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Management system for improving the efficiency of use water systems water supply

E.V. de Souza[a], M.A. Costa da Silva[a]*

[a] *HAGAPLAN, São Paulo – SP, Brazil*

Abstract

This paper presents a management proposal to improve the efficient use of water resources in water supply systems. This is based on management tools, project management and is organized into three levels of planning (strategic, tactical and operational), following definitions of theories of strategic planning. This paper details these levels of planning, with a focus on strategic management, i.e., action plans at the strategic level, describing a methodology and detailing the main tasks that should be executed, as well as the main tools that can be used in each task, such as SWOT analysis and Balanced Scorecard.

Keywords: Management system, reducing losses, improving efficiency, water resources, water supply

1. Introduction

Nowadays, water utilities of water supply systems in Brazil are facing a great challenge to save water, not only due to technical and economic reasons, i.e. to improve the performance of the whole system, but also because of the scarcity of water resources in many regions Brazil and the growing need for sustainable management systems. The water supply system in most Brazilian fund managers have water losses due to leaks and ruptures that result from the inevitable advanced age infrastructure, concepts and constructs deficient or inadequate operation and maintenance.

Corresponding author. Tel.: +55-11-33340355; fax: +55-11-33340355.
E-mail address: marcoantonio@hagaplan.com.br

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The development and implementation of effective water losses strategies and procedures is of the utmost importance for water utilities. The current paper aims at the presentation of a methodology for the improvement of the water resources use efficiency in water supply systems. This methodology is based on tools of strategic management, project management and is organized into three levels of planning (strategic, tactical and operational), following definitions of theories of strategic planning, associated with actions short, medium and long term. The paper details these levels of planning, with a focus on management, describing a methodology and detailing the main tasks that must be performed, as well as the key tools and technologies that can be used in each task to aid decision making, such as indicators performance, hydraulic simulators and optimization procedures.

2. Water Losses Control

Programs to reduce and to control water losses as well as to rationalize the consumption of water and energy should be applied to the various stages of the supply, since the water intake, including the treatment, transport and storage, distribution and the final delivery to the consumer. Water input into the system has two main components – authorized consumption and water losses (Fig. 1). Water losses are the difference between the system input volume and authorized consumption (measured or estimated). Losses have two components: real or physical losses that correspond to leaks and ruptures in transmission or distribution mains, in storage tanks and in service connections until the consumer meter (i.e., water that inadvertently leaves the system), and apparent losses include measurement errors (flow-meters), illegal connections and uncounted for uses (e.g., irrigation, street washing, fire fighting) (Alegre et al., 2005).

While apparent losses can be minimized by using more accurate measurement equipment, installing meters at uncounted for consumption sites and regularly surveying the system looking for illegal connections, real losses depend greatly on normal operating pressures, burst frequencies, infrastructure age, construction processes, and rehabilitation strategies and leakage reduction. Leakage control can be carried out by different types of actions (Covas et al., 2008):

- passive control that consists of the repair of leaks and ruptures only when they become visible;
- active leakage control that consists of the establishment and monitoring of district metering areas and the implementation leak detection surveys;
- pressure management that presupposes the establishment of pressure zones by the redefinition of the network layout or the installation of PRV;
- Implementation of short-term and long-term rehabilitation programs.

<table>
<tr><td rowspan="8">Input Volume (corrected for known errors) [m³/year]</td><td rowspan="4">Authorized consumption [m³/year]</td><td rowspan="2">Billed Authorized Consumption [m³/year]</td><td>Billed Metered Consumption (including water exported) [m³/year]</td><td rowspan="2">Revenue Water [m³/year]</td></tr>
<tr><td>Billed Unmetered Consumption [m³/year]</td></tr>
<tr><td rowspan="2">Unbilled Authorized Consumption [m³/year]</td><td>Unbilled Metered Consumption [m³/year]</td><td rowspan="6">Non-Revenue Water (NRW)

[m³/year]</td></tr>
<tr><td>Unbilled Unmetered Consumption [m³/year]</td></tr>
<tr><td rowspan="4">Water losses

