DRAFT PROPOSAL FOR A COMMON PI FRAMEWORK AND SELECTION CRITERIA FOR ISO TC 224

1 INTRODUCTION

The aim of this proposal is to establish the common grounds for the development of the performance indicators (PI) system that will support the standard emerging from the work of the ISO TC224. Although nowadays there are already several PI sets covering water distribution and wastewater activities, few of them present the guidelines to establish a formal PI system. Instead, they are basically a list of PIs and some complementary tools or information.

The IWA systems for water supply and wastewater get closer to a clear definition of the system and implicitly develop it. However, this is only clear to the trained eye, and a clearer and more detailed approach should be taken both to ensure that the work of TC224 is consistent and solid, and that the final produced standard also defines the guidelines of a PI system for water and wastewater services.

This document **does not** intend to specify any sort of indicators or elements to be included in the final proposal, but rather propose the criteria and the framework that will later allow determining which indicators to use and how to express them. The framework proposed here is mostly based on the IWA proposals, for they are the best known to the author, and to his knowledge the most detailed ones prepared for the water supply and wastewater industries.

2 BASIC PRINCIPLES OF PERFORMANCE INDICATORS

A performance indicator is just an expression of one or more combined measurable variables. The indicator is a tool that delivers better information than all its separate components.

A performance indicator should have a **univocal definition** that allows the user to evaluate it properly. In this way, the value of an indicator should be the same regardless who calculated it.

A performance indicator is the result of a mathematical combination of several *variables*. The most common form is the ratio, where one variable is divided by another. A variable is a magnitude that results directly from a reading, a measurement or a sound record.

A *performance indicators system* is an ordered and coherent set of performance indicators with an objective. Usually, the development of a PI system is the result of a certain necessity. Fulfilling that objective should condition the selection of the performance indicators for the system. The PI system also contains the necessary variables to calculate the PIs. In most PI systems, one variable is used to calculate several PIs. And consequently, the total number of variables in the system may be less than the result of considering the variables used for every indicator and adding them.

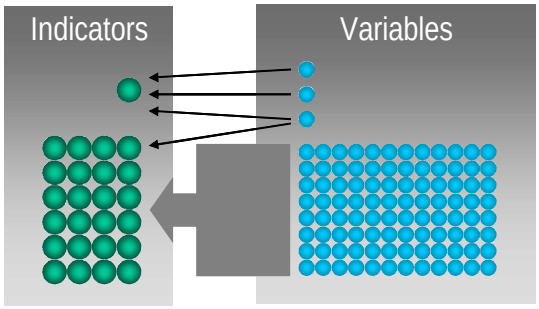

Figure 1. RELATIONSHIPS BETWEEN INDICATORS AND VARIABLES

However, a variable may be also the result of the combination of other variables (i.e., the total length of a distribution network –a variable- may be obtained by adding the total length of plastic pipes plus the total length of steel pipes, etc.). The final result is that although every variable should be properly considered and included in the system, the total number of variables to be used will depend on every user (if the total length of the network is known, and the partial lengths are not used, there will be no need for using these variables).

Finally, a PI system is not complete without the definition of the *context information*. The context information is necessary to depict the particular situation of the environment where the indicators are being applied. This is especially useful when comparing indicators of different origins (*metric benchmarking*). For instance, the difference in value of the indicator "water consumption per capita", could be used to show that the citizens of a particular undertaking are more environmentally conscious (consuming less water) than the people of another city. However, before reaching such a conclusion, some information about the context should be gathered (i.e., type of residence, presence of gardens/pools, average temperature, etc.)

It must be considered, that the final objective of a PI system is to obtain conclusions, and consequently an analysis stage is necessary. Defining appropriate context information will provide useful data at the analysis stage, although it is not relevant at the time of evaluating the indicator values.

The logical sequence to define a PI system, would then be:

1. Establish the objectives for the system (what needs to be tracked / controlled)
2. Define the appropriate performance indicators
3. Define the necessary variables to "feed" the indicators
4. Define the context information necessary to explain for differences in the indicators due to the contextual situation of the user.

