invited to participate in the program. They received a list of information necessary to calculate each indicator that is in the program. The gathered data is classified according to number of inhabitants and administrative region. The participants' behavior is shown in Fig. 1.

The analyses that are carried out are: i) management-indicator system according to city, ii) comparison of management-indicator system according to number of inhabitants; iii) comparison of management-indicator system according to administrative region and finally, iv) general comparison of management-indicator system.

3. Results Evaluation

Table 1 shows the results obtained from some indicators, as well as their evolution in the last four years.

These results permit the analysis of participating water utilities' general behavior, for example, in the year 2016 only 86 out of the 189 participants provided information related to the global efficiency of the system and the following was observed: of the participants only 70% report an efficiency between 30% and 50% (Fig. 2).

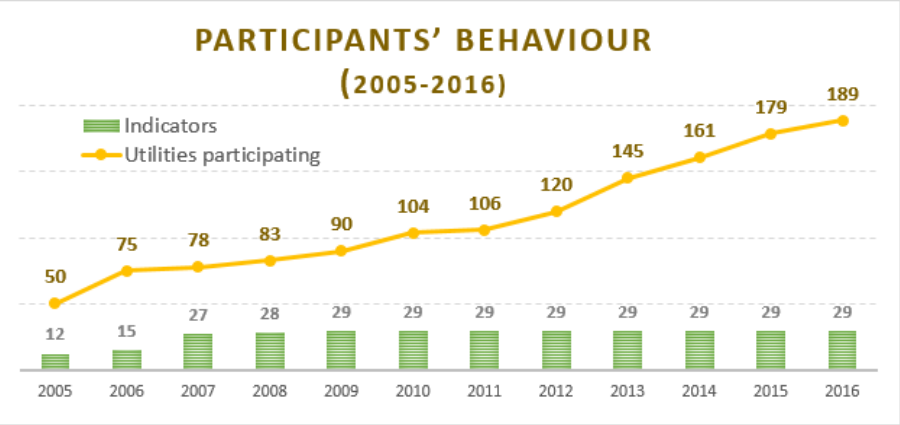

Fig. 1 Water utilities' behavior and indicator according to year.

Table 1 Results obtained in some indicators (national averages).

Indicator	Obtained (2015)	Desired	Evolution (2002-2015)
Continuous service intakes (%)	73.54	100	-1.09 ↓ (74.63-73.54)
Networks and installations (%)	59.33	100	-12.45 ↓ (71.78-59.33)
Users registered (%)	95.43	100	0.2 ↑ (95.23-95.43)
Macromeasurement (%)	70.56	100	-3.29 ↓ (73.85-70.56)
Micromeasurement (%)	54.85	100	-2.35 ↓ (57.2-54.85)
Treated Volume (%)	48.83	100	11.12 ↑ (37.71-48.83)
Complaints (complaints)	129.24	N/A*	-19.37 ↓ (148.61-129.24)
Users that pay on time (%)	55.19	95	-3.85 ↓ (59.04-55.19)
Costs divided by volume produced ($)	8.49	5	5.61 ↑ (2.88-8.49)
Employees per 1000 intakes	5.26	4	-0.18 ↓ (5.44-5.26)
Employees assigned to leak control	15.59	N/A*	4.95 ↑ (10.64-15.59)

Notes: *N/A not available no data could be found to establish a desired level.

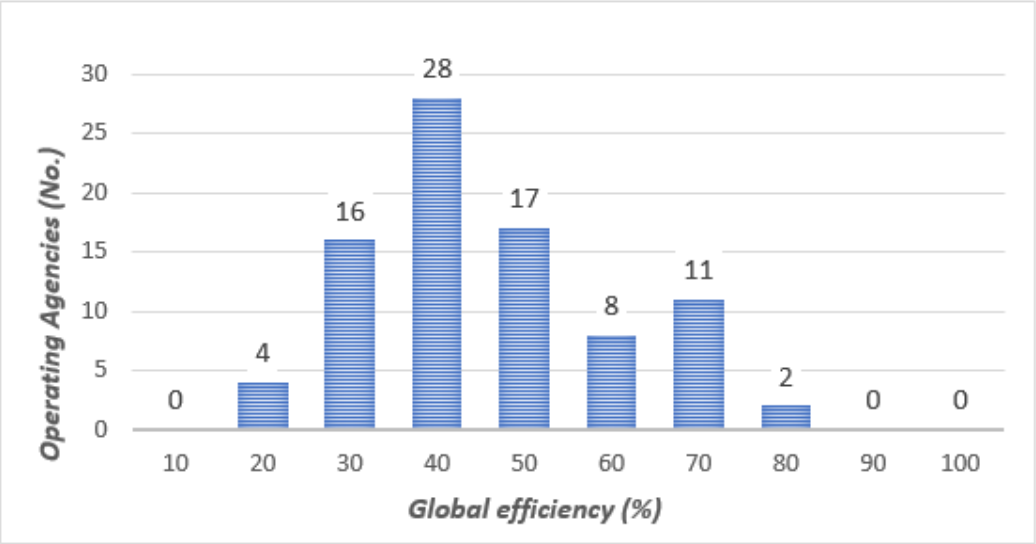

Fig. 2 Global efficiency (PIGOO).