[m³/year]</td><td rowspan="2">Apparent Losses [m³/year]</td><td>Unauthorized Consumption [m³/year]</td></tr>
<tr><td>Customer Metering Inaccuracies [m³/year]</td></tr>
<tr><td rowspan="3">Real Losses

[m³/year]</td><td>Leakage on Transmission and/or Distribution Mains [m³/year]</td></tr>
<tr><td>Leakage and Overflows at Utility's Storage Tanks [m³/year]</td></tr>
<tr><td>Leakage on Service Connections up to point of Customer metering [m³/year]</td></tr>
</table>

Fig. 1. The IWA 'best practice' standard water balance

3. Strategic Management and Project Management

The water supply system of a city is in fact a major industry which produces, stores, and distributes the most vital food for humans. As such, the services provided by a managing entity to a community have fundamentally two objectives which are: Preservation of public health and social Purpose.

With this approach, you can not admit that the company pays additional costs arising from potential inefficiencies, whether source technical, commercial or managerial.

Therefore, any company providing services to the public - and in the case of this article, the managing bodies of water - must meet some basic requirements, namely:

- Quality - the product supplied to users as well as after its consumption to disposal in the environment, should have the minimum quality required by the Standards for drinking water and effluent discharge;
- Amount - the company must provide a sufficient quantity of water to meet the demand of its users rational;
- Regularity - regular services should be both in quantity and in quality, I mean, should maintain the same quality standards at all times;
- Reliability - meeting the requirements above, will make sure that the user acquire public confidence in the company;
- Cost - the company should adopt an organizational structure, employing methods and work procedures - both source technical and operational, commercial, and managerial - meet the above requirements and, at the same time, resulting in the lowest possible cost. The company must be, in other words, efficient and effective.

In this context, the role of a managing body of water comes amid several processes and a project is important to understand the differences and similarities between these two types of work for their proper management.

According to the definition of the Project Management Body of Knowledge - PMBOK (2013) a Project is a temporary endeavor undertaken to create a product, service or result only, and managing a project is represented succinctly in Fig. 2. Furthermore, it has to be a Project is a unique process, consisting of a group of coordinated and controlled activities with start and end dates for, undertaken to reach a goal as specific requirements, including limitations of time, cost and resources.

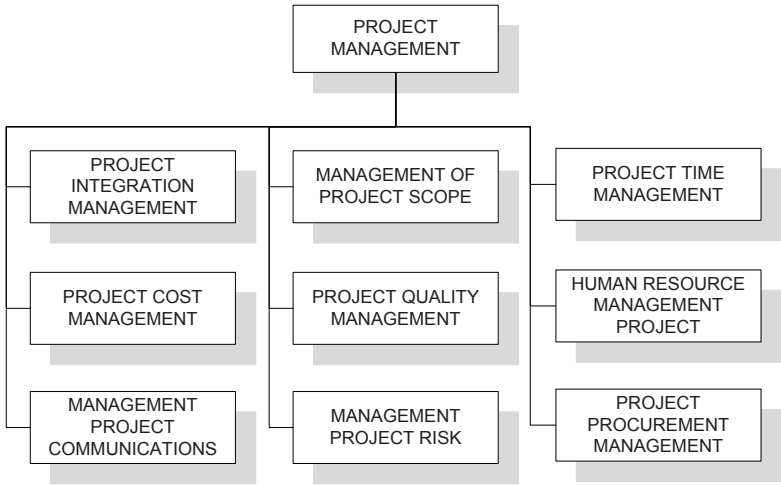

Fig. 2. Overview of knowledge areas of project management processes and project management. Source: PMBOK (2013)

Thus, it can be said that the work processes are repeated systematically, while projects occur in a unique way. Examples of processes within company sanitation routines are the billing, collection, customer service, operation of treatment plants, supervision and operational control, etc. How designs can be mentioned the conception, design, construction, delivery and startup of a treatment plant, or the development and implementation of a new business management system, among others. At the end of their life cycle these projects result in many processes for its operation.

