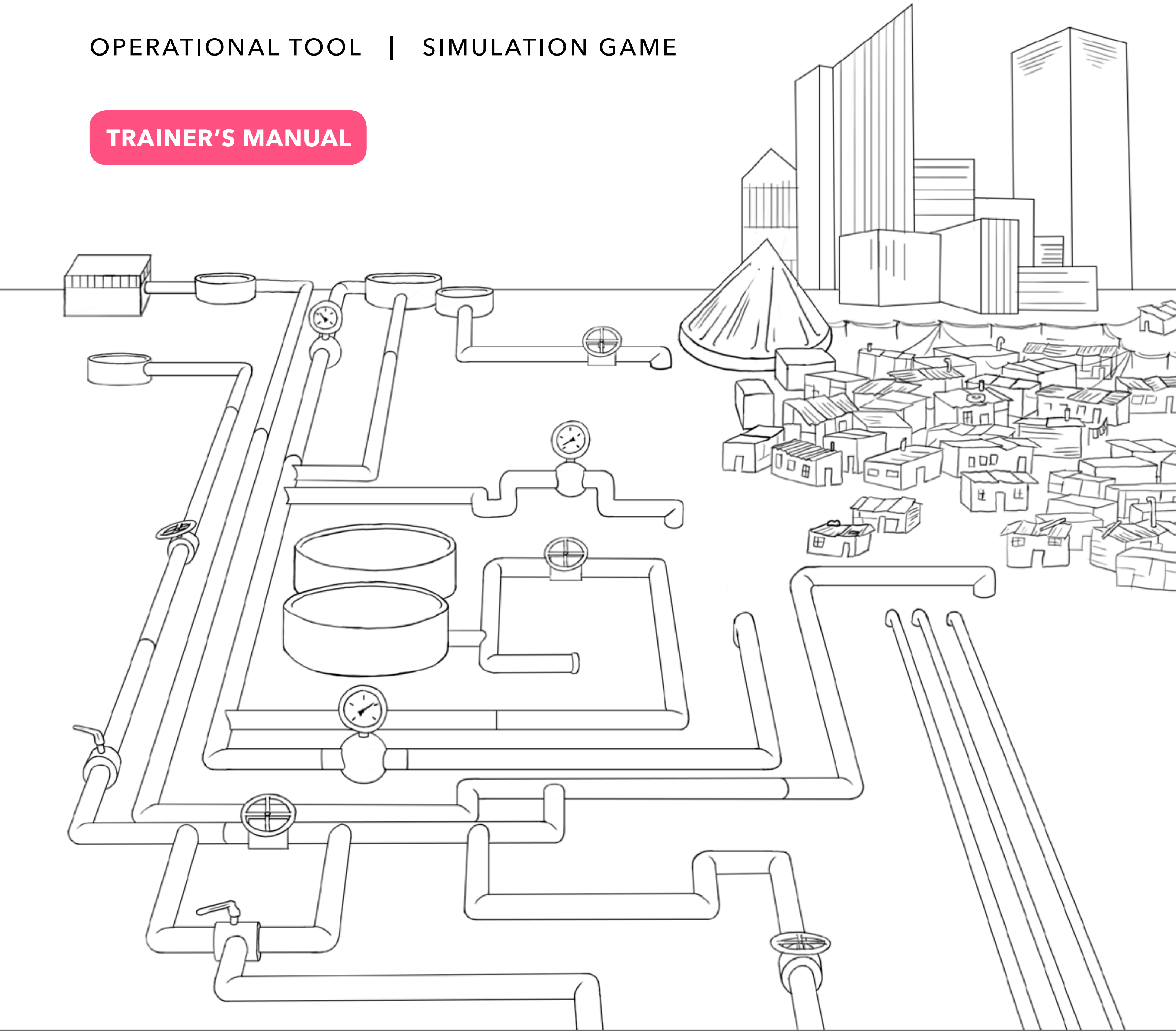
BEWOP

TOOL SERIES

Water Utility Management

OPERATIONAL TOOL | SIMULATION GAME

TRAINER'S MANUAL



GWOPA Global Water Operators' Partnerships Alliance
UN-HABITAT FOR A BETTER URBAN FUTURE
UNESCO IHE DELFT

A joint initiative of GWOPA/ UN-Habitat and IHE Delft Institute for Water Education

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Cooperación Española

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BEWOP

Water Operators' Partnerships are peer support arrangements between two or more water and sanitation operators, carried out on a not-for-profit basis with the objective of strengthening operator capacity.

The Boosting Effectiveness of Water Operators' Partnerships (BEWOP) initiative is producing a series of guidance materials, tools and games to help WOP partners expertly plan and implement WOP partnerships and effectively learn and share knowledge with one another.

Two types of products feature in the second phase of this BEWOP initiative. Process Tools support WOP participants prepare for, design, implement and follow through with their WOPs. Operational Tools support in the transfer of knowledge on specific operational topics relevant for water utilities.

Find out more

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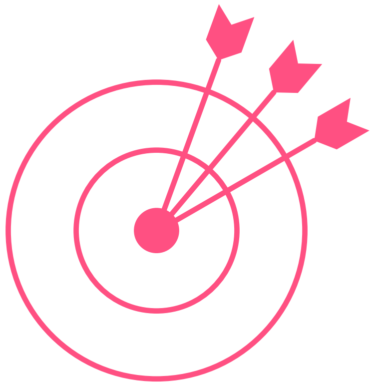


Objectives

This tool has been designed as a learning game to develop awareness and knowledge of the processes of strategic planning within utilities.

The game can be used as a team building or learning exercise for students, utility staff or other water professionals.

The Utility Management Simulation Game is played with a facilitator or trainer who guides discussions on how decisions, trade-offs, and actions play out in everyday business practice, and throws in some surprise elements.

The game draws from real cases and practical experience of experts, which allows participants to experience utilities' decision-making dilemmas in a safe environment.

How this tool works

Within a (water) utility, managers are tasked with achieving numerous, often conflicting objectives: full service coverage, high water quality, service affordability, adequate infrastructure operation and maintenance, HR management, bankability. Achieving these objectives simultaneously is tough and often involved foreseeing potential consequences and making trade-offs on investment and priorities.

The Utility Management Simulation Game groups players into teams of 4, with each player taking on the role of either a General, Financial, Commercial or Operational manager to run a utility for ten years. Based on data from a real utility from a developing country, players must work together to make strategic decisions on the best way forward to improve key performance indicators.

Several teams can play at once to compete (or just explore) how their decisions result in often unexpected outcomes.

Can you keep the utility from going bankrupt? Will service quality bring in more financial resources? What happens when your assumptions change? See how you would cope with this by playing the game.

Access the full Water Utility Management Tool here.

Contents

Introduction

The **UTILITY MANAGEMENT SIMULATION GAME** (UMSG) is a multi-player simulation game for capacity building programs. This simulation game mimics the challenges and uncertainties faced by water utility management teams, and reflects the influence of their decisions in the performance of the water utility company: Macondo, a fictitious utility modeled after a real-life utility. Players' performance is evaluated through the use of typical key performance indicators (KPI) for water utilities such as full cost recovery, non-revenue water (real and apparent), and staff development. Each of the possible decisions players make have a different influence on the different KPI's in terms of operational, financial and commercial performance. The game simulates an operational timespan of 10 years, where players make decisions for a total of 10 turns (1 turn = 1 year).

The objective of the UMSG is to enable players to experience the challenge of managing a water utility from different management positions. Within a water utility, middle-level managers often have to achieve objectives which can be conflicting. Achieving the desired objectives – such as attaining full service coverage, ensuring quality of water supplied, guaranteeing affordability of the service, fostering access to services for the poor, and sufficient cost recovery to mention some – is often difficult as these objectives inherently involve trade-offs. For example, increasing cost recovery may be achieved at the detriment of ensuring affordability of services. Moreover, managers in water utilities have to achieve both short-term objectives, which are often linked to the electoral cycle of the government-owned public utilities, and long-term objectives, which are often linked to the state of the utility infrastructure and services provided. Achieving these objectives simultaneously is difficult as the more political short-term objectives may be at odds with long-term objectives relating to infrastructure investment and asset management. The purpose of the UMSG is to let participants experience this challenge of utility management by simulating decision-making in the areas of customer, operational and financial management within the utility.

The game is best experienced in teams of 4 people and the UMSG can accommodate up to 4 water utilities in a single game. Playing with 2 or more water utilities allows for benchmarking between utilities (teams) and adds a sense of competition to the game. All utilities operate within the same case study, as provided by the facilitator at the start of the session. The challenge for the players is to estimate the implications of their decisions and convince other players in their utility to accept their proposals to improve the performance of the water utility.

How does the game work?

The main goal of the game is for participants to experience the management challenges and trade-offs needed within the utility's various departments, i.e.: General Management, Financial Management, Operational Management, and Costumer Management. This is simulated by having 4 participants per team discuss and decide on the most pertinent investment activities for the utility to implement. These decisions are made on the basis of an initial loan and a 10 year plan presented by the teams to the facilitator. The teams' progress is measured via the changes of the KPI's established within the game, which measure specific aspects of each of the players' management area. For further details on UMSG's game design, assumptions, and steps, please refer to the Participant's Manual section: **Playing the Game**.

N.B.: For the UMSG to run, you must **Enable Content** when the game opens, that is *Enable the Macros* with which the simulation runs. In most Excel versions, when you open the file a warning message should appear under the Formula bar allowing you to enable the necessary content.

Facilitator's role in the game

As the Facilitator for UMSG, there are several tasks you must undertake. These are as follows:

Presentation of UMSG: When implementing UMSG as a capacity development activity, the first step is to present the objectives, dynamics, and time commitment for the game. These will usually be defined on a case to case basis. Generically, you will provide participants with:

- The desired objective of the game, for example: to increase their awareness of the different processes and trade-offs that occur within a utility.
- The expected agenda of the game, namely each team's initial 10-year plan presentation, the amount of playing time/rounds you will do, and each team's presentation on the reflection of playing the game, lessons learned, etc.
- The creation of management teams and definition of roles within the teams. You can pre-assign teams and roles, or let the players choose by themselves.
- Explain the dynamics of the game and run the game as facilitator. This includes distributing decision-making sheets before you begin, running the simulations, and providing teams with feedback on the impact of their decisions. Highlight your role within the game in terms of running the simulation while at the same time be in charge of the overarching government policies the participants will need to adhere to.

Participants' strategies presentation: Before running the first simulation, management teams will be handed information regarding the current state of the utility and the relevant KPI's they will be assessed on. This information is located in the Participant's Manual. If desired by the facilitator, the governmental policy goals (and other relevant game parameters) can be shared with them at this point. Management teams will then need to prepare a presentation on the utility's objectives and how they intend to achieve this (for example: increase coverage to low income areas through network and water kiosks development). They will present their strategy to the facilitator, other teams, and audience (if desired), and receive a round of questions and feedback on their strategy. Following this, they will fill out per team the first year (Turn 1) in the **'Management Decisions Sheet'**, which can be found at the end of the Participant's Manual.

Running UMSG's Excel interface: The first task will be to open the Excel file called *Water Utility Management Simulation Game*. Once the file opens, click on the **PLAY GAME** button in the lower left-hand corner:

Figure 1. Play Game Button

This will lead you to the Yearly Decisions sheet (see *Figure 2*) in Excel, the main interface where you, as facilitator, will input the data provided by the teams, run the simulation, and produce the results that will be given back to the teams so they may make the relevant decisions for the next turn.

Once you have received each management team's "Yearly Decisions sheet", you will input the numbers into the Excel interface's 'Yearly Decisions' tab under the respective column, i.e. input for Turn 1 under the column for Turn 1. For each team, you will have to input their data one team at a time. Once the data has been input, you press the **Play Turn** button (see *Figure 6*); this will run the simulation. Depending on the processing power of your computer, you may see flashes of equations and numbers as the simulation runs, this is normal as long as the UMSG does not crash Excel[1].

1. If Excel continues to crash when running the game, we recommend updating to a computer with higher processing power. Currently, the UMSG is the lightest version of the game available and was tested on an Core i5 vPro processor.