Fig. 3 shows the results for performance indicators as well as location taken from the 245 organisms taking part in PIGOO dating back to the very beginning of the project. To generate these analyses, the database can be downloaded on the PIGOO website.

In 2005, a web application was developed with the purpose of disseminating the collected results through the website: http://www.pigoo.gob.mx, where the totality of the results from all participating water utilities were made available. The PIGOO website was hosted at the Mexican Institute of Water Technology, and was created using freeware.

In 2011, the website was updated with a redesign (Fig. 4) that implements usability characteristics for greater ease-of-use. Graphics and automatic comparisons were added, as well as download options for the information with popular CVS extensions (the recommended extension by the Digital Governance Unit) as well as with the PDF extension.

Fig. 3 Global efficiency results 2002-2015.

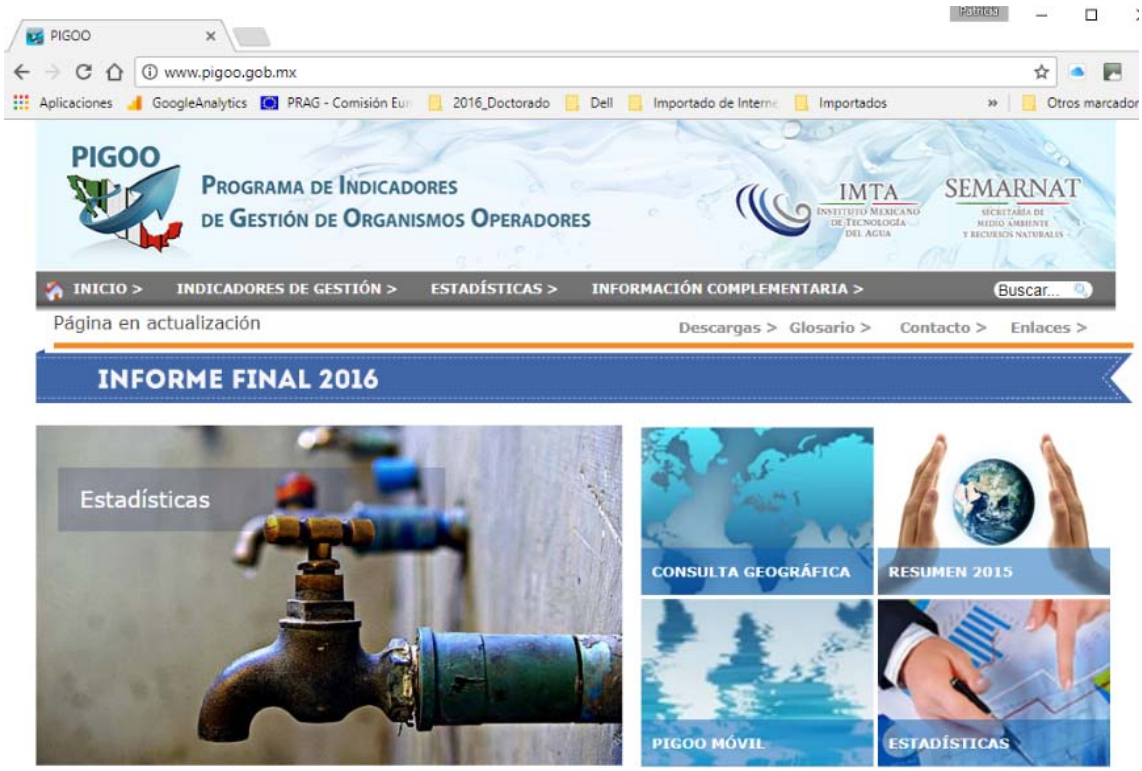

Fig. 4 PIGOO website's current design.

One of the requirements detected in recent years was the lack of access to the data of participating organisms, for this reason, a mobile app was developed that displayed PIGOO information through an HTML interface which had limited consulting functions.

Seeking to resolve these limitations efficiently, an objective was established: Create a program for a mobile app that permits easy consultation of the information related to PIGOO for those that might be interested in knowing the conditions under which the water services sector operates.

According to the Study of Media Consumption and Devices among Mexican Web Surfers 2017 [2], in 2016, 71.5 million Mexicans were web surfers, roughly 60% of the population, of these, 88% have a Smartphone. This is why many of them prefer to have a mobile application to satisfy their information needs.