A management company water supply must have control methodologies based on project management, advocated by PMI, as well as process management in a strategic way.

Strategic management encompasses the definition of strategic benchmarks, which communicate the guidelines of the management entity for its strategic business units and various functional levels, in order that their actions are consistent and aligned with general guidance. To illustrate this concept Rumelt (1984) discusses a methodology base strategic management, as shown in Fig. 3

Fig. 3. Methodology-based strategic management, according to Rumelt (1984)

An important tool in strategic management, in order to align and control strategic, is the Balanced Scorecard (BSC), which enables the development of measures that enable the deployment of strategies to be implemented. Strategists can better evaluate corporate performance and the strategic business units, developing the constant process of learning the whole value chain of the organization. The BSC allows managers to view and deploy strategies in four perspectives: financial, customers, internal processes, and learning and growth. The BSC complements financial measures with non-financial indicators, making the future performance at all levels of the servicer. (Kaplan and Norton, 1996)

4. Integrated Methodology

4.1. Levels of planning

The activity of water utilities should be planned in three levels (Murphy, 2003):

- strategic level, at long term (more than 5 years) establishing the strategic objectives and its goals, but not specifying the means to achieve the desired results;
- tactical level, at medium term (1 to 3 years) establishing the ways to achieve the desired results (i.e., the tactics);
- operational level, at short time (e.g., 1 year,) establishing the short term program and actions.

Strategic plans are usually established by the head of the organization, tactical plans by the responsible for each division and operational plans by those responsible for the operational teams. The methodology presented here is developed in the strategic planning.

4.2. The methodology

Associating a strategic management methodology proposed by Rumelt (1984), shown in Fig. 3, with the concepts of the Balanced Scorecard and the methodology proposed by Souza et al (2009), shown in Fig. 4, results in a methodology for a system management to improve the efficiency of water use for water supply systems shown in Fig. 5 which will be used in this article.

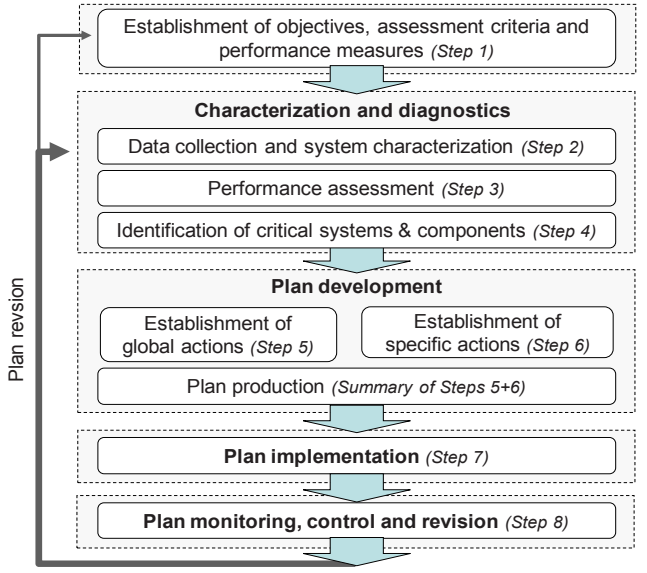

Fig. 4. Methodology for the improvement the efficiency in water resources uses (Souza et al, 2009).