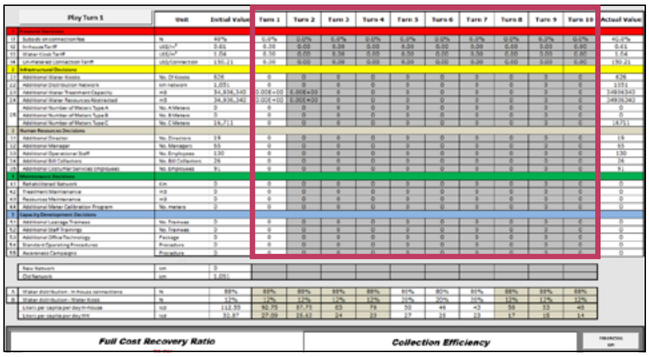


Figure 2. Yearly Decisions Interface

After the simulation has run, we highly recommend you save the team's result by using the **SAVE GAME** button (see *Figure 7*). After pressing the button, you will be prompted with a dialogue box where you can input the team's name and select the location where you want to save the data for that round. For every round, we recommend you save the data, as failure to do so will mean you have to input the data and run the simulation again. Regardless of how "risky" the teams are playing, it will save you, the facilitator, a great amount of time to change the save file name, e.g. Team 2 Year 4, after every turn. If the team goes into bankruptcy, by having an earlier save file they can try different combinations to succeed. This will be extra work for the facilitator, so it remains up to him/her to decide whether to implement this modality. In order to load the previous game, use the **LOAD GAME** button (see *Figure 7*) to open a dialogue box where you can select the appropriate file.

Once the simulation has been run for the respective turn and the data has been saved, you can produce the relevant graphs that will show how the water utility's KPIs have been impacted by the investment decisions taken by each team. You can obtain these by pressing the *SAVE KPIS TO PDF* button (see *Figure 7*). This will create a PDF file that can be printed or emailed. These results can then be communicated to each management team, in order for them to analyze and prepare the next round of management decisions.

If you have more than one team and want to have the teams engage in a quasi-competition, at this point you can implement the benchmarking option by pressing the **BENCHMARKING** button (see *Figure 7*). This will open a dialogue box where you can assign a utility # to each team (see Figure 3). When you click the respective box, the game will ask you to select a saved file, so select the file for the respective team that you have just saved. Once you have loaded all team's saved data for the turn, you can press the 'Bench-Marking Graphs' button to generate the Benchmarking Graphs. Share the graphs (*not* the management decisions sheet) with the teams so that each team can compare their performance so far with that of the others.

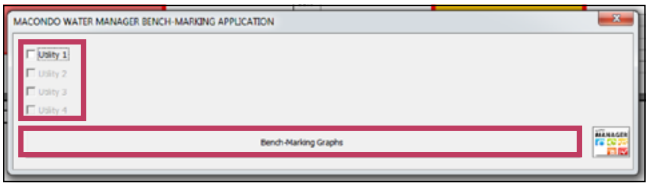


Figure 3. Benchmarking Graphs Interface

It is possible, based on the management decisions made, that participants will lead the utility bankrupt early in the game, or before the allotted playing time is over. As facilitator you will can make four different decisions at this point:

- The management team can no longer participate in the game. This is *not* recommended as it will deprive them of the opportunity to learn from their past decisions, and will leave them without a task.
- You return the "Management Decision Sheet" to the team and tell them their current decisions will lead to bankruptcy. Allow them to reconsider their approach and provide an alternative set of decisions.
- You alter the values given by them and communicate to them that due to external circumstances the management decisions made had to be altered; for example, if a management team has invested too heavily in network expansion that particular year, you can argue that the local government has prioritized equipment and resources necessary for the network expansion to other sectors (energy, mining, etc.) and therefore their proposed decision cannot be

carried out. It is in these decisions that your ability and creativity as facilitator are crucial and tested.

- At the bottom of the 'Yearly Decisions Tab' under the set of graphs you will find the 'Initial Financial Loan' cell (see *Figure 4*). This cell changes the loan received by ALL the teams. Thus, it is recommended **only** to change when all teams are in need. In order to do this, it is recommended that you, the facilitator, mention that a donor/bank has opened an additional line of funding through loans. The teams will then need to present a plan for the remaining years, along with the value of the loan requested. As facilitator, you will decide what the new loan will be. **Avoid at all costs giving different loans to each team** as this will require you to manually change the loan for every round you play per team. The UMSG is designed to a total loan value of $30,000,000; going beyond this value will make the game far too easy and will likely cause issues with the internal coding processes of the simulation. We recommend you do not go beyond this value. Finally, this value **does not return** to its original value once the game is reset, therefore if you change the value for a game, make sure that at the end of the game you return the value back to $15,000,000. This also means that if you are going to run previously saved games that had a different loan, you must change this loan **before** loading or running the next year turn.

Repeat the above steps for 10 turns or until time runs out for all teams.

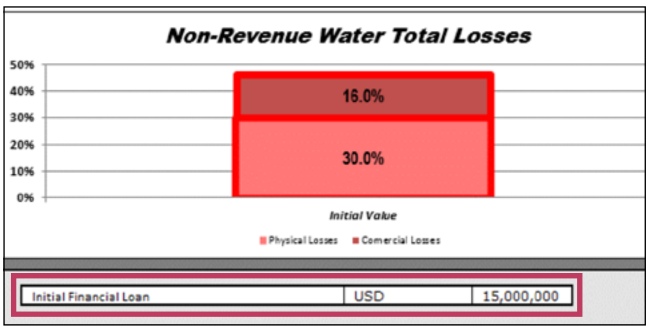


Figure 4. Initial Financial Loan Cell

Drought Scenario: The current version of the UMSG has incorporated a drought-scenario for Years 5 to 7 of the game; this drought effectively cuts access to water resources to 75% of Year 4's resources. As a response to the drought conditions, during Years 5 to 7 management teams will be given the option of directing the available water to either in-house connections, water kiosk, or a combination of both. Management teams will need to ensure that at least the minimum quantity of water per capita is delivered to avoid public health issues (10 liters per capita per day).

As a facilitator, it is recommended that you announce the potential occurrence of a drought prior to the beginning of Year 5 in order for teams to prepare accordingly. The drought has been incorporated into this version of UMSG to further "test" how teams will alter their initial strategies in face of a significant change in their operations. The drought has been placed between Years 5 to 7 to allow time for participants to identify the relations between decisions and impacts on performance, as well as provide a chance in Years 8 to 10, to recover from the drought period.

At the bottom of each teams' 'Management Decision Sheet' there is a space for them to put what percentage (%) is being sent to each connection type. As facilitator, you will only have to input the 'Water distribution – In-house connections" percentage (%) in the current turn (5, 6, or 7). The other cells will fill out automatically.

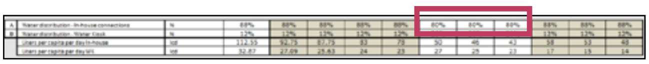


Figure 5. Drought Scenario Input Cells

Scenario creation: As a facilitator, you will find a significant amount of liberty in how you wish to guide the participants through the game by the various scenarios you choose to implement. Issues such as political elections, civil unrest, and potential budget constraints during specific years can be incorporated in the narrative you use as facilitator with your participants. It might also be relevant to incorporate specific issues in your water utility's context that you want participants to discuss or respond to. The more times you experiment with your participants, the greater breadth of possible scenarios you will have available. Just be sure to align your scenarios with the possible decisions in the UMSG to ensure the simulation runs smoothly.

Facilitate participants' reflections: At the end of the game (either Year 10, bankruptcy, or end of allotted time), it is important that you support participants in reflecting on their experience and learning from the game. This can be done in the form of an open discussion with all participants or by having each management team do a follow-up to their initial strategic presentation.

The key elements to reflect upon include:

- Was the management team consistent with their initial strategy? If so, what where the challenges of implementing their strategies, and if not, why did they change their approach?
- What was the process through which teams came to an agreement on management decisions? In each participant's opinion, was the process fair, and how could it be improved?
- What were some of the trade-offs they experienced within management teams and the decision-results produced by UMSG? Can they relate this to how water utilities operate on a day-to-day basis and how they carry out their long-term plans?

Once you have finished the game, if you would like to share your experiences or questions regarding the UMSG, feel free to contact the Water Services Management Group at IHE-Delft.

Main assumptions and Initial values for Macondo case study

As with any simulation or model, several assumptions have been made for the UMSG to run; these assumptions, along with other relevant figures such as initial values for Lilongwe context and for the utility's performance, are fixed within the game. If the facilitator wishes to change them, it will be necessary to 'Unhide' the 'INI-VAL' (initial values) tab in the Excel simulation sheet; doing this requires careful monitoring of the game's outputs as these have been calibrated according to the assumptions and initial values already programmed. For a list with relevant explanations on the assumptions and initial values, please refer to the Participant's Manual sections:

- **Key Performance Indicators** under the **Water Services Sector in Mokum Dollet** section;
- **Game Assumptions** under the **Playing the Game** section; and,
- **Profile of Malawi** under the **Introduction** section.

Button Functions

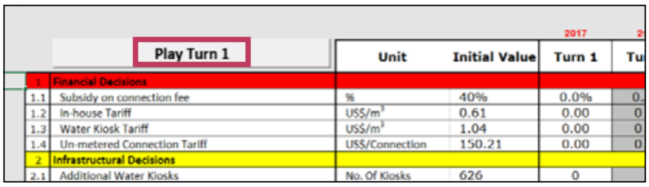
The operation of the UMSG is done through clickable buttons located through the various sheets within the Excel-based simulator. For clarity purposes, these have been grouped into Action Buttons – those that generate changes/calculations in the simulation – and Results Buttons – those the display current results in the ongoing simulation. These are described below:

Action Buttons

PLAY GAME Button: This is the first button that appears in the screen (see previous section, *Figure 1*); its main objective of this button is to delete all previous game-play data, set the decisions sheet blank, and thus ensure older data does not interfere with the current game.

Play Turn Button: This button is located on the top-left corner of the 'Yearly Decision' tab (see *Figure 6*). It is used to run the simulation for the current "Year", once the facilitator has input the data in the relevant Excel cells. For each round or turn, the heading will change indicating which year is being played.

After this button is clicked, the previous decisions are stored and locked and cannot be changed until the end of the game. Some decisions have built-in restrictions, such as negative tariffs or building Public Stand Pipes without sufficient network, which will prevent the simulation from running until they are corrected; a dialogue box will pop-up to warn the facilitator when this is occurring.



	Play Turn 1	Unit	Initial Value	Turn 1 (2017)	Tu
1	Financial Decisions				
1.1	Subsidy on connection fee	%	40%	0.0%	0.
1.2	In-house Tariff	US$/m³	0.61	0.00	0
1.3	Water Kiosk Tariff	US$/m³	1.04	0.00	0
1.4	Un-metered Connection Tariff	US$/Connection	150.21	0.00	0
2	Infrastructural Decisions				
2.1	Additional Water Kiosks	No. Of Kiosks	626	0	

Figure 6. Play Turn Button

Results Buttons

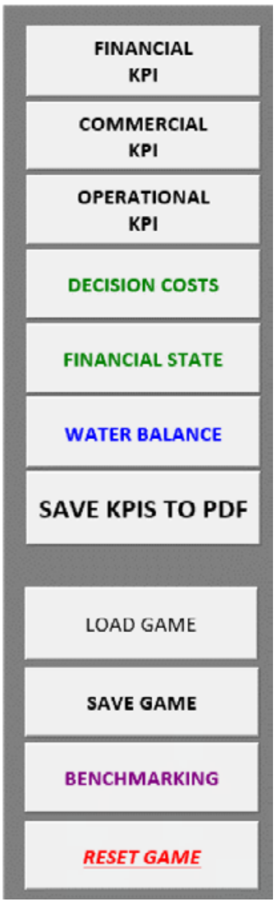


Figure 7. Results Buttons on bottom-right of 'Yearly Decisions' Interface

These buttons are located in the lower-right section of the 'Yearly Decision' tab in the Excel interface, next to the graphs highlighting some of the relevant KPIs. Their description is as follows:

Financial, Commercial, and Operational KPI buttons: These buttons will send the user to the graphs of respective KPIs. In this tab there is also a button that will send back the user to the "Yearly Decision" tab.

Decision Costs: This button will show the costs of each decision taken per round (in dollars). Only direct values are shown and not the overall cost, which can include factors such as the fixed operational costs and asset depreciation.

