

CASE STUDY

Evolution of a Systemic Approach Application for the Management of the Water Supply and Collection System in the City of Leon

Annabel Membrillo – advisor
annam@strategic-clarity.com
Conrado García Madrid – advisor
cong@strategic-clarity.com

Strategic Clarity
José María Ochoa No. 478
Col. Los Candiles,
Queretaro, Qro. México, 76190.
Tel/Fax: (52) (442) 228 3449
www.strategic-clarity.com

Felipe Polo – CEO
fpolo@sapal.gob.mx
Andrés Méndez – OD manager
sapal@sapal.gob.mx
Ernesto Enei – IT manager
eenei@sapal.gob.mx

SAPAL
Blvd. Torres Landa No. 2620, Ote.
León, Gto. México, 37480.
Tel/Fax: (52) (477) 788 7800
www.sapal.org.mx

Abstract

This paper discusses the experience in using a systemic approach to aid group decision making and strategy development for the public water management system in the city of Leon, Mexico, named SAPAL. The project focused on gaining clarity in how the government's management team designed and managed five strategic elements – its goals, resources, actions, structure and people. This focus gave the managing group guidance in how to move SAPAL in the desired direction and it provided them with a dynamic and comprehensive tool that was incorporated into the existing strategic management system. Though much has been done, it is still a work in progress.

SAPAL background

SAPAL (Sistema de Agua Potable y Alcantarillado de Leon) is a governmental water management system in the city of Leon, Guanajuato in Mexico. SAPAL exists to guarantee the provision of high-quality water, sewer services and water treatment for the city of Leon today and in the future at a fair price.

In 1992, Felipe Polo was selected as the new CEO of SAPAL. He and his team performed an in-depth analysis of the organization to better understand what was going well and what needed improvement. They identified symptoms of what were wrong and specific challenges for improvement. Since then, transformation has been constant. The board of directors has been open to innovation. In the technical area, they have tested new materials, suppliers and processes. In the managerial field they have applied and integrated new management theories, methodologies and approaches. They have gone through several cycles, focusing on organizational change and implementing different approaches (see **Figure 1**).

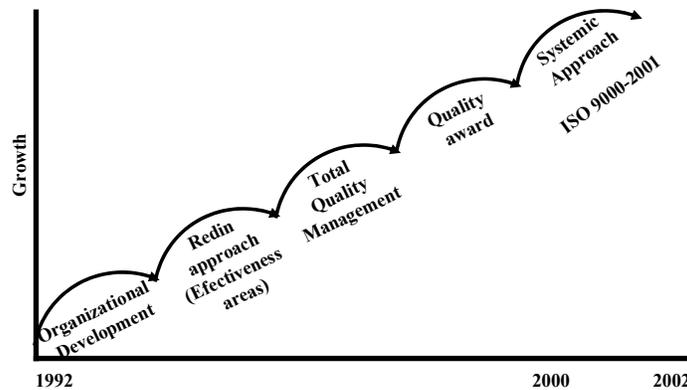


Figure 1: SAPAL’s organizational change cycles ranging from Organizational Development, Redin and Total Quality Management to Systemic Approach. Each cycle moved SAPAL closer to their global goal.

For his leadership and positive results, Felipe Polo has been elected three times. In addition, SAPAL won the state quality award in the year 1997. In 2002 SAPAL was elected by the American State Organization (OEA – Organización de los Estados Americanos) as one of the two most efficient water systems in Mexico. In fact, they are now considered an example to follow for others who manage public water systems in Latin America. However, the environment continues to become more demanding in every sphere, especially in the social and political realms.

“The only constant of this time is change. The challenge that the SAPAL management team faces is not just to look for new technologies for process and products improvements, or new approaches for personal and group efficiency and effectiveness; the genuine and larger challenge is in how to cope with a constant population growth, with scarce water supplies and with the increasing political and social aspects of water management in the city, the towns around it and, in the forthcoming years, among federal states. These situations demand that we explore and learn from other social and political systems in order to be able to accomplish the mission that has been given to us: to fulfill the needs of high quality water, sewer systems and water treatment for the population of Leon.”