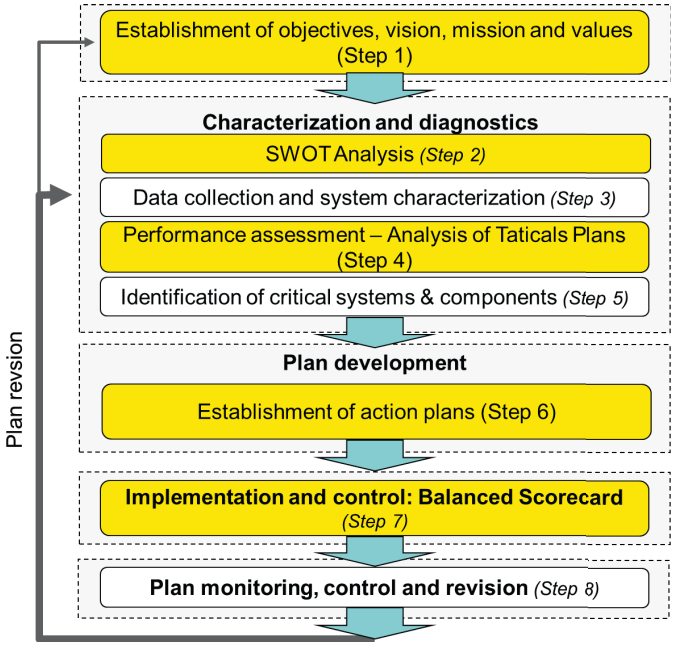

Fig. 5. Modified methodology applied in this article

Unlike the method proposed by Souza et al (2009), this paper seeks to establish guidelines for strategic management, from which data can take operational and tactical decisions and propose guidelines for the direction of the managing body of water to maximize the results and minimize disabilities using principles of efficiency, efficacy and effectiveness.

4.3. Establishment of objectives, vision, mission and values (Step 1)

The first step in the methodology is the definition of the objectives, vision, mission and values of the water utilities. The strategic objectives for water utilities are the following (ISO 24512: 2007): (i) protection of public health; (ii) satisfaction of the needs and expectations of the users of the service; (iii) provision of service in normal and emergency conditions; (iv) sustainability of the water utilities; (v) promote the sustainable development of the community; and (vi) environmental protection.

In addition to the strategic objectives will be defined vision, which is what is idealized to the management company, the mission, which is your purpose of existence, and values, which are the basic beliefs for decision making of the fund manager.

4.4. SWOT Analysis (Step 2)

In the SWOT analysis will be evaluated the Strengths, Weaknesses, Opportunities, and Threats of the water utilities.

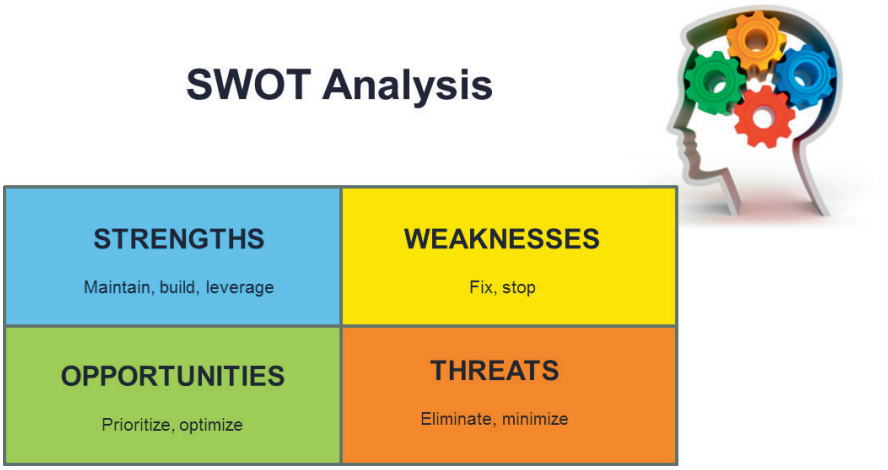

Fig. 6. SWOT Analysis

4.5. Data collection & system characterization (Step 3)

The first step towards the diagnostic of the system is the collection and systematization of existing information and the characterization of different systems. These systems can be defined based on the water sources, tanks, existing levels of pressure, the network topology and the number of consumers. It is essential to characterize the current situation in terms of physical characteristics of the systems, billed consumption, failure records and cost data. The comparison between different systems allows to obtain an overall picture of the water supply system as well as to identify the main gaps and needs in terms of the management of the information system.

4.6. Performance assessment – Analysis of Tactical Plans (Step 4)

Based on the set of performance measures established in tactical plans considered the most relevant in the context of water losses control use, the performance of the different sectors of the system is assessed. For each performance measure, reference intervals should be defined in order to allow the evaluation in "good", "satisfactory" or "bad" performance.