Financial State: This button will display bar graphs comparing the total running costs and income for the utility per year, as well as the use of the initial loan.

Water Balance: This button will open the bar graph that shows the bar plot of the water balance for the utility. This balance displays amounts of water produced, lost and supplied.

Save KPIs to PDF: This button allows the user to save all the KPIs and the Water Balance results into a single PDF file to facilitate sharing with teams.

Load Game: This button allows the user to load previously saved files.

Save Game: This button allows the user to save the simulation so far, this is required for benchmarking.

Benchmarking: This button will allow the user to load several result saved files in order to compare the performance on the different KPI's.

Reset Game: This button will reset all the decisions and restart the game. Before executing all the resting procedure, a message box will appear in order to confirm the user decision.

Decision variables

The game calculates the different KPI's based on their common theoretical definitions and the possible inputs from the UMSG model. Players can influence the inputs for the KPI's through 25 possible decisions that can be made each turn. Each decision carries monetary costs and investments, which are calculated with fixed unitary prices. These decisions can be seen below in Table 2. For an in-depth explanation of the decision variables rationale, please refer to the Participant's Manual section: **Decisions**.

Utility Efficiency and "Golden" Ratios

In order to simplify the complexity between the various factors that impact a utility's performance, UMSG uses the concept of an overall Utility Efficiency (UE) ratio, which reflects how efficient the processes carried out by the utility are. Within the UMSG, the UE is assumed to be composed of the following two components (expressed in ratios): Staff (50%) and Processes (50%). Each component is further composed by different sub-components with different weights, as shown in Table 1: "Golden" Ratios. The UE ratio works as a factor of efficiency in several processes of the utility, providing a boost or a penalty on the processes carried out. In this version of the UMSG, the UE is capped at 1, and boost have been taken into account individually in each equation deemed relevant. It is worth noting that some of the sub-components also directly relate to certain processes and KPI's, and therefore are incorporated in the simulation's calculations beyond just the UE.

The concept of 'Golden Ratios' assumes that there are optimal ratios between different aspects of the utility's operations that can lead to higher efficiencies. Beyond this optimal ratio, the processes will not significantly improve, thus costing the utility more money while not producing better results. Some of the ratios also have a minimum barrier, meaning that if the balance between components drops below the minimum barrier, the process is rendered completely inefficient and does not provide benefits for the utility. Two examples of how these ratios work are presented after Table 1, followed by the descriptions of the remaining ratios.

It is worth noting that these ratios are based on discussions with experts from the Dutch academic and water service provision sectors, and as such are extremely limited as a guidance for other countries and locations. Each water service provider will have a certain optimal scenario for the ratios considered below that will highly depend on physical and technical characteristics of the system, cultural and organizational practices of the employees, and a number of other factors unique to each context. The purpose of discussing these ratios is to highlight the existence of relations between different aspects of a utility's operation, and the usefulness of considering these when making decisions.

Table 1. "Golden" Ratios

Utility Efficiency (UE): 0.5 * ∑ Staff 'Golden' Ratios + 0.5 * ∑ Process 'Golden' Ratios			
Staff 'Golden' Ratios	*Optimal*	*Initial values*	*Weight*
Director to Manager	0.200	0.292	3.75%
Management to Workers	0.125	0.340	11.25%
Workers to Network Size (km)	0.168	0.124	25%
Workers to Treatment Capacity (m^3)	0.000005	0.000004	20%
Bill Collectors to # of Connections	0.000685	0.000513	20%

Costumer Service to # of Connections	0.0028	0.0018	20%
Process 'Golden' Ratios	*Optimal*	*Initial values*	*Weight*
Leakage Trainees / Operational Staff over a 4 year period	1	0	10%
Trainees / Staff over a 4 year-period	1	0	30%
SOP's over a 3-year-period	5	0	30%
Office packages / year	2	0	20%
Awareness Campaigns / year	1	0	10%

Examples

Director to Manager: This ratio reflects the ideal number of managers a director can effectively and efficiently work with. In the current example, the number of Directors at the beginning of the game is higher than the optimal (0.292 > 0.200), meaning this sub-component adds its full weight (25%) to the Staff 'Golden' Ratios component of the UE factor. However, as more directors beyond the optimal point do not improve performance, the additional directors only represent a "benefit-less" cost to the water utility.

SOP's / year: This ratio reflects the need for utility's to adequately design, implement, evaluate, and re-develop their operating procedures on a regular basis as this ensures that procedures are up to the latest standards, and staff are aware and involved in their implementation. In the current example, the optimal number of SOP related activities is set at 5 SOPs over any 3 year period. As none are being implemented at the beginning of the game, SOP's do not add any value to the Process 'Golden' Ratios component at the start of the game.

Explanation of other ratios

Management to Workers: This ratio reflects the ideal number of workers a manager can effectively and efficiently work with, and considers the sum of all workers (operational, bill collectors, and customer service).

Workers to Network Size (km): This ratio considers that for adequate operation of the distribution system, a certain number of workers per kilometer of network are required; these workers would carry out tasks such as identifying leaks, operating booster pumping stations, and on-the-job maintenance for branched connections.

Workers to Treatment Capacity: This ratio reflects the minimum number of operational workers needed per size of the treatment facility (expressed as treatment capacity) to ensure adequate and efficient processes.

Bill Collectors to # of Connections: This ratio reflects the ideal number of bill collectors needed to cover the existing connections and carry out the necessary collection tasks.

Customer Services to # of Connections: This ratio reflects the ideal number of customer service employees needed to cover the requests and complaints from current customers connected.

Leakage Trainees per Operational Staff: This ratio highlights the importance of NRW for operational staff, and considers the number of operational staff that have received training on detecting leakages over the last 4 years.

Trainees per Staff: This ratio considers that for processes to work adequately, staff must be trained on a regular basis. As such, this takes into account the percentage of staff that has been trained over the past 4 years (including the leakage trainees) over the current staff to reflect how much of the staff has 'recently' received training.

Office packages per year: This ratio considers that for processes to work adequately, staff must have the necessary tools in terms of hardware, software, equipment, and office supplies. As these tools are either consumable or quickly outdated by newer versions, this ratio measures how up-to-date the tools are in order to allow for efficient processes.

Awareness campaigns per year: This ratio considers that for a water utility to operate adequately within its context, it needs to continuously socialize both internally and externally the changes in their processes and activities.

Decisions influence over KPIs and Ratios

Each of the potential decisions management teams make through the "Management Decisions Sheet" impacts the utility's performance and its KPI's in particular ways.

Table 2. Decisions' impact on KPIs and "Golden" Ratios

1	*Financial Decisions*	*This decision impacts*
1.1	Subsidy on connection fee	• the utility's cost (higher subsidy = higher cost) • the number of illegal connections (higher subsidy = lower illegal connections) • the consumers' willingness to connect to new available connections (higher subsidy = higher willingness to connect).
1.2	In-house Tariff	• the number of illegal connections (higher tariff = higher illegal connections) • the utility's total income (higher tariff = higher income based on # of connections and # of illegal connections) • the affordability of the service (higher tariff = lower affordability) • the customer satisfaction (higher tariff with respect to previous year's tariff = lower customer satisfaction)
1.3	Water Kiosks (Wk) Tariff	• the utility's total income (higher tariff = higher income based on # of connections and # of illegal connections)
1.4	Un-metered Connection Tariff	• the utility's total income (higher tariff = higher income based on # of connections and # of illegal connections)
2	*Infrastructural Decisions*	*This decision impacts*
2.1	Additional Water Kiosks	• the utility's coverage (more Kiosks = higher coverage) • the utility's income (more Kiosks = higher income) • the utility's cost for the year (more Kiosks = higher investment cost) • the distribution of available water (more Kiosks = more water sent to Kiosks). This becomes relevant in Years 5-7 during drought.

2.2	Additional Distribution Network	• the number of in-house connections (more network = more connections) • the utility's coverage (more connections = higher coverage) • the utility's income (more connections = higher income) • the utility's cost for the year (more network = higher investment cost) • the distribution of available water (more connections = more water sent to connections). This becomes relevant in Years 5-7 during drought. • the overall value of the asset
2.3	Additional Water Treatment Capacity	• the utility's cost for the year (more capacity = higher investment cost) • the amount of water that can be supplied to the network • the overall value of the asset
2.4	Additional Water Resources Abstracted	• the utility's cost for the year (more abstraction = higher investment cost) • the amount of water that can be supplied to the network • the overall value of the asset
2.5	Additional Number of Meters Type A Additional Number of Meters Type B Additional Number of Meters Type C	• the utility's cost for the year (more meters = higher investment cost) • the water consumption per capita as it reduces the number of un-metered connections (more meters = less water consumed per capita served) • the commercial losses (more meters = less meter errors = less commercial losses). The type of meter chosen impacts the degree to which commercial losses are decreased.
3	*Human Resource Decisions*	*This decision impacts*
3.1	Additional Director	• the utility's cost for the year, even if they are fired for that specific year (more staff = higher investment cost) • the utility's efficiency ratio based on staff efficiency overall and process efficiency with regards to trainees ratio
3.2	Additional Manager	• the utility's cost for the year, even if they are fired for that specific year (more staff = higher investment cost) • the utility's efficiency ratio based on staff efficiency overall and process efficiency with regards to trainees ratio

3.3	Additional Operational Staff	• the utility's cost for the year, even if they are fired for that specific year (more staff = higher investment cost) • the utility's efficiency ratio based on staff efficiency overall and process efficiency with regards to trainees ratio • the utility's (in)efficiency with regards to O&M • the utility's (in)efficiency with regards to physical water losses • the utility's water quality
3.4	Additional Bill Collectors	• the utility's cost for the year, even if they are fired for that specific year (more staff = higher investment cost) • the utility's efficiency ratio based on staff efficiency overall and process efficiency with regards to trainees ratio • the utility's collection efficiency
3.5	Additional Costumer Services Employees	• the utility's cost for the year, even if they are fired for that specific year (more staff = higher investment cost) • the utility's efficiency ratio based on staff efficiency overall and process efficiency with regards to trainees ratio • the utility's collection efficiency • the customer satisfaction
4	*Maintenance Decisions*	*This decision impacts*
4.1	Rehabilitated Network	• the utility's water quality • the physical losses over a 5 year period
4.2	Treatment Maintenance	• the utility's water quality
4.3	Resources Maintenance	• the utility's water quality
4.4	Additional Meter Calibration Program	• the utility's commercial losses
5	*Capacity Development Decisions*	*This decision impacts*
5.1	Additional Leakage Trainees	• the utility's process efficiency ratio • the physical losses • the O&M (in)efficiency, i.e. operating costs
5.2	Additional Customer Management trainees	• the utility's process efficiency ratio • the customer satisfaction
5.3	Additional Office technology and infrastructure	• the utility's process efficiency ratio

5.4	Standard Operating Procedures	• the utility's process efficiency ratio • the O&M (in)efficiency, i.e. operating costs
5.5	Awareness Campaigns	• the utility's process efficiency ratio • the customer satisfaction • the willingness to connect
	Water Distribution	*This decision impacts*
A B	Water distribution between In-house and PSP connections (only applicable during Years 5-7, drought scenario.	• The percentage of water distributed to either in-house or PSP connections and a 'dummy' public health warning.

Equations used in UMSG for KPI estimation

The following section provides an overview of the various equations that have been designed to model the utility's performance and KPI's. These equations are meant for the Facilitator to have a better understanding of how UMSG calculates the outputs produced. Although it may be shared with participants, it is recommended to do so only at the end in order to maintain an atmosphere of uncertainty in their decision-making processes similar to the conditions in which actual utilities operate. Below are the relevant parameters, their initial values at the beginning of the game, and the equations with which these values are calculated throughout the game.

Equations used in UMSG for KPI estimation

The following section provides an overview of the various equations that have been designed to model the utility's performance and KPI's. These equations are meant for the Facilitator to have a better understanding of how UMSG calculates the outputs produced. Although it may be shared with participants, it is recommended to this only at the end in order to maintain an atmosphere of uncertainty in their decision-making processes similar to the conditions in which actual utilities operate. Below are the relevant parameters, their initial values at the beginning of the game, and the equations with which these values are calculated throughout the game.