According to the different surveys carried out by several web pages in the technology field, the system of choice for such an app is Android due to distinct factors such as personalization and liberation and primarily price. It is found in 82% of mobile devices in Mexico due to its accessibility [3]. By using Android as an operating system, a broader array of users can be reached with a greater impact.

The application was created with the purpose of easing the use and collection of program data and can be consulted in Spanish or English depending on the device's settings. Figs. 5 and 6 show several app screenshots.

Once the manner of consulting the information is established whether it is by city, state, hydrological region or indicator average, the app takes you to the consulting section, for example, if the indicators for the municipality of Celaya, Guanajuato were consulted, the module would be comprised of the following:

Under "city", information is shown for the management indicators reported the year before. In 2016 the data submitted for 2015 was given, the other years follow this pattern successively.

Under "Indicators" a map appears of the participating water utilities and the average for every collected indicator (see Fig. 7).

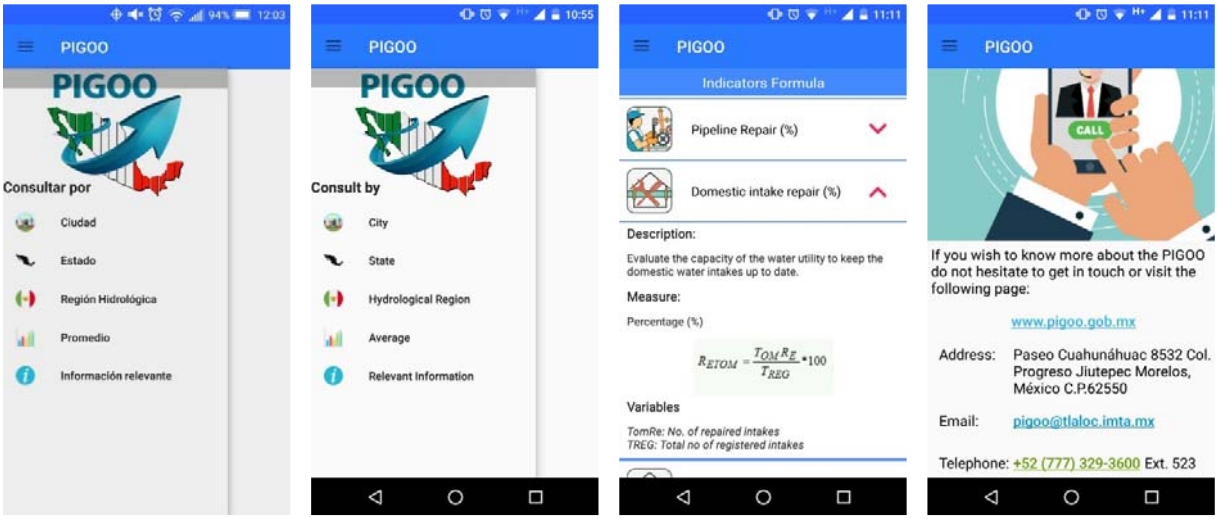

Fig. 5 PIGOO app for Android main menu, start, indicators, relevant information.

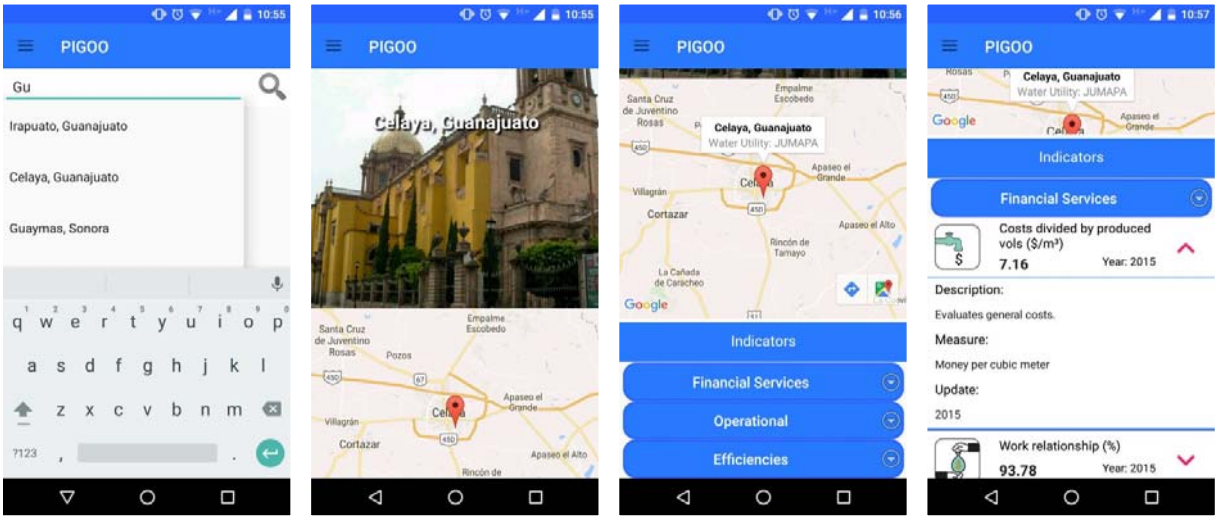

Fig. 6 Example of the consultation feature on the PIGOO app according to city.