4.7. Identification of critical systems & components (Step 5)

Step 5 consists of the identification of the most critical sectors and components of the system, which are the ones with lower values of performance indicators for different tactical objectives. This allows the definition of priorities.

4.8. Establishment of action plans (Step 6)

Action plans should be defined with the previous analyzes, consolidated and summarized in Fig. 7.

Perspectives	Strategic Objectives	Critical Factors	Action	Measurement	Responsibility	Implementation date	Resourse
TEMPLATE							

Fig. 7. . Strategic Action Plan (Template)

4.9. Implementation and control: Balanced Scorecard (BSC) (Step 8)

The management control should be done through a Strategic Committee which will monitor all the actions defined, as well as through the BSC that allows managers to view and deploy strategies in four perspectives: financial, customers, internal processes, and learning and growth. The monitoring will be done through these four perspectives, as presented in Fig. 8.

Strategy	Financial	External customers	Internal processes	Learning and development
TEMPLATE				

Fig. 8. Monitoring by Balanced Scorecard – BSC (Template)

4.10. Plan monitoring, control and revision (Step 9)

Due to the strategic objectives, SWOT analysis and definition of action plans, defines a monitoring plan with goals for each objective, besides setting the charge and frequency of monitoring. The Strategic Committee plays a key role in this process. From these results, one should undertake periodic review of action plans in relation to the objectives, as well as SWOT analysis, because the internal and external conditions change, requiring a reassessment of the action plans. This allows the evaluation of the efficiency of human resources, physical and technological resources, as well as the effectiveness of actions, comparing the baseline configuration with the final plan.

5. Case Study (in progress)

The HAGAPLAN is a Consultancy Company and it is in consortium with SANEAR, which is developing a work to reduce losses in Guarulhos. So is underway to apply the methodology described above.

In the complex context of the water of the great metropolis that surrounds the city of São Paulo, Guarulhos is one of six autonomous systems. However, although it has complete independence in relation to the distribution of water, the city's main supplier Sabesp - Basic Sanitation Company of the State of São Paulo, which supplies the region through the Metropolitan Aqueduct System.

Since the last two decades of the twentieth century the supply of drinking water produced by us for the MRSP has been limited, and the prospect of population growth, mainly concentrated in layers of middle and low income located in peripheral regions, the municipality is seeking to increase its autonomy in terms of water production, mainly through the implementation of systems independent producers, rooted in the exploration of deep wells with low flow and small watersheds in the region.

Despite significant investments that have been made since 2001, distributor system, even if no progress on increasing efficiency, and to pursue the full implementation of the supply sectors designed in previous studies and in other structures that may contribute to the effective control of drinking water distributed.

An increase in efficiency translates into an obviously reducing the amount of water distributed and therefore a greater protection of resources, without compromising the quality of services provided by SAAE its users. Therefore, these situations can be not only a quantitative but also qualitative, reducing water availability in the appropriate quality resulting in the provision of services.

It is therefore increasingly a concern to promote more efficient use of water, by optimizing the use of this feature, without, of course, forget the intended goals - efficient use - the level of the vital needs of society, quality of life and socio-economic development of the municipality. The goal is to use less water to achieve the same goal, also allowing as indirect benefits, reduced pollution of water resources and the reduction of energy consumption, highly dependent aspects of water consumption.

Therefore, the water utility hired of the Guarulhos Partnership HAGAPLAN-SANEAR to analyze the water supply system and propose a plan to reduce water losses. Within this contract to provide services, from HAGAPLAN we are starting to implement the method defined in this paper. The aim will be to implement all the steps described above, i.e., focusing the strategic actions to reduce water losses and the organization of the water utility in the customer requirements and goals (Partnership HAGAPLAN-SANEAR, 2012). However the success of strategic actions defined in this methodology (Fig. 5) is related to actions at the tactical level defined in the methodology proposed by Souza *et al* (2009), which was summarized in Fig. 4.

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