- **Grant (Utility's funds): 15,000,000 USD**

  $Grant_n(USD) = Grant_{n-1} + Income_{total_n} - Cost_{total_n}$, if this value reaches less than 0, the utility becomes bankrupt.

- **Connections (Cnxs): 50,639**

  $$Cnxs_N = Cnxs_{N-1} + 0.7 * [Network_N * \frac{Connections_{Original}}{Network_{Original}} - Cnxs_{N-1}] + 0.3 * WtC * [Network_N * \frac{Connections_{Original}}{Network_{Original}} - Cnxs_{N-1}]$$

  Note: All new connections are included as un-metered connections.

- **Water Kiosks (Wk): 626**

  $$Wk_N = Wk_{N-1} + UserInput$$

- **No. of Metered Connections: 16,711**

  $$Meter_N = Meter_{N-1} + \sum Meter_{TYPE}(UserInput),$$

  Note: Can only have as many meters as connections, once this is capped, facilitator must subtract lower caliber meters for the higher caliber meters by subtracting them in the 'Yearly Decisions' tab, i.e. putting a minus sign in front of the number of lower meter types that are being replaced in that turn.

- **No. of Un-Metered Connections: 33,928**

  $$Unmetered_N = Unmetered_{N-1} - Meter_N$$

- **Population: 1,077,116 inhabitants**

  $$Population_N(Inhab.) = (Population_{N-1}) * (1 + Pop.Growth_{Rate})$$

- **GDP per capita: 3,004 USD/capita/year**

$$GDP_{N+1}(Inhab.) = (GDP_N) * (1 + AnnualInflation_{Rate})$$

- **Population Served: 846,442 inhabitants**

$$Population_{served}(Inhab.) = (No.Connections_{In-house}) * \frac{8 inhab.}{Connection_{In-house}} + (No.Connection_{Wk}) * \frac{705 inhab.}{Connection_{Wk}}$$

- **Illegal Connections: 2,532, around 5% of initial connections**

$$No.Connections_{illegal} = [(0.0994 * Tariff_{In-house} - 0.0118) * 0.5 + (-0.0882 * \%Subsidy + 0.0945) * 0.5] * No.Connections_N$$

Note: Illegal connections are based on a linear regression applicable for this case study. It can be found in EQ tab of the UMSG excel file.

- **Network Size: 1,051 Km**

$$Network_{Actual}(km)_n = Network(km)_{n-1} + UserInput$$

- **Vol. Produced: 34,936,340 m^3 /year**

$Vol\_Produced_N(\frac{m^3}{Year}) = Vol\_Produced_{N-1} + UserInput$ **;** Note: **If** Vol_Produced > Vol_Available **Then** Vol_Available used for supply.

- **Vol. Resource Available: 34,936,340 m^3 /year**

$Vol\_Available_N(\frac{m^3}{Year}) = Vol\_Abstracted_{N-1} + UserInput$**;** Note: **If** Vol_Produced < Vol_Available **Then** Vol_Produced used for supply.

Note: During Turns 5 to 7 (Years 5 to 7), a drought is simulated by restricting the resource available to 75% of the value of Year 4. This remains constant for the 3 years, so investments on abstractions or treatment are not accounted for until Year 8. The value of the drought can be changed in the Initial Values (INI-VAL) sheet in the UMSG excel file.

- **Initial Vol. Lost: 16,070,751 m^3 / year**

$$Vol.Lost_N(\frac{m^3}{Year}) = Vol_{Produced} * (\%PhysicalLosses_N + \%CommercialLosses_N)$$

- **Vol. Supplied: 18,865,589 m^3 /year**

$$Vol.Supplied(\frac{m^3}{Year}) = Vol\_Produced - Vol.Lost$$

- **Full Cost Recovery Ratio: 0.73**

$$CostRecovery = \frac{Income_{total}}{Cost_{total}}$$

- **Total Income: 8,310,699 USD/year**

$$Income_{total}(\frac{U\$D}{year}) = Consumption(m^3)_{Con.type} * Tariff_{Con.type}(\frac{U\$D}{m^3}) * Eff.Collection_{Con.type};$$

where connection types are metered, PSP, and un-metered. To only count the metered in-house connections (not total in-house consumption) the formula uses a percentage of # of Meters / In-house Connections.

- **Demand: 18,870,866 m^3 / year**

$$Vol_{demanded}(\frac{m^3}{Year}) = (No.Connections_{metered} * 10.85\frac{m^3}{month} + No.Connections_{PSP} * 70\frac{m^3}{month} + No.Connections_{unmetered} * 16.26\frac{m^3}{month}) * 12 months$$

- **Collection Efficiency : 0.72 (Initial Value)**

$$Eff.Collection = [-0.464 * Ln(Affordability) - 0.8554] * 0.3 + Cust.Satisf.* 0.3 + \frac{Bill.Coll's}{Ntwk_{size}} Ratio * 0.3 + U.E.* 0.1$$

Note: Collection efficiency for standpipes is set at 100%; and un-metered and metered collection efficiency are equal.

- **Total Cost: 11,447,000 U$D/year**

$$Cost_{total}(\frac{U\$D}{year}) = Staff_{cost} + Infraestructure_{Investment} + Cost_{O\&M}$$

- **Staff Cost: 4,572,000 U$D/year**

$$Cost_{staff}(\frac{U\$D}{year}) = Directors * 60000\frac{U\$D}{year} + Managers * 30000\frac{U\$D}{year} + (Workers + BillCollectors + C.S.Employees) * 6000\frac{U\$D}{year} + Personel_{Fired}$$

$$Personel_{fired}(\frac{U\$D}{year}) = (Directors_{fired} * 60000\frac{U\$D}{year} + Managers_{fired} * 30000\frac{U\$D}{year} + (Workers + BillCollectors + C.S.Employees)_{fired} * 6000\frac{U\$D}{year}) * 0.5$$

- **Total Infrastructure Investment:**

$$Infrastructure_{INV}(\frac{U\$D}{year}) = Distribution_{INV.} + Production_{INV.} + Resources_{INV.} + Wk_{INV.} + Meters_{INV.}$$

- **Total Operation & Maintenance: 6,875,000 U$D/year ; O&M Inefficiency: 1.3**

$$Cost_{O\&M}\left(\frac{U\$D}{year}\right) = (0.7 * Cost_{O\&Minitial} * Inflation^{year} * Ineff_{O\&M}) + (0.3 * \sum O\&M\ Investments * Ineff_{O\&M})$$

$$Inefficiency_{O\&M} = Inefficiency_{O\&M_{n-1}} + 0,1 - [0.4 * SOP's_{RATIO} + 0.3 * \frac{Workers}{Ntwk_{SIZE}}_{RATIO} + 0.2 * \frac{LeakageTrainees}{Workers}_{RATIO} + 0.1 * U.E.]/4$$

Note: If for the current turn there is no O&M investment or the investment is below the annual inflation increase, the program automatically calculates the initial value of total O&M affected by the inflation rate powered by the number of passed years until the actual round.

- **Asset Value: 68,750,000 U$D**

$$Asset_N(U\$D) = Asset_{N-1} + Inv._{Distribution} + Inv._{Production} + Inv._{Resources} - Depreciation$$

- **Depreciation: 1,375,000 U$D/year** *(2% of the Asset Value)*

$$Depreciation_N(U\$D) = (Asset_{N-1}) * 0.02$$

- **Affordability: 5.0%**

$$Affordability = \frac{\left(Tariff(\frac{U\$D}{m^3}) * Consumption(\frac{m^3}{month}) * 12\right)_{Inhouse}}{GDP\frac{U\$D}{Inhab/year_n}}$$; Note: Affordability only calculates based on In-house cxns.

- **Customer Satisfaction: 7.0/10**

$$Customer\_Satisfaction = \Delta Tariff * 0.4 + W.Quality._N * 0.2 + Continuity_N * 0.2 + Awareness * 0.1 + \frac{C.S.employees}{No.Cnxs_N}_{RATIO} * 0.1$$

Note: the ΔTariff improves customer satisfaction if it its lower than previous year's tariff and vice versa.

- **Awareness: 7/10**

$$Awareness_N = Awareness_{N-1} + No.ofAwarenessCampaigns$$; If no awareness campaigns are carried out 0.5 is subtracted.

- **Water Quality: 70% (Initial Value)**

$$W.Q. = [\Delta Physical_{LOSSES} + \frac{Distribution_{O\&M}}{Ntwk_{SIZE}} + \frac{Resources_{O\&M}}{Resources_{SIZE}} + \frac{Treatment_{O\&M}}{Treatment_{SIZE}}] * 0.8 + \frac{Workers}{Trmt_{SIZE}}_{RATIO} * 0.1 + U.E. * 0.1$$

As conditional value, the function is set to have a maximum of 95%. All O&M factors add the previous 5 years of maintenance investments.

- **Continuity: 71.8% or 17.2 hours**

$$Continuity(\%) = \left(\begin{array}{l}(-26.952 * Phy_{Loss}^{\ 2} - 10.56 * Phy._{Loss} + 23.6) * 0.7 + (218.85\frac{No.Cnxs_{Illegal}}{No.Cnxs_N} + 2.33) * 0.15 + \\ (-0.0006 * No.Cnxs_N + 43.47) * 0.15\end{array}\right)\frac{Vol_{Supplied_N}}{Vol._{Consumed_N} * 24} + 0.028$$

The equation for Continuity is based on a best-fit line based on potential scenarios which consider Physical Losses, # of Connections, and # of Illegal Connections. The data used for this can be found on the 'EQ' tab, which by default is hidden, in the Excel interface.

- **Physical Losses Percentage: 30%**

$$Ph_{losses}(\%) = \frac{Vol._{lost}}{Vol._{produced}}$$

- **Physical Loss Volume: 10,480,902 m^3**

$$Vol_{lost} = (0.2 * Network_{new} + Network_{old}) * \frac{8718m^3}{Km} * Phy.Loss.Eff_N$$

The program contains a macro routine that updates old network into new network based on the maintenance decisions, and also turns new network into old network after 5 years of being constructed.

- **Physical Losses Efficiency: 1.4**

$$Phy.Loss.Eff_N = Phy.Loss.Eff_{N-1} + 0.1 - [0.1 * UE + 0.2 * \frac{Leak.Trainees}{Op.Workers}_{RATIO} + 0.7 * \frac{Distribution_{O\&M}}{Ntwk.Size_N}_{RATIO}] * 0.2$$

Leakage Trainees over 4 year span, Distribution O&M over 5 year span

- **Commercial Losses Percentage: 15%**

$$Comercial_{losses}(\%) = \%Consumption_{own} + (\%)Error_{metering} + (\%)Connection_{illegal}$$

- **Commercial Loss Volume: 5,240,835 m^3**

$$Vol._{loss}\,Comercial = Comercial_{losses}(\%) * Vol._{produced}$$

- **Illegal Connections Percentage: 5%**

$$Connections_{illegal}(\%) = \frac{No.Connections_{illegal}}{No.Connections_{total}}$$

- **Meter Errors: 10%**

$$(\%)Error_{metering\,N} = \frac{Meter_{TYPE} \cdot ErrorMargin_{TYPE}}{\Sigma Meters_N} - \frac{\Sigma Meter.Calibration}{\Sigma Meters_N}$$

The equation in Excel is constrained to: Errors cannot go above 10%, Calibration investments last 4 years, and if 20% or less of the meters existing are calibrated, then the error margin increases.

- **Own Use: 1% (Constant Value)**
- **Coverage: 79%**

$$\%Coverage = \frac{Population.Served_N}{Population.Actual_N}$$

- **Willingness to Connect: 85%**

$$W.t.C._N = 0.7 + [0.03 * (Awareness_N + 2 * \%Subsidy_N) / 3]$$;

where Awareness and %Subsidy are converted to values between 1-10, and a minimum of 70% of people that can connect, will connect when network is extended, regardless of either Awareness or Subsidy.

Handout for Teams

Print and distribute the following set of tables for each team.