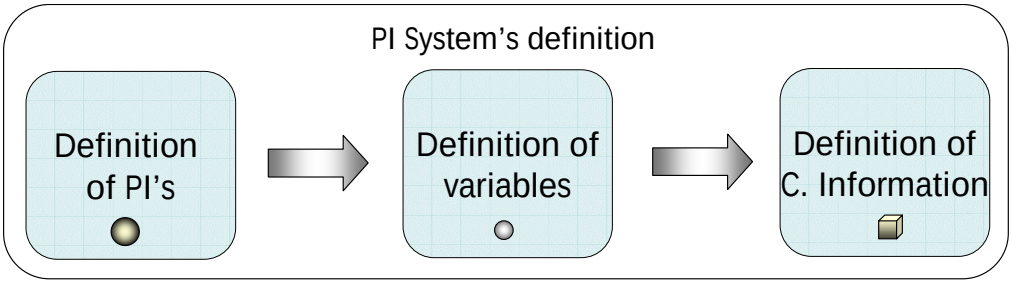

Figure 2. DEFINITION OF A PERFORMANCE INDICATORS' SYSTEM

3 CONFIDENCE GRADES

In some of the already existing PI systems (IWA, OFWAT) an indicator value does not consist of just a number. Since the finality of performance indicators is to allow for some kind of decision making, the quality of the represented data is as important as the value of the data itself. For instance, it would not be wised to start a large rehabilitation program just on the presumption of a deteriorated state of some pipes of the network. Depending on how reliable or accurate the information is, it is possible to do a risk analysis of the decision to be made.

The assessment of PI quality data is not new. OFWAT conceived a confidence grading system to assess the quality of data, to be used when reporting water undertakings' performance in its annual report. This system defines the *confidence grade* of a PI expressed as a binomial of parameters, which describes the quality of the information:

- *Reliability*, which reflects data obtaining and storage aspects;
- *Accuracy*, which reflects the probable range of error.

The reliability describes the quality of information depending on the source or procedure used to obtain data. The OFWAT defines four reliability bands to classify PI. On the other hand, the accuracy characterizes the measurement process. The OFWAT defines seven bands, comprising each one of them a percentage range of possible deviation of the measured value from the true PI value.

The combination of those two parameters results in the aforementioned confidence-grading scheme. Certain combinations are considered incompatible. It would make no sense that data from highly reliable sources would not be close enough to the true value, and neither could unreliable data have a minimum error.

The IWA system and the SIGMA Lite software further developed this system. Instead of directly grading the indicators, all variables were assigned a reliability and an accuracy value, allowing to calculate the resulting confidence grade of the indicator (please check relevant document "*A new approach to assess performance indicators' data quality*" by Herrero et al., for more information on this matter).

4 PERFORMANCE INDICATORS SELECTION

4.1 Selection criteria

A performance indicators system and its application goes beyond the simple selection, definition, and evaluation of a few ratios. A PI system should also take into account the necessary tools to manage it, the personnel needed to feed it, and a whole specific philosophy that should transmit the conclusions to the decisions makers.

The implementation of a performance indicators system must overcome several difficulties. On one hand the technical ones, inherent to the need of obtaining the necessary data for the system. On the other hand, several other constraints of a social or political nature. Depending on the final use of the PI system, some of these inconveniences have been identified.

- **Rejection by the company's personnel**: that may view the PIs as auditing tools.
- **Confidentiality issues**: In the competitive water market, the mere possibility of key figures reaching the competitors is a great obstacle that companies may not overcome.
- **Regulation**: The use of a PI system for regulatory purposes represents a significant distortion in the water market in any country. Companies are consequently reticent to these initiatives.

The truth is that most of these obstacles often appear during the selection process –as it seems logical. Depending on which indicators are selected, the conclusions that may be drawn from their values will be of a very different nature. This is the reason why the objectives of the PI set must be established beforehand, to make sure what the true mission is accomplished in the selection process. A good example may be found in the conclusions collected by Guèrin among the participants in a workshop held in Montpellier (Guèrin, 1998):

- Objectives must be defined before indicators are.
- There must be a **limited** number of key indicators.
- Aggregate use of the indicators must be avoided
- The system must be dynamic (allowing for revisions and evolution)
- Univocal definitions
- Expert interpretation of the PIs (most of the times, PIs are only useful in knowledgeable hands).

Although these issues are **only an example**, they are a sample of the sort of criteria that must be defined before defining an endless number of performance indicators.