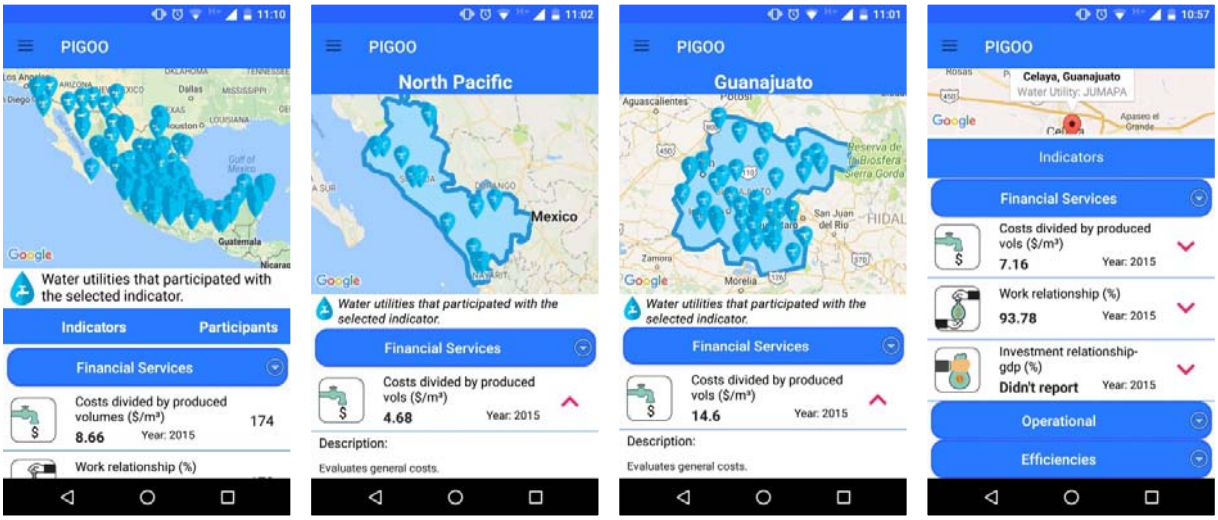

Fig. 7 Consulting modules: per indicator, administrative region, state or municipality.

4. Conclusions

In this paper, results are shown for a work that has been carried out since 2005 for performance indicators linked to the water utilities in Mexico. This job has been possible thanks to the collaboration of 245 participating organisms. During that period, a culture of information-sharing has been promoted among water utilities so that they may know their performance in the technical-operative, commercial and financial areas.

The project is in alignment with the National Water Plan 2013-2018 in its objectives, strategies and lines of action; particularly with line *4.4.1 Strengthen automated networks and informants that supply water data*.

Having the website for the program, as well as the mobile application developed helps the field of governance stipulated in the Federal Budget and Fiscal Responsibility Law under the component "*Databases, information and integrated tools that help to improve decision making*".

Through an analysis of the published management indicators, the demographic evolution, the availability of water, budget and relevant contextual information, each potable water utility can design and implement a program of improvement actions in parameters such as the increase in coverage and quality of its services, economic sustainability, elimination of leaks etc. In this course of actions, it is necessary to identify the best practices associated with the actions that have a positive impact on the values of the indicators. Each water utility should identify the relevant performance indicators and the order of importance according to their objectives, goals and particular needs.

Acknowledgements

In the present study would not have been possible without the support received from the representatives of the 245 water utilities, and so we want to underscore our gratitude and we hope to continue collaborating to enrich the aforementioned results even more.

References

[1] INEGI, Panorama censal de los organismos operadores de agua en México, Censos Económicos. Obtenido de Instituto Nacional de Estadística y Geografía, 2009, available online at: http://www.inegi.org.mx/est/contenidos/espanol/proyectos/censos/ce2009/pdf/Mono_Orgs_ operadores_agua.pdf.

[2] IAB México, Estudio de Consumo de Medios y Dispositivos entre Internautas Mexicanos 2017, available online at: http://www.iabmexico.com/estudios/consumo-medios-2017/.

[3] StatCounter, Mobile operating system market share in Mexico, Mayo de (2016-2017), available online at: http://gs.statcounter.com/os-market-share/mobile/mexico.