-- CEO – Felipe Polo, Management Director – Edgar Hernández. 1st Learning Forum in Mexico, October 25 2002

Application of systems thinking and system dynamics concepts

System dynamics modeling allows the integration of multiple political, environmental, social, and structural variables into a single model. System dynamics models also calculate the behavior of all the variables in the system, allowing policies to be tested (Forrester 1961). Following strong improvements in their organizational development and operations, the SAPAL management team felt they needed an integrative approach for the whole organization. They selected the GRASP systemic methodology, which has helped other organizations face similar integration issues (Ritchie-Dunham and Rabbino, 2001).

The project has evolved over the past three years. In 2000, SAPAL applied the systemic approach for the first time through the development of a detailed causal loop diagram (CLD) and analyzed the CLD from a systemic perspective. In 2001, the team introduced dynamic simulation to explore the interaction of the key resources associated with each major SAPAL initiative. This generated a set of integrated action points. Finally, in 2002, SAPAL incorporated the products developed from the systemic approach with their existing management tools into a new strategic management system. The evolution is explored in more detail below by year.

2000

In September 2000, SAPAL was about to start the first phase of a new water treatment plant. Because this plant imposed additional costs to living and producing in Leon, this initiative met with resistance from political organizations as well as from the business community. To understand the growing complexity of the environment, SAPAL called in external support to apply a systemic approach to the situation.

The modeling team included the SAPAL management team, the director of the industrial council and two system dynamics consultants. The team developed a qualitative, systemic, resource map and performed a systemic analysis of it.

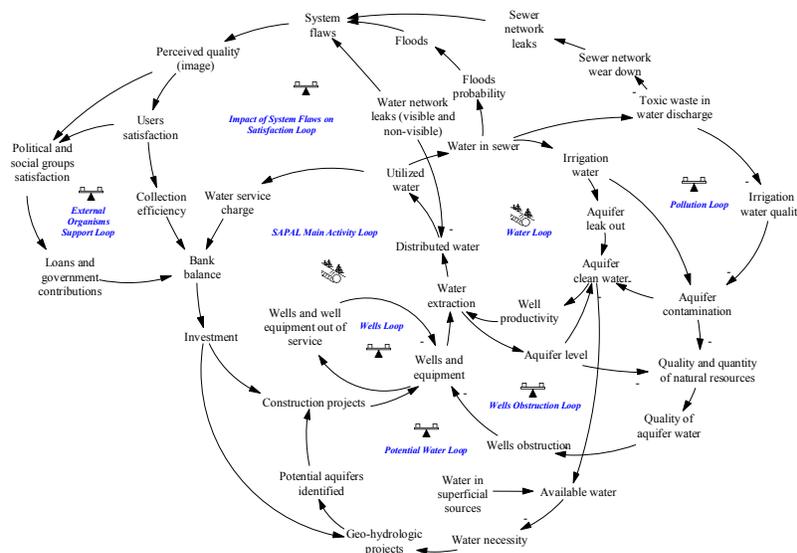


Figure 2: Causal Loop Diagram showing the major dynamics and limits of SAPAL main activity loop

The analysis explored the main feedback loops, identified shared strategic resources, systemic performance indicators and leverage points, and highlighted multiple actors' perspectives of the system. The main purpose of the analysis was to increase the management team's understanding of the complex dynamics in their organizations. For a detailed explanation of the stages of analysis, see (Ritchie-Dunham and Rabbino, 2001). Several archetypes were extracted to describe the principle dynamics more clearly. One of the most powerful insights was best explained using the "The Attractiveness Principle" archetype (Senge *et al.*, 1994).

The model demonstrated the multiple limits to SAPAL's main activity (see Figure 2) including:

- *Pollution Loop* – Discharge of polluted water by industrial users limits available water in the long term;
- *Well Obstruction Loop* - Water quality limits water well productivity;
- *Impact of System Flaws on Satisfaction Loop and External Organisms Support Loop* – Government contributions and collection efficiency limit investment capital;
- *Potential Water Loop* – Nature cannot replenish the non-renewable resource as quickly as the population uses it.