Furthermore, a certain set of "characteristics", applicable to all indicators defined must be established. This will often help to answer the questions like *what is an indicator and what is not* (versus a data variable or a context information item, for instance).

A good example may be the criteria proposed by the OECD (1998) for an *ideal* environmental indicator:

Criteria for selecting environmental indicators

As indicators are used for various purposes, it is necessary to define general criteria for selecting indicators. Three basic criteria are used in OECD work; policy relevance and utility for users, analytical soundness, and measurability (these criteria describe the "ideal indicator; not all of them will be met in practice)

POLICY RELEVANCE	An environmental indicator should: • Provide a representative picture of environmental conditions, pressures on the environment or society's responses; • Be simple, easy to interpret and able to show trends over time • Be responsive to changes in the environment and related human activities • Provide a basis for international comparison • Be either national in scope or applicable to regional environmental issues of national significance • Have a threshold or reference value against which to compare it, so that users can assess the significance of the values associated with it.
ANALYTICAL SOUNDNESS	An environmental indicator should: • Be theoretically well founded in technical and scientific terms • Be based on international standards and international consensus about its validity • Lend itself to being linked to economic models, forecasting and information systems
MEASURABILITY	The data required to support the indicator should be • Readily available or made available at a reasonable cost/benefit ratio • Adequately documented and of known quality • Updated at regular intervals in accordance with reliable procedures

Table 1. SELECTION CRITERIA FOR ENVIRONMENTAL INDICATORS (OECD, 1998)

Although all the OECD criteria are probably not applicable to the ISO TC224 work, the spirit is certainly of great use. Before defining a set of indicators, the TC should know what sort of PIs are wanted and to which use they are going to be put.

4.2 PI selection

The actual process of selecting the performance indicators has usually been performed so far on a trial and error basis. Considering the sets of indicators documented so far (in the water industry) and the selection process that led to them, all methods used appear to be rather arbitrary. Regardless of the actual consistency and quality of those systems (which in some cases is unquestionable) the selection process was usually approached

exclusively on the personal appreciations and experience of those in charge of the selection, regarding whether a certain indicator was appropriate for the task.

Although there are documented methods for PI selection (Cabrera Jr., 2001), the truth is that the time constraints for the work of the TC224, and the fact that meetings will only take place every 6 months, do not advice to follow them.

However, a certain methodology should be used to avoid the presentation of endless sets of indicators, since almost every expert in the working groups could probably contribute one if asked to (resulting the later selection in a much more difficult task than the one consisting in building up the system from scratch). Following the ideas presented in this document so far, a draft methodology could be summarized as follows:

Proposal of a PI Selection methodology for ISO TC 224

1. Establishment of the objectives of the PI system to be defined by ISO TC 224.
    - What is the system to be used for?
    - Which types of users are expected to use the system?
    - What sort of information should the system provide
    - How many indicators should the system have
    - How is the system going to be used once defined

2. Definition of the characteristics of the PIs in the ISO system, including –if necessary – variables and context information. For instance (and only as an example)
    - Every PI should provide information significantly different from the other PIs in the system
    - PIs may be divided into sub-indicators when needed to provide further detail
    - PIs may be grouped into different levels, to provide guidance to the users (higher level for higher management, lower levels for departmental management)
    - Variables to calculate PIs should be easily measurable at a reasonable cost
    - Definitions of PIs, variables and context information should be univocal
    - PIs should favour an easy and intuitive interpretation when possible
    - PIs should be accompanied of the necessary context information to aid in its interpretation

3. Selection of the key issues to be represented by the PIs in every area.
    - Each working group can define topics that need to be addressed by the indicators (quoting ideas and areas, and not indicators or their definitions)

4. Proposal of indicators for the key issues identified in 3.
    - Indicators from existing sets (IWA, World Bank, etc.) that represent the issues identified in 3 can be proposed
    - Additional indicators may be defined or modification to existing indicators proposed
    - All definitions should be quite precise in terms of variables needed to calculate the indicators, processing rule, units, etc.

5. Selection of the best proposed indicators to fulfil conditions in 1, 2 and 3.
    - The final selection of indicators should match the target total number of indicators defined in 1
    - Redundant indicators should be avoided (i.e. representing the same concept, simply changing units or slightly the definition)
    - Consistency of the indicator system should be looked after (consistent units / concepts throughout the system –even for the different WGs-, consistent definitions, consistent periods of evaluation, etc.)