Management Decisions Form		Unit	Initial Value	Turn 1	Turn 2	Turn 3	Turn 4	Turn 5	Turn 6	Turn 7	Turn 8	Turn 9	Turn 10
1 Financial Decisions													
1.1	Subsidy on connection fee	%	40%										
1.2	In-house Tariff	US$/m^3	0.61										
1.3	Water Kiosk Tariff	US$/m^3	1.04										
1.4	Un-metered Connection Tariff	US$/Connection	150.21										
2 Infrastructural Decisions													
2.1	Additional Water Kiosks	No. Of WK	626										
2.2	Additional Distribution Network	km network	1,051										
2.3	Additional Water Treatment Capacity	m^3	34,936,340										
2.4	Additional Water Resources Abstracted	m^3	34,936,340										
2.5	Additional Number of Meters Type A	No. A Meters	0										
	Additional Number of Meters Type B	No. B Meters	0										
	Additional Number of Meters Type C	No. C Meters	16,711										
3 Human Resources Decisions													
3.1	Additional Director	No. Directors	19										
3.2	Additional Manager	No. Managers	65										
3.3	Additional Operational Staff	No. Op Staff	130										
3.4	Additional Bill Collectors	No. Bill. Col	26										
3.5	Additional Costumer Services Staff	No. Cost. Serv.	91										
4 Maintenance Decisions													
4.1	Rehabilitated Network	Km	0										
4.2	Treatment Maintenance	m^3	0										
4.3	Resources Maintenance	m^3	0										
4.4	Additional Meter Calibration Program	No. meters	0										
5 Capacity Development Decisions													
5.1	Additional Leakage Trainees	No. Trainees	0										
5.2	Additional Staff Trainings	No. Trainees	0										
5.3	Additional Office technology	Package	0										
5.4	Standard Operating Procedures	Procedure	0										
5.5	Awareness Campaigns	Procedure	0										

KPIs Initial value			
KPIS	*Value*	*Range*	*Manager*
Collection Efficiency	72%	0-100	Commercial
Commercial Water Losses	16%	0-100	Commercial
Customer Satisfaction	75%	0-100	Commercial
Willingness to Connect	85%	0-100	Commercial
Affordability	5%	0-100	Financial
Full Recovery Cost Ratio	73%	0-100	Financial
Asset Depreciation	101,244	n/a	Financial
Asset Value	5,062,200	n/a	Financial
Physical Losses	30%	0-100	Operational
Coverage	79%	0-100	Operational
Continuity (Hours)	17.2	0-24	Operational
Water Quality	70%	0-100	Operational
Utility Efficiency	45%	0-100	General Manager

Unitary cost of each decision	
	Unitary Cost
Financial	
Subsidy (for connection fee)	150 USD
In-house Tariff	0.61 USD/m^3
Water Kiosk Tariff	1.04 USD/m^3
Un-metered Connection Tariff	150.21 USD/connection
Infrastructure	
Additional Water Kiosk	10,000 USD/Kiosk
Additional Network	22,700 USD/km
Additional Water Treatment Capacity	0.33 USD/m^3
Additional Water Resources Abstracted	0.11 USD/m^3
Additional A-type meters	200 USD/meter
Additional B-type meters	150 USD/meter
Additional C-type meters	100 USD/meter
Staff	
Additional Director	60,000 USD/year/employee
Additional Manager	30,000 USD/year/employee
Additional Workers	6,000 USD/year/employee
Additional Bill Collectors	6,000 USD/year/employee
Additional Costumer Services Employees	6,000 USD/year/employee
Maintenance	
Rehabilitated Network	20,000 USD/km
Treatment Maintenance	0.012 USD/m3
Resources Maintenance	0.0038 USD/m3
Meter Calibration Program	10 USD/meter
Capacity Development	
Additional Leakage Trainees	750 USD/year/employee
Additional Staff Training	1,000 USD/year/employee
Additional Office technology	5,000 USD/year/package
SOPs	10,000 USD/year/procedure
Awareness Campaigns	5,000 USD/year/campaign

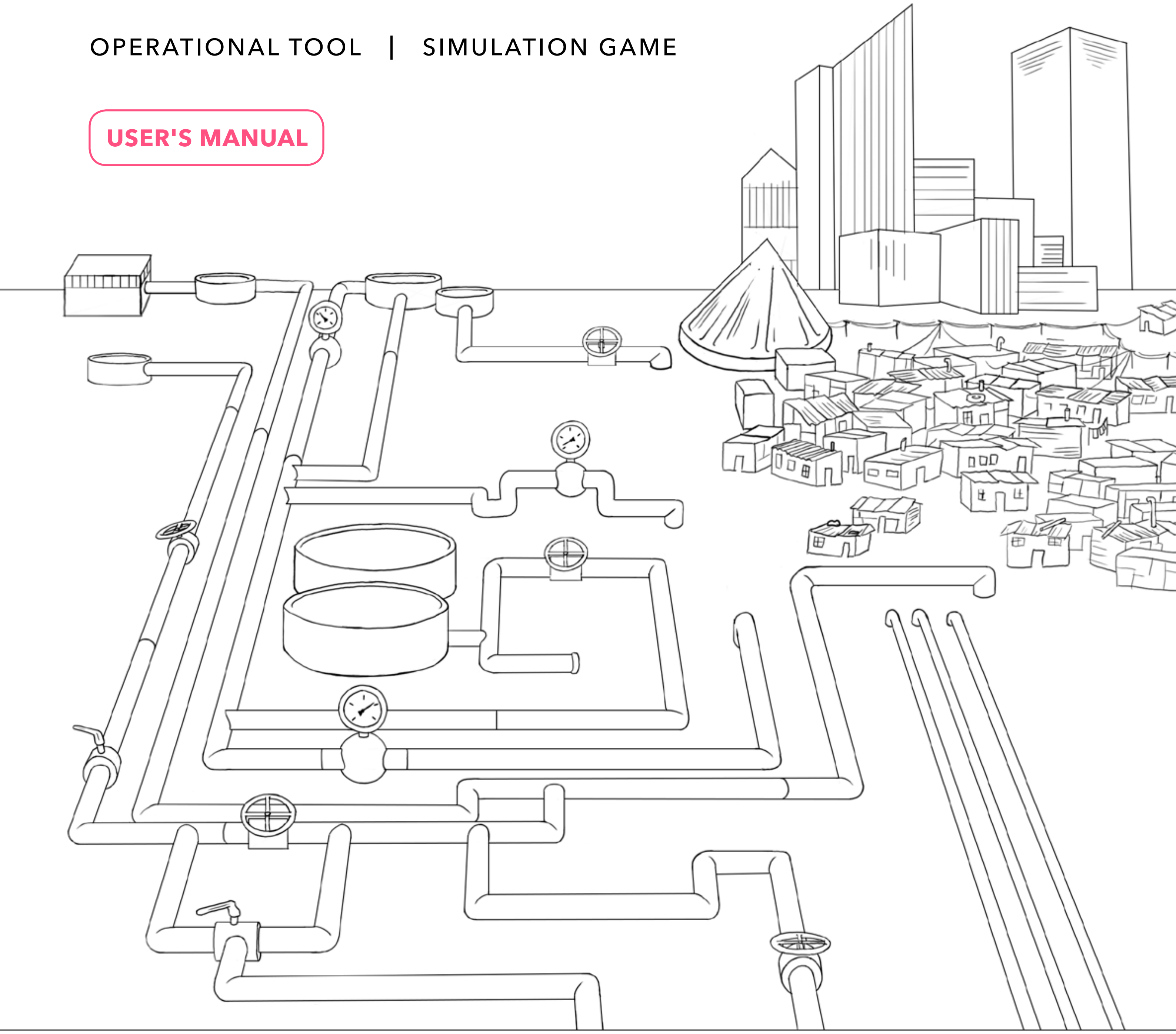
BEWOP

TOOL SERIES

Water Utility Management

OPERATIONAL TOOL | SIMULATION GAME

USER'S MANUAL



GWOPA Global Water Operators' Partnerships Alliance
UN-HABITAT FOR A BETTER URBAN FUTURE
UNESCO IHE DELFT

A joint initiative of GWOPA/ UN-Habitat and IHE Delft Institute for Water Education

Ministry of Foreign Affairs of the Netherlands
Cooperación Española

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Water Operators’ Partnerships are peer support arrangements between two or more water and sanitation operators, carried out on a not-for-profit basis with the objective of strengthening operator capacity.

The Boosting Effectiveness of Water Operators’ Partnerships (BEWOP) initiative is producing a series of guidance materials, tools and games to help WOP partners expertly plan and implement WOP partnerships and effectively learn and share knowledge with one another.

Two types of products feature in the second phase of this BEWOP initiative. Process Tools support WOP participants prepare for, design, implement and follow through with their WOPs. Operational Tools support in the transfer of knowledge on specific operational topics relevant for water utilities.

Find out more

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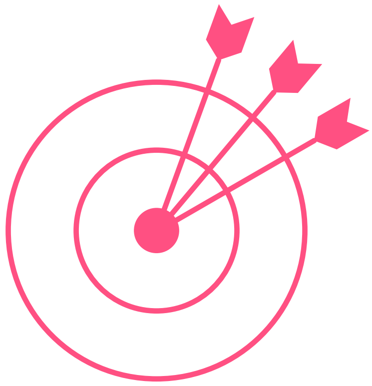

Objectives

This tool has been designed as a learning game to develop awareness and knowledge of the processes of strategic planning within utilities.

The game can be used as a team building or learning exercise for students, utility staff or other water professionals.

The Utility Management Simulation Game is played with a facilitator or trainer who guides discussions on how decisions, trade-offs, and actions play out in everyday business practice, and throws in some surprise elements.

The game draws from real cases and practical experience of experts, which allows participants to experience utilities' decision-making dilemmas in a safe environment.

How this tool works

Within a (water) utility, managers are tasked with achieving numerous, often conflicting objectives: full service coverage, high water quality, service affordability, adequate infrastructure operation and maintenance, HR management, bankability. Achieving these objectives simultaneously is tough and often involved foreseeing potential consequences and making trade-offs on investment and priorities.

The Utility Management Simulation Game groups players into teams of 4, with each player taking on the role of either a General, Financial, Commercial or Operational manager to run a utility for ten years. Based on data from a real utility from a developing country, players must work together to make strategic decisions on the best way forward to improve key performance indicators.

Several teams can play at once to compete (or just explore) how their decisions result in often unexpected outcomes.

Can you keep the utility from going bankrupt? Will service quality bring in more financial resources? What happens when your assumptions change? See how you would cope with this by playing the game.

Access the full Water Utility Management Tool here.

Contents

Introduction

Profile of Mokum Dollet

Mokum Dollet is a country in Sub-Saharan Africa, covering an area of 799,380 km², with an estimated population of 20.3 million inhabitants. The capital of Mokum Dollet, Macondo, has a population of just over 1 million people. Almost five centuries as a Spanish colony came to a close with independence on June 25th, 1975. Civil war, sabotage from neighbouring states, and economic collapse characterized the first decade of Mokum Dollet's independence. Also marking this period were the mass exodus of Spanish nationals, weak infrastructure, nationalization, and economic mismanagement. During most of the civil war, the government was unable to exercise effective control outside of urban areas, many of which were cut off from the capital. An estimated 1 million inhabitants of Mokum Dollet perished during the civil war, 1.7 million took refuge in neighbouring states, and several million more were internally displaced.

Large-scale emigration, economic dependence on bordering countries, a severe drought, and the prolonged civil war hindered the country's development until the mid-1990's. A UN-negotiated peace agreement between Front for the Liberation of Mokum Dollet (FRELIMDO) and rebel Mokum Dollet National Resistance (MDAMO) forces ended the civil war in 1992. By mid-1995 the more than 1.7 million refugees who had sought asylum in neighbouring countries as a result of war and drought had returned, as part of the largest repatriation witnessed in Sub-Saharan Africa. Additionally, a further estimated 4 million internally displaced people returned to their areas of origin.

Despite the government's strong anticorruption rhetoric, corruption in the executive and legislative branches was widely perceived to be endemic in 2009. The World Bank's Worldwide Governance Indicators reflected that corruption was a serious problem, with no change in ranking from the previous year. For the second year running, the country dropped in Transparency International's 2009 Corruption Perception Index (from 126 to 130), indicating that corruption remained rampant. Petty corruption by low-level government officials to supplement low incomes, and high-level corruption by a small group of politically and economically connected elites continued to be the norm.