The team realized that the more successful they were in achieving their main activity – providing quality water to the city – the faster the limits would push the system back and the more difficult it would be to achieve their goal in the future. In the strategic plan they included actions for each one of these limits.

In the last quarter of 2000 and the beginning of 2001, the CLD was used in the planning team's strategic conversations, as a thinking tool. A high-level, summary map was used to communicate the long-term relevance of how each initiative contributed to achieve SAPAL's global goal. Some archetypes were used to communicate the purpose of specific actions to outside participants.

2001

After the implementation of the first phase of the water treatment plant, the management team asked for additional support in applying the systemic approach to a broader range of SAPAL challenges. In the last quarter of 2001, six initiatives for 2002 were generated:

1. *Plant II* - Second phase of the water treatment plant
2. *Rio Verde I and II* – Build an aqueduct to bring water from another state
3. *Muralla II* - Bring water from a town nearby Leon
4. *Feasibility Studies* - Understand how land feasibility for home builders influences the system and what SAPAL may do to control it
5. *Money Collection* - Explore how to increase collection efficiency
6. *Financial Resources* - Explore management of the different financial options for initiatives 1, 2 and 3.

The modeling team now included managers and people from the next hierarchical level. For each initiative, the modeling team built a causal loop sub-model. Each sub-model had clear linkages with the detailed model developed previously. These models helped the modeling team explore the key dynamics around critical resources. The models also guided their: (1) identification of opportunity areas, often across functions, (2) generation of additional ideas around each initiative, (3) development of agreement around possible actions, and (4) articulation of an integrated message regarding the group of initiatives to communicate to stakeholders outside SAPAL.

After identifying the key strategic resources for each initiative, several expert groups were formed to develop a stock-flow model for each resource. This exercise had four objectives: (1) clarify key dynamics, (2) validate the model, (3) test assumptions regarding the dynamics of these key resources, and (4) communicate the implications of these dynamics to the governmental agencies (municipal and state) in Leon and the Leon industrial association. Two of the key resource dynamics are presented below.

Water resource – This resource involved three initiatives: Rio Verde, Muralla II and Plant II. The analysis identified key leverage points in the delays in reincorporating lost water, clean water and polluted water back into the extractable water supply, against which all demand is drawn.