6. Establishment of the final PI set
    - All indicators developed by all WGs should be put together. A re-run of step 5 (trying to avoid duplicates, seeking consistence) should be done
    - All the necessary variables needed to calculate the indicators should be identified, and when possible reduced (trying to use a variable in as many indicators as possible to reduce the size of the system, without compromising the indicators definition and concept)
    - All the necessary context information needed to interpret the indicators should be identified, and when possible defined.
    - The whole system should be standardized in terms of every PI having a definition, a processing rule, units defined, associated variables, etc.

As mentioned before, this is a **draft proposal**, presented as a starting point. However, it must be stressed that the difficulties of having several working groups developing systems in parallel, and the scarcity of meetings seem to demand a well defined methodology in order to reach a consistent and useful system in the allocated time.

5 DEFINITIONS

This section is not an attempt to forecast or replace the work of WG1. However, previous work in the PI field has led to certain concepts that are defined here. The main goal of these definitions is to provide a better understanding of **this document**, and not to define concepts for the ISO standard.

Performance indicators' system: Consists of the PIs, variables, and context information necessary to identify, monitor and control all major areas in a water supply or wastewater system. Performance indicators are only useful when compared to another reference. Depending on the reference used for the comparison, the PI management technique is different. Although there may be additional uses for PIs, PI systems are basically divided into two:

- Internal PI system: Comparing PI values with historical data of the own company.
- Metric benchmarking: Comparing PI values with those of another system…

Water supply / Wastewater System: The result of considering all areas of interest, stakeholders and influencing factors in a certain environment to be monitored. In the case of water undertakings or wastewater companies, the considered system would comprise the whole company, the stakeholders, the users, the environment, and all related areas that may be worth monitoring for management purposes.

Performance indicator: A performance indicator is a figure resulting of a ratio or simple combination of several basic variables of the system. The full performance indicator consists of a value (resulting from the evaluation of the "processing rule") expressed in a certain unit, and a confidence grade which indicates the quality of the data represented by the indicator.

Variable: A variable is a basic parameter from the system which can either be measured from the field or is easily obtainable. Variables can be combined into processing rules in order to define the performance indicators. A full variable consists of a value (resulting

from a measurement or a record) expressed in a certain unit, and a confidence grade which indicates the quality of the data represented by the variable.

Context information: Context information are those data in the system that account for differences between systems. Context information does not change in the short term and is not affected by management decisions (demographics, geographics, etc.). Context information is specially useful when comparing indicators from different systems.

Confidence grade: The quality of data represented by variables can be assessed in terms of its accuracy and reliability. The confidence grade of a variable or an indicator is expressed by a binomial in which the first term is the accuracy (A to D) and the second the reliability (1 to 6). Neither a performance indicator nor a variable are complete without their confidence grade. The proposed confidence grade originated first in the OFWAT (UK) and was adapted by IWA.

Accuracy: It accounts for measurement errors in the acquisition of variables. No measurement device is completely accurate, and some of the data available in the system may have been obtained by less accurate methods. Accuracy values are divided in ranges, and represented by letters.

Reliability: It accounts for uncertainties in how reliable the source of the data may be. Old records (i.e. pipe schematics from early 20th century) may not be reliable in terms of depicting the current situation of the assets. Reliability values are divided in bands, and represented by numbers.

Processing rule: Mathematical combination, usually with simple operators (÷, ×, +, -) of system variables. It is the mathematical formulation of the indicators definition.

Definition: of a variable or an indicator. Phrasing which accounts for the concept and the way to obtain the value of a variable or an indicator. In the case of an indicator, when translated into mathematical terms it leads to the processing rule.

6 REFERENCES

Most of the work presented here is a result of a PhD thesis (Cabrera, 2001) and the invaluable experience gathered within the ongoing IWA taskforce on Performance Indicators. Only the sources referenced in the text are quoted here, although many others (such as some of the *Relevant documents* already distributed by the TC secretariat) have implicitly also been considered.

Cabrera Jr. (2001)

Diseño de un sistema para la evaluación de la gestión en abastecimientos urbanos. PhD Thesis. Polytechnic University of Valencia. Spain.

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Towards sustainable development. Environmental indicators. Organisation for Economic Co-operation and Development.