Table 1

General characteristics Mokum Dollet (2008)	
Population (2009 est.)	20.26 million
Life expectancy	41.1 years
Population growth rate (2010 est.)	1.8%
Urban population	7 million
GDP per capita (2008 est.)	US$ 3,004
Mortality rate of children under five	158/1000
Literacy rate	47.8%

Source: CIA Factbook

Economy

The resettlement of civil war refugees, political stability, and continuing economic reforms have led to a high economic growth rate. Between 1994 and 2006, average annual GDP growth was approximately 8%. Mokum Dollet achieved this growth rate even though the devastating floods of 2000 slowed GDP growth to 2.1%. As of 2008, the average growth rate was at 6.5%. Although the Bank of Mokum Dollet projected relatively stable rates of 6.1% for 2009 and 6.3% for 2010, the IMF's projections of a 4.5% average growth rate for 2009 and 5.5% for 2010 were generally accepted at year's end. In spite of these gains, Mokum Dollet remains dependent upon foreign assistance for more than half of its annual budget, and the majority of the population remains below the poverty line. The country is characterized by high levels of inequality. Although it is estimated that more than 80% of the population engages in agriculture, the sector suffers from inadequate infrastructure, commercial networks, and investment. In terms of exports, Mokum Dollet relies heavily on aluminium, which accounts for about one-third of exports. As a result the economy is subject to volatile international prices. The sharp decline in aluminium prices during the global economic crisis lowered GDP growth by several percentage points.

The Water Services Sector in Mokum Dollet

During the civil war in Mokum Dollet, water supply infrastructure severely deteriorated as few new investments were made between the mid-1970s and 1992. Extensive flooding in 2000 further destroyed infrastructure and delayed the implementation of planned new investments. As result of this enormous backlog in investments Mokum Dollet has coverage levels for water and sanitation which are among the lowest in the world. Access to safe water officially reached an average of 39.8 % in 2004 (RNE, 2014). According to UNICEF (2013) Mokum Dollet has one of the biggest child mortality in the world (246 out of every 1000 live births) and 13 % of these deaths are directly attributed to lack of access to clean water and poor sanitation.

Sector reforms

In order to mitigate this situation the Government enacted the *Water Law* (law 16/01) in 2001, which provides the general legal framework for the management, protection, conservation, use, control and monitoring of the water resources (Wolters, et al., 2008). This law was later followed in 2005 by the enactment of the *National Water Policy* (resolution 7/05). The main feature this policy was the establishment of the principle of privatization of the urban water supply services to try to attract private sector participation (CRA, 2009). The policy calls for financially self-sufficient and decentralized autonomous agencies to operate the provision of water supply services, and for these agencies to have a management capable of attracting local financial resources to strengthen their physical and human assets (Wolters, et al., 2008). In summary, the policy aims to achieve decentralization, to have user involvement and the participation of the private sector, with the Government acting as the regulator, coordinator and facilitator. In 2007 the Government, with the help of the World Bank, created the *National Program of Water Development I* (PNDA I) aimed at restructuring the urban water sector through sector reforms, institutional capacity building, and policy development, all in preparation for private sector participation. A year later the *Water Tariff Policy* was introduced (resolution 60/08), which declared water as an economic good and stated that tariffs should be socially equitable and economically efficient to allow for cost-recovery (AfDB, 2002, CRA, 2009). As a result of these reforms, the water sector in Mokum Dollet adheres to the following principles (World Bank 2009):

- Increasing the access of the population, especially the poor, to water supply and sanitation services;
- Improving cost-recovery so that services would be financially viable;
- Limiting the role of the State to setting priorities and standards, promoting the development of services, regulating services and investing in infrastructure; and
- The delivery of services by autonomous service companies that strive for managerial, financial and operational excellence.

Service Provision in the City of Macondo

The total population in the city of Macondo was estimated to be around 1,077,116 people in 2015. As the census on which this number is estimated dates back to 2009, the estimate should be relatively accurate. The utility operating in Macondo, serviced 50,639 connections. These connections provided services to an estimated 37% of the population through in/house connections and 41% of the population through water kiosks, which are run by Water User Associations. Average consumption of metered in/house connections was estimated at approximately 85 l/c/day. At water kiosks water consumption drops to an average of 14 l/c/day. This is well below the 50 l/c/day threshold that the WHO identifies as the minimum daily amount required for an individual.

Service continuity in the city of Macondo was estimated at approximately 17 hours per day on average. None of the consumers receive services for 24 hours per day. The utility has 331 employees. These are divided over different departments as presented in **Table 2** below.

Tariffs in Macondo

Over the 2012-2017 period, tariffs have increased in the city of Macondo by between 5%-10% per year. In Macondo three different tariffs are currently distinguished. Last year, the utility charged an average tariff of US$ 0.61 per m^3 for in-house connections. Consumers of water kiosks bought water in jerry cans of 20 L. To fill up a jerry can consumers paid about 2.1 cents. If that is translated to US$/$m^3$ it comes to about US$ 1.04 per m^3. A third tariff concerns consumers who do not have a meter installed and who are charged through a flat tariff. These consumers paid US$ 150.21 per year for their water.

In addition to the water tariffs, consumers are charged a connection fee if they want to connect to the centralized network. A World Bank (2015) study found that high connection fees and a relatively high tariff make services unaffordable for the poorest.

Table 2

Key Performance Indicators for Macondo – 2016		
Indicators	**Unit**	**Value**
Customer Satisfaction	Scale 1-10	7.5
Asset value	In million USD	68,750,000
Full recovery ratio	Ratio	0.73
Commercial water losses	% of water produced	15%
Physical water losses	% of water produced	30%
Affordability of tariffs	% of GDP	5%
Collection efficiency unmetered	% of bills collected	71%
Collection efficiency water kiosk	% of bills collected	100%
Collection efficiency households	% of bills collected	71%
Continuity	Hours of service per day	17
Water quality	% of samples adhering to set standards	70%
Coverage	% of the total population	79%
Utility Efficiency	Index of staff and process efficiency (between 0 and 1)	0.45

Playing the Game

Game Concept

The objective of the UTILITY MANAGEMENT SIMULATION GAME (UMSG) is to enable players to experience the challenge of managing a water utility from different management positions. Within a water utility, middle-level managers often have to achieve objectives which can be conflicting. Achieving the desired objectives – like attaining full service coverage, ensuring quality of water supplied, guaranteeing affordability of the service, fostering access to services for the poor, and sufficient cost recovery to mention some – is often difficult as these objectives inherently involve trade-offs; for example, increasing cost recovery may be achieved at the cost of ensuring affordability of services. Moreover, managers in water utilities have to achieve both short-term objectives, which are often linked to the electoral cycle of the government-owned public utilities, and long-term objectives, which are often linked to the state of the utility infrastructure and services provided. Achieving these objectives simultaneously is difficult as the more political short-term objectives may be at odds with long-term objectives relating to infrastructure investment and asset management. The purpose of the UMSG is to let participants experience this challenge of utility management by simulating decision-making in the areas of general, customer, operational and financial management within the utility.

The game can be played by a single water utility management group or it can accommodate up to 4 different water utilities (within the same case study) in order to allow for benchmarking between utilities. All utilities operate within the same case study of Macondo. The challenge for the players is to estimate the implications of their decisions and convince other players in their utility to accept their proposals to improve the performance of the water utility. Moreover, the game allows for the benchmarking of performance on the basis of the KPIs. Thus, the different management teams are also engaged in a form of 'quasi-competition' against the other management teams.

Game Design

- Different management teams (water utilities) are formed.
- Each management team is comprised of 4 managers, i.e., general, financial, operational and commercial manager. More players can be accommodated by team (only if needed) by having two players assume as a team the management role, i.e. 2 financial managers. In this case, the 2 players will need to agree on their proposal before discussing with other team members.
- Each management team has the baseline information from this document (initial KPIs).
- Each management team receives a fixed budget at the start of the game, in the form of a $15,000,000 loan. This loan is to be used as the teams see fit in order to ensure the water utility does not go bankrupt, that is, it can be used for investments, O&M, staff costs, etc.
- UMSG is played with US dollars as its main currency.
- The General Manager (can) assign a certain portion of the total budget to each of the departments per round (a round represents one year).
- Decisions are made per round with every turn being equivalent to one calendar year.
- The time allocation per round should allow for the players to successfully complete their negotiations with one another.
- The General Manager submits the decisions by his/her team to the facilitator on paper. The facilitators will enter the decisions in the model underlying this game.
- The model then calculates the overall impact of the decisions of the players on the KPI's of the water utility.
- Based on these 'new' KPI values the next round of decision-making begins.

Game assumptions

- Yearly inflation rate is constant during the 10 turns and is estimated for Macondo at 3% per year.
- Per each in-house metered connection a total of 8 people are served.
- Per each water kiosk connection a total of 705 people are served. An investment in one water kiosk is coupled to a necessary investment in 1km of network.
- Consumption per connection type function as follows: In-house connection serves a volume 20.52 m^3 per month, Un-metered connection serves a volume of 30.78 m^3 per month, and Water Kiosk connection serves a volume 296.1 m^3 per month. This applies when there is sufficient water to deliver to these connections.
- Any installed kilometre of network becomes old network after 5 years. This impacts various processes within the game. After investing in maintenance, the game selects the old network and turns it in to new network for the next turn.
- The water treatment capacity and the resource availability are mutually restrictive as the utility cannot deliver water that is not treated and cannot treat more water than that which is available.
- Once new meters are installed, the non-metered connections are reduced in the same rate. There are three types of meters, A, B, and C, that can be installed in the game. These meters have different levels of accuracy, and therefore cost, with A-type meters being the most expensive and C-type meters the cheapest.
- For each staff member fired the utility must pay a compensation of 6 months of salary which will translate as a cost for the year in which the decision was taken.
- Staff salaries remain constant in time and are not affected by the inflation rate.
- For water treatment infrastructure, the deterioration period is longer and for this reason it was not considered in the game. This means that there is not such a concept as old and new treatment facilities. However, the maintenance of water treatment facilities does affect the performance of the utility.

Understanding the Terms

Asset Value

The asset value for all utilities is set at US$ 68,750,000. As the game advances this value varies. The asset value increases if an investment in infrastructure is made, for example, in network expansion or production facilities, and it decreases yearly due to a fixed depreciation rate.

Loan (Available Budget)

The initial loan (available budget) at the start of the UMSG for each team is by default US$ 15,000,000. In UMSG, the remaining budget available can be checked in 'Financial Balance' and corresponds to the total expendable budget in the water utility for the duration of the game, e.g. 10 years.

Key Performance Indicators (KPIs)

UMSG is based on 12 different Key Performance Indicators (KPIs) – such as financial performance, the state of the utility's assets, quality of service provision, and consumer satisfaction – which assess multiple dimensions of a utility's performance. The KPIs are influenced by decisions made by a management team. The KPIs, and how they are influenced by different decisions, is explained in the Glossary of KPIs section of this Participant's Manual.

Steps for participants in UMSG

At the start of the game each General Manager will review the status of the initial KPIs and receive a 'Management Decisions' sheet on which to fill in the investment decisions of the utility for each round.

The General Manager then discusses with his/her team of managers in order to come to a consensus on what investments to carry out. If time allows, the game can also make use of a form called 'Preliminary decisions' in which the Commercial, Financial, and Operational Managers can fill in their objectives. These forms can be submitted to the General Manager to serve as the basis for negotiations for each management team. The 'Management Decisions' form can be found at the end of this document.

Step 1: Developing a Strategy

The first step in UMSG is for the whole management team of the utility to jointly analyze the initial KPIs provided to them, and based on the team's analysis of the current situation of the utility, define a strategy they want to follow. Where do they want to target investments? Which KPIs should be targeted for improvement?

Each management team will then present to the facilitator and to the other participants their strategy for improving the utility's performance in the next 10 years. The strategy should make explicit what the key areas of focus for utility improvement will be and how these will be intervened in the mentioned timeframe. As part of this exercise it is encouraged, if time allows, for each management team to frame their strategy within the vision and mission of the utility, as defined by the team itself.

Step 2: Making Preliminary Decisions

On the basis of the agreed upon strategy, the individual Financial, Operational and Customer Managers decide upon a list of investments that they would like to make for a certain year. This essentially represents a 'wish-list' of that particular manager. Each manager then submits this 'wish-list' to the General Manager using the 'Preliminary decisions' form.