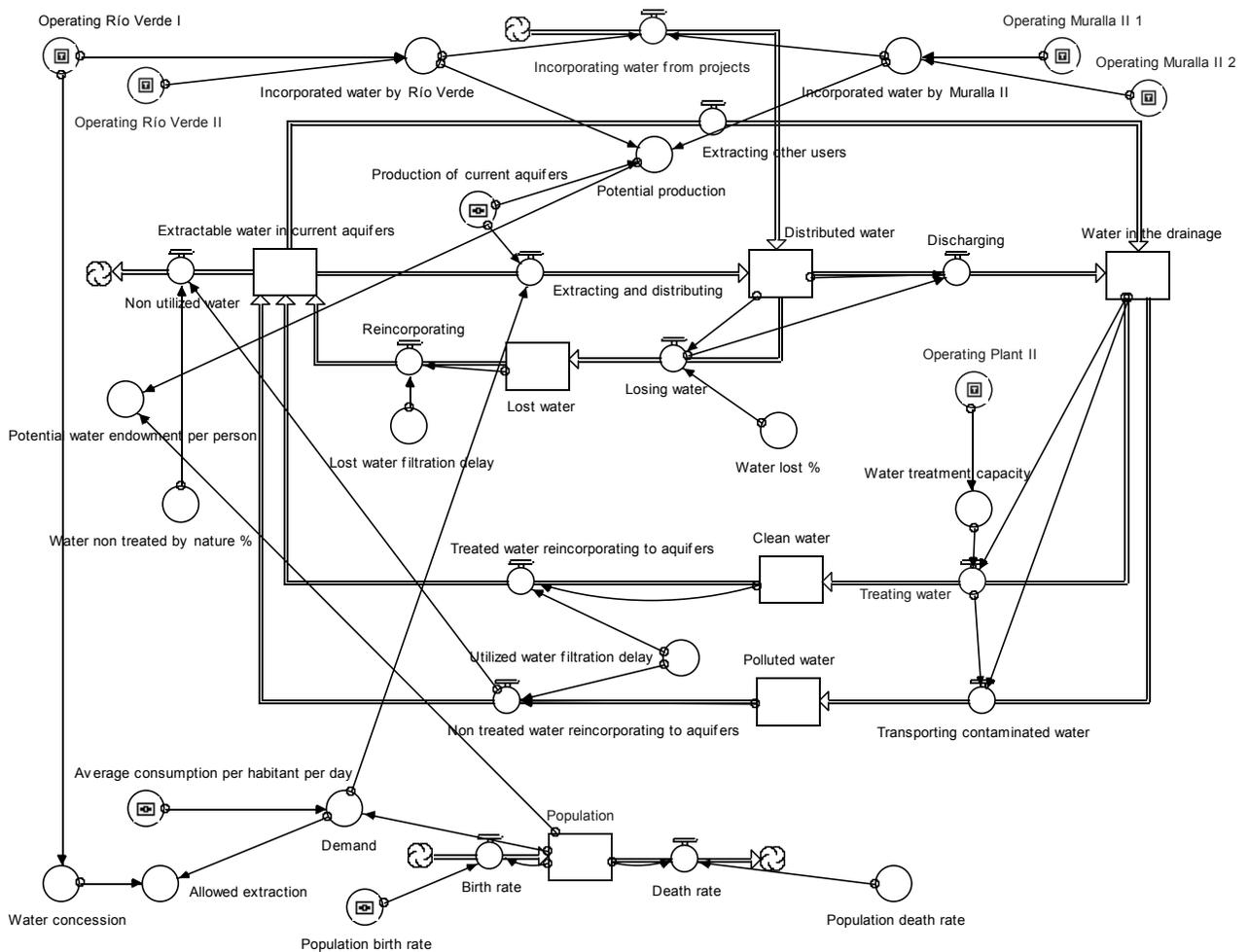


Figure 3: The Water Resource model describes the main flow of water from distribution to reincorporation to aquifers. Plant II contribute to restore extractable water faster to the aquifers and the completion of Rio Verde I and II and Muralla II is needed to contribute to meeting future demand growth due to population increases.

This analysis of resource dynamics provided some interesting insights to the management team. For example, after understanding and analyzing the dynamics around the extractable water cycle, the resource management group realized that to be able to build any of the two

aqueducts they would require support from the upper governmental level involved with the project and they would need to develop integral programs and joint plans with local governments.

Money Collection – The model (see **Figure 4**) helped to guide conversations around the collections cycle. The expert collections group described how they were focusing on three main activities to improve the collection cycle: (1) recover payments from uncollectible clients, (2) identify and stop illegal connections and (3) change incentives for past due accounts.