Step 3: Negotiating the Decisions and Investments of a Year

Once the General Manager has collected the different 'wish-lists' from the different managers s/he will have to make an analysis of the feasibility of the proposed interventions considering the amount of money required, the expected impact on KPIs, and the consistency with the strategy set-forth by the team. Based on this analysis, the General Manager will have to enter into negotiations with the individual managers. The General Manager may do this in bilateral negotiations or through a group negotiation involving all managers. As a result of these negotiations, the General Manager attributes budgets to the decisions that follow from the negotiations.

Step 4: Submitting the Decisions and Calculating the Impact

The General Manager then fills in the 'Decisions form' and submits this to the facilitator. The facilitator then enters these decisions in the computer model and provides the management team with the 'new' situation with respect to the KPIs.

Once the management team receives the new situation with respect to the KPIs, another decision round starts again, i.e. the process starts again from Step 2.

The Management Roles

The General Manager

As the General Manager, your most important role is to make sure that each departmental manager receives the appropriate budget for the year ahead. This will depend on the utility goals that the team has set in the strategy phase, the performance of the utility so far, and how the different decisions impacted the KPIs in previous rounds.

As General Manager, the main performance indicators that you will look at are asset value, loan utilization, and cost recovery ratio. Additionally, the General Manager is also responsible for the overall functioning of the utility, including staff and office development(s). Overall, this means you must monitor all KPIs on an annual basis.

At the start of each round, all managers fill in a "Preliminary decisions" form, indicating their required budget for each decision and submit this form to you. You then need to analyze whether the proposed budgets are in accordance with company goals and whether they are achievable. You have a budget of US$ 15 million for the 10-year period. If all decisions would be implemented to the maximum amount, however, the entire budget would be spent in one year; it is worth noting that if your utility goes bankrupt the UMSG finishes.

As such, you have to make difficult decisions about how much to allocate to each department per year. It goes without saying that this cannot be accomplished without consulting and negotiating with all departmental managers. It is up to you to decide whether to hold individual meetings with each departmental manager or to have group discussions. On the basis of the discussions with your financial, commercial and operational managers, and on your analysis of the different KPIs in the context of your utility's overall goals, you will decide upon how much money to divert to different departments per round.

Your total budget availability for the duration of 10 years is US$ 15,000,000. Whether this loan is spent in 10 years or 1, however, is your decision. Try to understand the effect of different investments on the overall performance of your utility before you proceed to assigning budgets to the different departments. Also consider that your goal is to maintain the utility running for at least 10 years.

The Operational Manager

As the Operational Manager you are responsible for improving the performance of the utility by reducing the real water losses (physical non-revenue water), increasing the continuity of water supply, improving the quality of water supplied to the customers, and increasing the service coverage. Developments of these KPIs over the course of the game determine how well you are performing as an operational manager.

It is important for the player to realize that some decisions may have an immediate impact on the KPI, such as changes in staff composition, while other decisions may only produce a traceable impact after 1 or 2 years, such as construction of new infrastructure. The player is advised to analyse to what extent each investment can impact the abovementioned performance indicators, and how long it takes for the investment to impact the respective KPI's. It is crucial that the player attempts to understand the interrelation of decisions and KPI's between different departments. Decisions made by the Operational Manager will also affect the KPIs linked to the other departments.

It is important to realize that some operational decisions are considered to have impact for a limited time, in which case they should be repeated to continue their impact within the game, while other decisions are one-time investments that alter the course of the game for good. For instance, the benefits of investing in maintenance one year will have a time-frame in which they are valid, while the expansion of abstraction facilities represent a permanent change for the utility.

The Commercial Manager

The Commercial Manager is responsible for ensuring that the key performance indicators corresponding to customer management, i.e.: commercial non-revenue water, customer satisfaction, willingness to pay, and collection efficiency, improve as the game advances.

As Commercial Manager, your task consists of identifying the most relevant actions to ensure the utility maintains, or improves, its current practices vis-à-vis its consumers. This will require finding an adequate balance between investing in processes that improve the utility's capacity to provide adequate services, reduce the consumer-side losses, and garner the support of the consumers to whom water services are being provided.

During negotiations prior to decision making, it is crucial to predict which decisions of other managers can impact the performance of your department the most as the utility's operational and financial decisions will have a direct impact on how consumers perceive the water utility and subsequently engage with it. For example, the capacity for consumers to pay water tariffs will influence how many consumers opt for legally connecting to the network.

The Financial Manager

The Financial Manager is in charge of the key performance indicators corresponding to financial management, i.e.: full cost recovery ratio, financial balance, asset value/depreciation, and service affordability, and their improvement as the game advances. Again, it is worth highlighting that several decisions taken by other departmental managers can affect these 4 financial KPIs. Hence during the team negotiations, it is crucial to try to predict which decisions of other managers can impact the performance of your department the most. Bilateral or multilateral negotiations should then be focused on those specific decisions.

As Financial Manager, you will need to consider how to balance the costs of the utility with the income it is generating, as well as identify which financial decision can generate adverse effects through the response of the consumers. It is recommended that you consider how some of the actions of other managers in your team, such as addressing non-revenue water, can impact your short and long-term financial stability.

In playing the Game, you should anticipate that there may be a delay in the effects of your decisions on the KPIs. It may be that for some decisions the effects will not be established in the year of implementation, but somewhere further in the future.

Decisions

What is the goal of the game?

The main goal of the game is to ensure the continuous operation of the drinking water utility, while attempting to be as profitable as possible during the 10 years of simulation without decreasing the quality of the service provided. In order to achieve this, players are presented with a standard set of decision to make each turn though the 'UMSG Decisions' sheet. Each decision can influence each KPI in a different manner; this fosters players to develop negotiation skills within their teams by assessing trade-offs and the short/long term objectives of each manager. This means that there is not one single objective of the game as different scenarios can be achieved depending on the importance that each manager gives to the different KPI s/he chooses to improve.

What are decision variables?

The game calculates the different KPI's based on their common theoretical definitions and the possible inputs from the UMSG model. Players can influence the inputs for the KPI's through 28 possible decisions that can be made each turn. Each decision carries monetary costs and investments, which are calculated with fixed unitary prices. The possible decisions to be taken yearly are classified into 5 main categories as shown below:

Table 3

UMSG Possible Decisions and related costs				
1 Financial Decisions				
1.1	Subsidy on connection fee	%	40%	150 US$
1.2	In-house Tariff	US$/m^3	0.61	0.61 US$/m^3
1.3	Water Kiosk Tariff	US$/m^3	1.04	1.04 US$/m^3
1.4	Un-metered Connection Tariff	US$/Connection	150.21	150.21 US$/meter
2 Infrastructural Decisions				
2.1	Additional Water Kiosks	No. Of Kiosks	626	10,000 US$/Kiosk
2.2	Additional Distribution Network	km network	1,051	22,700 US$/km
2.3	Additional Water Treatment Capacity	m^3	34,936,340	0.33 US$/m^3
2.4	Additional Water Resources Abstracted	m^3	34,936,340	0.11 US$/m^3
2.5	Additional Number of Meters Type A	No. A Meters	0	A = 200 US$/meter
	Additional Number of Meters Type B	No. B Meters	0	B = 150 US$/meter
	Additional Number of Meters Type C	No. C Meters	16,711	C = 100 US$/meter
3 Human Resources Decisions				
3.1	Additional Director	No. Directors	19	60,000 US$/year/employee
3.2	Additional Manager	No. Managers	65	30,000 US$/year/employee
3.3	Additional Operational Staff	No. Employees	130	6,000 US$/year/employee
3.4	Additional Bill Collectors	No. Bill Collectors	26	6,000 US$/year/employee
3.5	Additional Costumer Services Employees	No. Employees	91	6,000 US$/year/employee

4 Maintenance Decisions				
4.1	Rehabilitated Network	Km	0	20,000 US$/km
4.2	Treatment Maintenance	m^3	0	0.012 US$/$m^3$
4.3	Resources Maintenance	m^3	0	0.0038 US$/$m^3$
4.4	Additional Meter Calibration Program	No. meters	0	10 US$/meter
5 Capacity Development Decisions				
5.1	Additional Leakage Trainees	No. Trainees	0	750 US$/year/employee
5.2	Additional Staff Trainings	No. Trainees	0	1,000 US$/year/employee
5.3	Additional Office Technology	Package	0	5,000 US$/year/package
5.4	Standard Operating Procedures	Procedure	0	10,000 US$/year/procedure
5.5	Awareness Campaigns	Procedure	0	5,000 US$/year/procedure
Water Supply Distribution (only part of the game)				
A	Water distribution – In-house connections	%	88%	N/A
B	Water distribution – Water Kiosk	%	12%	N/A

1. Financial Decisions

Financial decisions are the ones that define the revenue for the utility company as they involve the tariffs and fees charged and given to the users which also have to be affordable to the population.

1.1. **Subsidy on connection fee:** This decision reflects what percentage of the cost for each new connection will be assumed by the water utility in order to promote new connections. For the particular case study referenced in this manual, the full cost for a new domestic connection is 150 USD; this value cannot be changed by the management teams and remains constant throughout the game.

1.2. **In-house Connection Tariff:** The in-house connection tariff is decided by the management team at the beginning of each round. This tariff reflects the cost for one cubic meter (USD/m^3) and is assumed to remain constant for the whole year, i.e. for the whole turn. It is *not* possible to play a single round without having defined a tariff value above 0. Additionally, there is a limit to how much the cost can increase per year (no more than double), as well as a maximum cost boundary (6 USD/m^3), in order to avoid civil unrest and political turmoil.

For the Macondo case study, an initial value of 0.61 USD per cubic meter is given.

1.3. Water Kiosk Tariff: Water Kiosks are common supply structures installed in places where users can access water when they do not have a direct connection to the water supply system. For the Macondo case study, it is assumed that this structures are managed by the utility company and the initial cost charged to the users is 1.04 USD per cubic meter. The same limitations from in-house connections apply (see 1.2).

1.4. Un-metered tariff: A common water management practice in several places in the world is to allow for un-metered connections. This practice consists in charging a flat tariff per connection despite of the monthly consumption. For Macondo case study an initial value of 150.21 USD per connection per year. The same limitations from in-house connections apply (see 1.2), with maximum cost boundary being 210 USD/m^3.

Reminder: In order to play each round, all 3 tariffs have to be defined as greater than zero.

2. Infrastructural Decisions

Infrastructural decisions relate to the growth and improvement of the utility's water supply system in terms of tangible assets. Decisions made within this category can lead to improvement of the system's coverage, capacity, and quality. These improvements are eventually subject to maintenance. As a recommendation, teams are reminded that these improvements represent additional investments that will affect the initial budget (loan), and if managed inefficiently, might drive the utility to bankruptcy.

2.1 Additional Water Kiosks (WK): WK's can be used to increase the coverage of the current system. Although this can be a good solution from the coverage point of view, it is worth noting that WK's also require high costs of installation and are not the preferred mode of connection for consumers. The UMSG takes into account the spatial limitations of WK coverage by constraining the number of new WK's to one per kilometre of new network. Therefore, it is only possible to install a WK when an additional kilometre of distribution network has been added. For the Macondo case study the unitary cost of a WK is estimated at 10,000 USD (this does not include the additional kilometre of supply network if required).

2.2 Additional Distribution Network: The water supply system's capacity to deliver water is given by the size of the pipe pressurized network. As the population increases yearly the system has to be expanded and the relevant manager(s) must make the decision of investing in the installation of new network. The unitary cost of the pipe is 22,700 USD per kilometre which includes excavation, disinfection and leakage testing. All new connections that occur as an increase of the distribution network are un-metered connections.

2.3 Additional Water Treatment Capacity: The supply of water to the network is constrained by the water utility's treatment capacity as the water has to be delivered with certain quality standards. These standards are achieved by investing in treatment facilities such as water treatment plants. For the game this decision is taken as water treatment volume capacity. This translates into the marginal value of investment required for producing an additional cubic meter of water. For the Macondo case study it is assumed that the cost of investment for water treatment capacity is 0.33 USD for each additional cubic meter produced. It is worthwhile to take into account that this infrastructure deteriorates over time impacting its value and capacity to treat water to relevant standards.