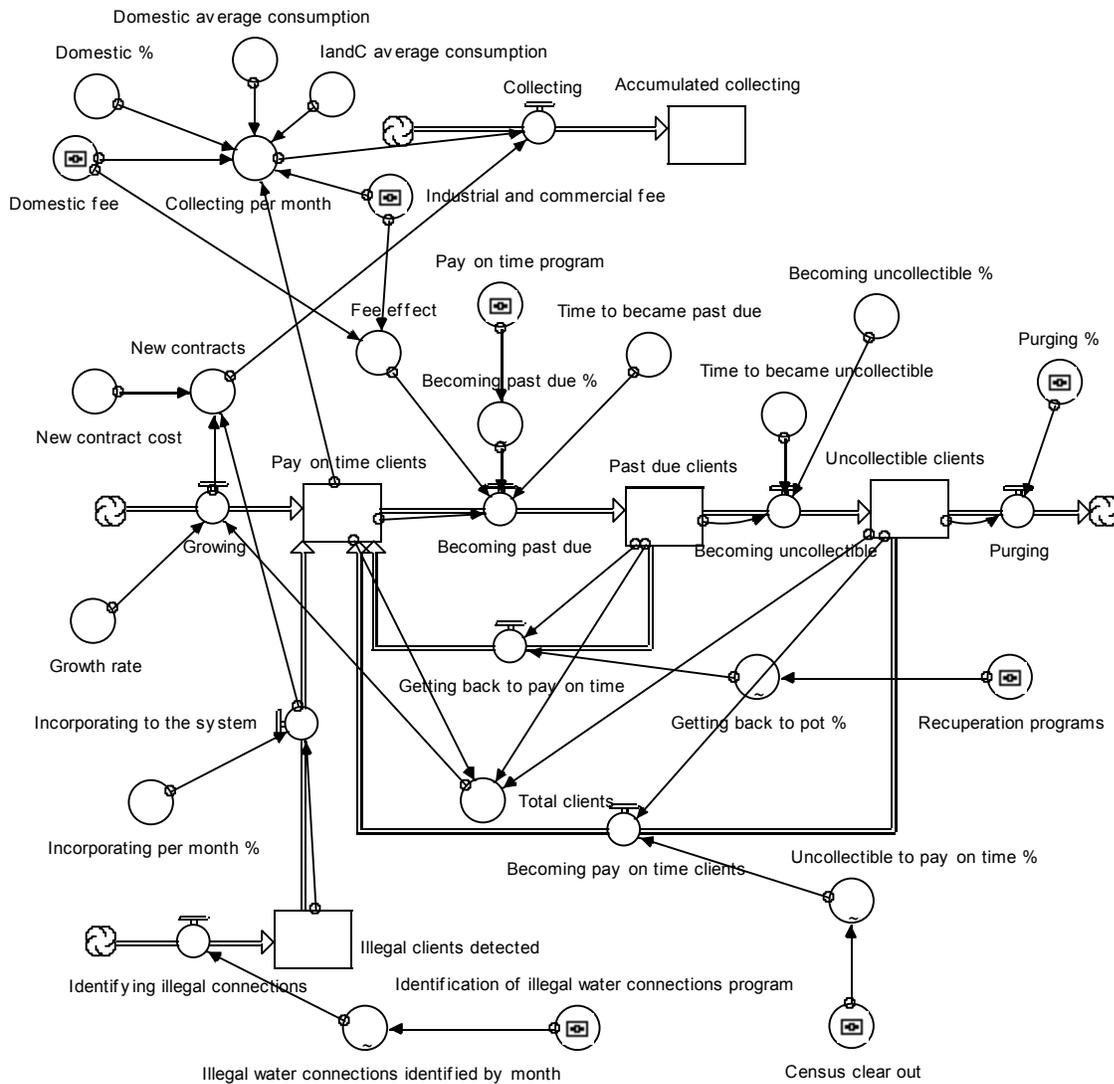


Figure 4: The Collection model shows the dynamics of: (1) how users convert from pay-on-time customers to past due to uncollectible accounts and how the last two are rehabilitated again to pay-on-time clients, (2) how the fee impact on-time collections and (3) how illegal clients are incorporated to the system.

However, uncollectible accounts were usually written off faster than they were recovered. The illegal connections were hard to find and hence difficult to estimate. The incentive programs for past due accounts, such as no interest charged, had little influence and created dissatisfaction among the on-time clients, as they were given no additional bonus for their good behavior. These programs required significant resources but the total effect on collections was low.

Analysis of the model’s behavior helped the expert group responsible for collections to generate new solutions, such as differentiated communication programs for each type of client (domestic – massive, industrial – personalized) and new and easier payment options (technology and places to pay). In this way, the focus shifted to keeping more clients in the on-time stock and recycled from the past due stocks versus recovering funds from the uncollectible and illegal client stocks (see **Figure 5**).

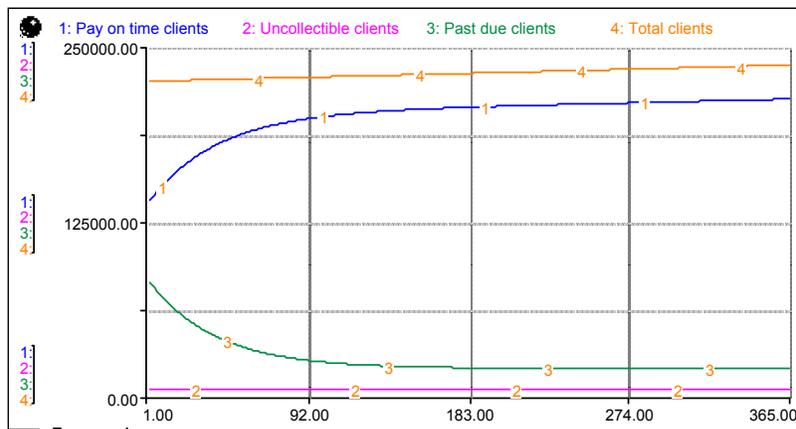


Figure 5: The graph reflects the behavior of collections implementing an integrated program for the pay-on-time and past due clients.

Following development and validation of the model for each initiative, the modeling team developed a thinking and communication tool, integrating the work done in September 2000 with the work done in the last quarter of 2001 (see Appendix 1). With this integration, the management team was able to see the actions that were identified through the process linked to each one of the initiative resource maps and finally linked to the detailed resource map of the whole organization. By linking all of the different initiatives together back into the original detailed map, the management team was able to navigate the course of each initiative across all of the functions of the organization, visualize where they sat in relation to the rest of the organization and how the initiatives overlapped in some key resources. For example, the team realized that five of the six initiatives required a strong focus on political work outside SAPAL and that delays may be longer than they expected. This led them to look for internal options to support water demand.

Now the leadership team had an agreed-upon, holistic platform with which to strategize, while maintaining a clear focus on operating realities and limits. Depending on the objective of the

conversation, different versions of the integrated map were printed out in large, 5x3-foot pages. The detailed qualitative map (Figure 2) was printed out for their internal meetings in order to guide strategic conversations. The team used the high-level resource sub-models and some of the initiative maps to communicate the impact of the set of actions to government agencies and industrial associations.

2002

In November 2002 a team was formed to integrate the systemic approach into the strategic management process at SAPAL. The team initially included the SAPAL Organizational Development manager and two system dynamics consultants. The IT manager was incorporated later in the process. The work focused on integrating the frameworks, methodologies and tools currently used by the organization with system dynamics tools and methodologies in a final product that could be implemented as the strategic management process in the organization. The most useful characteristics of each approach were selected in order to bring to life this new approach that integrated systems thinking, system dynamics, resource-based strategy, scenario planning, managing by objectives, and the balanced scorecard.

The new strategic planning process emerged with five phases. The team worked together for four weeks through the first cycle of this new planning approach. Below is a description of the activities in each step of this annual process:

1. Internal Systemic Analysis (one and a half weeks) – Based on the systemic work done in the previous years, the integration team generated and validated an initial set of key systemic indicators with interrelated reference behavior graphs based on past information for each performance area, such as water, sewer service, treatment, finance and human resources. To identify the initial draft of action points, the systemic maps were used in phase 3 to perform a Systemic SWOT analysis¹ with the managing group.
2. External Systemic Environmental Analysis (one week parallel to step one) – Scenario planning has been applied to water management in several occasions (Pinkham and Chaplin, 1996). Interviews were held with finance, communications and law department representatives to define the main uncertainties around SAPAL and to develop the first draft of scenarios. Four scenarios, including political, economical, societal and legal factors, were chosen as a result of these interviews and were then used in phase 3 to generate milestones and strategies for each scenario.
3. Strategic Initiatives Development (three-day meetings with the management team and one and a half weeks with the expert teams) – From the internal and external analyses the management team determined strategies, timing, initiative owner, team participants and key supporters for each initiative in a meeting of three intensive days. The initiatives chosen from this process to be analyzed systemically were the following: (1) Reduce losses – water and collections – (2) Implement ISO 9000-2000; (3) Redesign of water volume distributed to strategic sectors; (4) Increase client

¹ This refers to the widely-used SWOT analysis (Strengths, Weaknesses, Opportunities, and Threats) which was already in use in SAPAL as a support for strategic planning.

satisfaction – focus on improving technical and administrative services. The water resource diagram developed in 2001 was reviewed in phase 4.

4. Strategy Systemic Integration (one-day meeting) – trace the strategic initiatives against the backdrop of the detailed causal loop diagram.
5. Dynamic Scorecard Design – The integration team refined the indicators for each strategy, and then designed the first draft of the Dynamic Scorecard interface with the IT manager. The Organizational Development manager was in charge of communicating the high level scorecard and the strategies developed to the rest of the organization to ensure that the tactical objectives were aligned with the global strategy. This is still a work in progress. The management team thought that this scorecard would significantly reduce the time spent in phases 1 and 3 in the next planning cycle.

As an example of the work resulting from this process, one of the initiatives developed in 2002 is described below. Loss reduction is one of the key strategies that had been on stand-by for some time, which the process described above brought to attention. Loss reduction involves two main groups in the organization that usually struggle with each other, production and finance. Production is in charge of water recovery and distribution efficiency. Finance is in charge of collection efficiency and invoice correctness. The tension originates from the gap between produced water and water delivered, which often creates a problem over the amount invoiced to the client. This gap is created, on the one hand, by evaporation, friction and other normal losses in the distribution system plus leaks in old tubes that reduce the physical amount of delivered water, which are the responsibility of operations. On the other hand, the gap is created by old measurement equipment, adequate measure technology and union people in charge of reading water consumption, which are the responsibility of finance.

A conflict over this gap and how to solve it emerged between the finance and operations areas. Finance managers thought that the operation group was not taking the right actions to ensure that the whole amount of produced water was supplied to the final consumer. The operations group thought that the finance people were not invoicing the right amounts. To solve this dilemma, the integration team used the tools from the strategic management process developed over the past two years. First, each group separately used the stock-flow language to map out their understanding of the key resources underlying the situation. These two maps were then integrated by developing a causal loop diagram to facilitate the dialog between the operations and finance groups. This process allowed each side to make their case, then for both sides to come together under a single, common understanding of how they both contributed to the initial conflict, and then finally to start focusing on potential actions to reduce losses. At the time of this writing, the two groups were using these models to guide their conversation toward a joint solution. The causal loop diagram with the main actions identified is showed in figure 7.

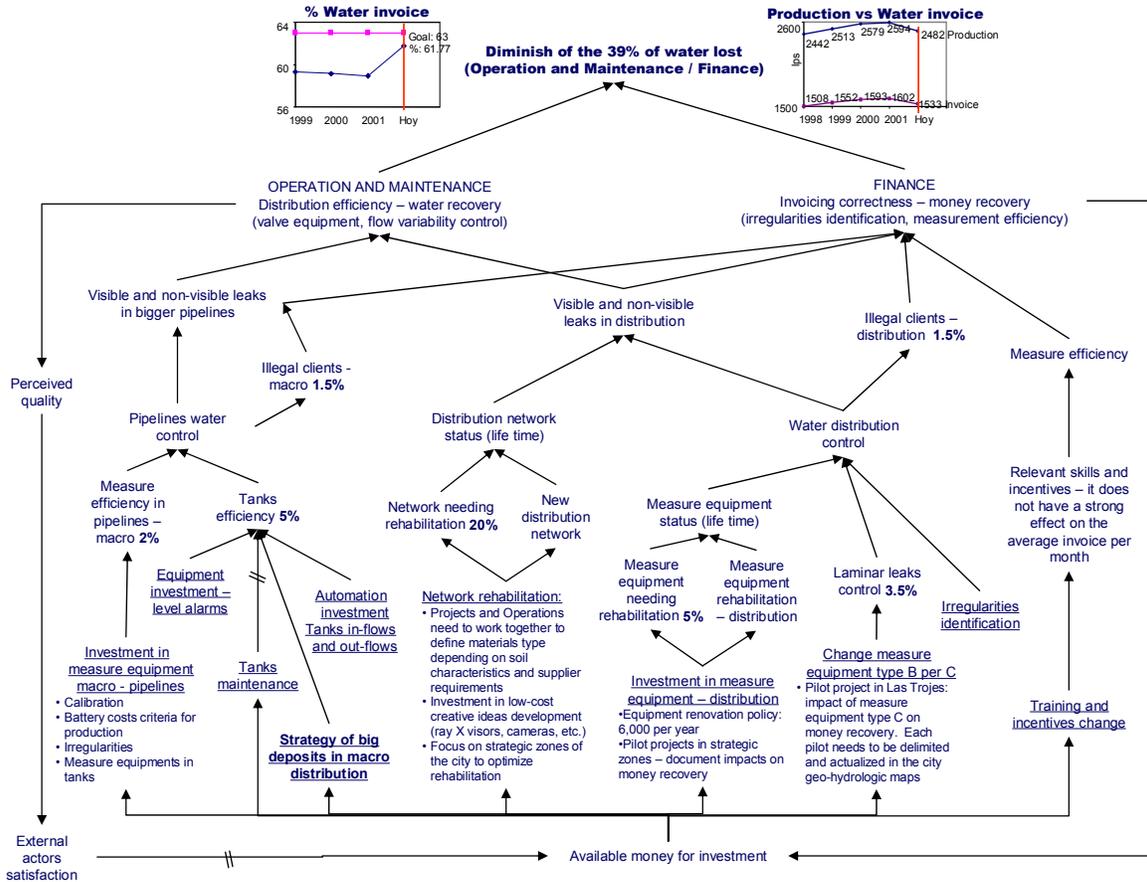


Figure 6: The map illustrates the main variables involved in the initiative Reduce losses. The left hand of the map focus on the technical variables the operational group manage; the right hand of the map points up the administrative variables that the finance group supervises. In the bottom are the actions each group can execute to reduce losses linked with the effect and the potential impact it will have on the initiative global goal.

The team made an interesting twist in the focus of their initiatives, as compared with 2001. The previous year most of the initiatives focused outside SAPAL and required a heavy time investment in political efforts. The new process, however, highlighted the importance of working inside of SAPAL as well as outside on strategic resources, in both the political and industrial domains. As a result, the strategic plan turned out to be more balanced, with a shift of management’s emphasis towards overseeing internal resources and building partnerships with respected stakeholders in the political and industrial environment for strategies beyond SAPAL’s authority and influence versus the SAPAL management team taking accountability for the whole progress of external strategies.

Conclusions

Having a systemic understanding of the system, knowing how to move it in the desired direction, and being able to communicate this understanding to others gave the SAPAL management team a strong framework for thinking about strategic issues and acting upon

specific initiatives from a systemic perspective. The process not only focused on strategic decisions and the consequences of those actions, but more importantly on how to think systemically about these decisions. This approach significantly influenced how SAPAL considers improving its performance and how it needs to coordinate efforts inside and outside the organization in order to achieve its global goal.

“In my opinion, one of the reasons the systemic approach adds value is in its focus on improving the ‘leadership team,’ in how it helps to determine the path and to strengthen the communications and internal knowledge of all the departments. This approach permits us to see the organization as a whole, taking into consideration the external environment and its relation with all of the internal pieces, even when those are not my direct responsibility. It was very interesting to see SAPAL in black and white on one page. It is a strategic lens that helps reaffirm, or define, the organization’s current and future direction. We can find expected consequences or even better, the unexpected....”

--SAPAL Director of IT

“The systemic tools support the consolidation of the holistic approach, bring clarity regarding the functional relationships within the organization and they support our strategic planning system with performance indicators linked to impacts in the rest of the organization”

--SAPAL Organizational Development team member

The integration process has not yet ended. The information technology and organizational development managers are working towards the completion of the dynamic scorecard, with assistance from the two system dynamics consultants.

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Appendix 1. Integration of high-level SAPAL map with strategy stock-flow diagrams