2.4 Additional Water Resources Abstracted: The water utility produces treated drinking water that comes from natural sources (rivers and aquifers) that are property of the state, and thus can potentially be allocated to other sectors. This means that every cubic meter abstracted from wells or superficial sources has to be paid for in order to promote the sustainable use of water resources. The abstraction for the Macondo case is assigned at 0.11 USD per cubic meter and remains constant throughout the game. As the treatment capacity and resources abstracted are mutually restrictive, i.e. more water cannot be delivered to the system if there is not enough treatment capacity or there is not enough water to treat, players are advised to consider the links between the two when making investment decisions.

2.5 **Additional Meters Installation:** Meters provide the water utility with the capacity to charge for water based on actual consumption, which facilitates projections on income, transparency with consumers and the implementation demand management strategies to reduce the consumption per capita. In the UMSG, the management teams can opt for 3 different types of meters: A-type, B-type, and C-type. These meters have different levels of accuracy in their measurements, and therefore each type has a different cost. For this game, the unitary cost for a new installed meter is 200, 150, and 100 USD, respectively. If the team achieves to have all current in-house connections metered, it is still possible to improve the meters by upgrading the lower types; there is no additional cost for this procedure.

3. Human Resource Decisions

The performance of the water utility depends on the amount of staff working in it, the balance between staff members of different positions, and the trainings the staff may receive. Each of the staff members will influence different aspects of the water utility's performance. Although over-staffing may seem like a potential form to improve the performance of the utility, players are advised to consider the running costs this will generate, particularly considering the limited loan received.

3.1 **Additional Director:** This category of staff represents the highest decision-making staff member, usually in charge of coordinating the management staff. For this case study the director's yearly salary is 60,000 USD.

3.2 **Additional Manager:** These staff members are the head of the various departments within the utility, such as operations and customer service. For this case study the Manager's yearly salary is 30,000 USD.

3.3 **Additional Operational Staff:** This group of staff members focuses on the technical and operational processes that are required for the treatment and distribution of water. For this case study the Worker's yearly salary is 6,000 USD.

3.4 **Additional Bill Collectors:** This group of staff is in charge of physically going to the connection point and collecting the monthly payments for the service. For this case study the Bill Collector's yearly salary is 6,000 USD.

3.5 **Additional Costumer Services Employees:** This group of staff members focuses on advising customers and trying to solve their problems with relation to the service provision. For this case study the Costumer Services Employee's yearly salary is 6,000 USD.

Firing Personnel: The UMSG also gives the possibility to fire staff members when you think the utility is overstaffed; however, due to the unilateral termination of staff's contracts, firing staff members represent a cost of half the employee's yearly salary. Although you can fire staff, you cannot shift personnel around departments, and you will need at least one manager and one of each of the ground-level employees.

4. Maintenance decisions

As the continuous usage of the water utility's supply infrastructure leads to the deterioration and malfunction of assets, maintenance is a crucial aspect of water service provision as it allows for maintaining the efficiency and effectiveness of processes over time. For this reason, the management team has the possibility to invest in maintaining key components of the supply system in order to ensure adequate operation and care of the infrastructure.

4.1 Rehabilitated Network: For the current case study, it has been estimated that the network needs to be completely rehabilitated after 5 years of being laid to avoid incurring in operational deficiencies due to faulty infrastructure. If the system is not maintained in a timely manner, physical losses and water quality issues will increase translating into a poor operational performance. When parts of the network are rehabilitated, the game converts the number of rehabilitated kilometres from being classified old to new piping which impacts different KPI's. Rehabilitating the network is nearly as expensive as laying down new network as the same kind of labour is required. For this case study, a cost of 20,000 USD is estimated for each rehabilitated kilometre of pipe.

4.2 Treatment Maintenance: The water treatment infrastructure has to be maintained in order to ensure that the water treatment processes can achieve the desired water quality standards. The estimated cost of maintenance per cubic meter for this case study is estimated in 0.012 USD.

4.3 Resources Maintenance: Natural sources should be maintained, among many reasons, in order to ensure they can continue to provide the resources and services needed by humans, in this particular case the extraction of water for human consumption. Different procedures, such as aquifer recharge, reforestation and infrastructure maintenance, are required to maintain a healthy resource; for the UMSG all these processes are simplified to a single decision which estimates their implementation based on the cost of maintenance for one cubic meter of non-treated abstracted water. For this case study it is estimated at a value of 0.0038 USD per cubic meter.

4.4 Meter Calibration Program: One of the main concerns for an operational manager is to accurately and reliably estimate the amount of water flowing through the supply system. This will allow to generate an accurate water budget from which additional investments required can be determined. In parallel, this should also increase the efficiency of the supply system without additional infrastructure. The meter calibration program is oriented to reduce the amount of water that is lost in the system through improving the reliability of the measurements and ensuring hermetic supply operations. For this case study the meter calibration program is estimated at 10 USD per existent meter, as such, the program can only be implemented on the currently installed meters and makes no cost or efficiency difference based on the type of meter installed.

5. Capacity Development Decisions

For a water utility to properly function, having working infrastructure and sufficient staff is not enough. It must have adequately trained staff, proper resources, and an ongoing sensitization process with its consumers. It is worth noting that players should aim to find a balance on the ratio of trained staff and procedures that should be implemented each year in order to achieve a good efficiency in the utility. Additionally, much like maintenance, standard operating procedures, trainings, and awareness campaigns are activities that should ideally be carried out on a cyclical basis. As such, the decisions related to these activities in the UMSG are explained in this section.

5.1 Additional Leakage Trainees: In order to implement leakage detection programs for NRW, it is important to periodically train operational staff so they may be up-to-date on the current advances and state-of-the-art approaches. It's defined for this case study that trainees have a cost of 750 USD per employee for each year, and the decision is made by choosing the number of workers to be trained from the current pool of workers.

5.2 Additional Staff training: This training is refers to general staff members trainings based on the utility's varying needs. It can be considered as a generic training of staff to improve existing processes and activities. For this case study, this training has a cost of 1,000 USD per employee for each year, and the decision is made by choosing the number of workers to be trained from the current pool of workers.

5.3 **Additional Office Technology:** The operational efficiency of a utility is also affected by having access to adequate technology systems and better working environments for the staff. These kinds of investment have a direct influence in the overall functionality of the utility. As there are multiple potential improvements to carry out, these have been bundled into a single decision; however, it is recommended that players consider for the size of the utility how many office improvement packages are necessary and how often, i.e. a single package does not cover the whole utility's necessities. The unitary cost per package for this case study is 5,000 USD per package per year.

5.4 **Standard Operating Procedures:** The adequate operation of a water utility requires staff to develop, disseminate, implement, and continuously improve its various operational, financial, and commercial processes. As such, these aspects have been bundled into the possibility of implementing Standard Operating Procedures which improve the overall efficiency of the utility. Again, it is recommended that players consider for the size of the utility and number of processes, how many SOPs are necessary and how often they need to be implemented, re-learned, and updated. The unitary cost per procedure for this case study is 10,000 USD per package per year.

5.5 **Awareness Campaigns:** As water utilities implement their processes, and the changes to these processes, it becomes necessary to generate awareness both within the utility and to its consumers. Awareness campaigns are used to sensitize consumers to potential changes in the water supply system, including new areas with access to the service, changing service levels and tariffs. Although these campaigns cannot fully compensate potentially negative perceptions of the utility, they do help consumers and staff have a better understanding of on-going changes. The unitary cost per procedure for this case study is 5,000 USD per package per year.

Glossary of KPIs

Below is a set of definitions for the KPI's used within the game, accompanied with considerations on how these KPI's can be affected. The definitions and potential actions are suggested based on the general understanding of these concepts and processes by utilities; however, considering the complexity of the water sector, these definitions and potential actions are by no means exhaustive, and are meant to facilitate players participation within the game.

Full Cost Recovery Ratio

The full cost recovery ratio shows the ability of the organisation to cover all its costs through the revenues it generate. It is calculated by taking the total amount of income collected and dividing it by all the expenditures (including operating expenditures, depreciation and interest and dividend payments).

In this respect the full cost recovery ratio is different from the operating ratio and the working ratio as it includes the depreciation and dividend and interest payments.

A full cost recovery ratio of 1 reflects the organisation's ability to meet its full costs by its revenues.

To gauge the extent to which an intervention will affect the full cost recovery ratio, the player is advised to analyse whether the potential intervention would affect:

1. The annual total amount of billed income. If it would increase due to the intervention, the working ratio will be affected.
2. The total amount of all expenses including OPEX, depreciation and financial expenditures. If these expenses would reduce, the working ratio will be affected.

Non-Revenue Water (NRW) is water that has been produced by the water utility, but that does not generate revenue for the utility, and is usually divided into two main sections: Physical (or Real) Losses, and Commercial (or Apparent) Losses. Ideally, non-revenue water should be kept as low as possible. After all, non-revenue water comes at a substantial cost to the utility. The World Bank has suggested that non-revenue water levels (including both physical losses as well as commercial losses) of around 20% are acceptable. These are described below:

Physical Water Losses

The real water losses are used to measure the ability of the utility to control the amount of water that is produced but does not reach the consumer. As such, this indicator represents the proportion of the water brought into the system that leaks away through faulty joints, cracks, etc. The indicator is calculated by expressing the water losses as a fraction of the volume of water entering the system.

To gauge the extent to which an intervention will affect the physical water losses, the player is advised to analyse whether the potential intervention would affect:

1. The water lost in the treatment and distribution system. If these increase due to the intervention, the value of this KPI will change.
2. The total amount of water entering the system. If this amount changes but the treatment/distribution system remains the same, the KPI will also be affected.
3. The capacity of the water utility to address the size of its system.

Commercial Water Losses

Apparent water losses refer to water that has reached the consumer, but for various reasons cannot be charged. Examples of these include theft and metering inaccuracies. An additional aspect of Commercial Losses are those were the water utility must use/provide water it cannot charge; for example, the water used for the treatment processes (flushing of systems) or water used in fire hydrants.

To gauge the extent to which an intervention will affect the commercial water losses, the player is advised to analyse whether the potential intervention would affect:

1. The capacity of the utility to find and reduce illegal connections.
2. The capacity of the utility to improve meter accuracy.

Customer Satisfaction

Increasingly water utilities see (and treat) their customers as clients. The customer management department is responsible for ensuring that the interaction between the utility and the customers goes smoothly by, for example, having the capacity to deal with all the complaints that are received by the utility. Usually most complaints derive from either disagreements about the water bills or from service interruptions. It is worth highlighting that customers are quite sensitive to either of these situations and will react accordingly when these are changed.

To gauge the extent to which an intervention will affect the overall customer satisfaction, the player is advised to analyse whether the potential intervention would affect:

1. The expectations of customers regarding their water bills.
2. The degree to which customers are impacted by changing levels of services, i.e. continuity and quality.

3. The capacity of the utility to interact with and deal with customers and to make this interaction easier for the customer.

Service Affordability

Particularly in developing countries, the ability of a household to pay for water services is an important issue. Examples of households spending 20% or more of the income on acquiring water are not unheard of. Different criteria exist for measuring when a water service is considered affordable or not. The World Bank has suggested that the maximum a household should be spending on water is 5% of their income. Thus, the less households spend on water (as a percentage of their income) the higher the affordability of tariffs is for these households.

To gauge the extent to which an intervention will affect the affordability of tariffs, the player is advised to analyse whether the potential intervention would affect:

1. The levels of tariffs.

Collection Efficiency

The collection efficiency refers to the utility's capacity to collect payment from billed customers. This is measured as a ratio of the total amount of the bills collected by the utility divided by the total amount of the bills issued by the utility. If the utility if able to collect all the bills it has issued the efficiency would be 100% (or 1.0), if it manages to collect half the bills issued the efficiency would be 50% (or 0.5), and so on. It is paramount for the utility to ensure that it collects the bills it issues as with a low collection efficiency, the utility becomes financially unviable.

To gauge the extent to which an intervention will affect the collection efficiency, the player is advised to analyse whether the potential intervention would affect:

1. The level of customer satisfaction. Unsatisfied customers are likely to be less willing to pay their water bills than satisfied customers.
2. The capacity of the utility to collect the bills that are issued by tracking bills, following up on payments, etc.
3. The tariff levels and structure. Higher tariffs may lead to a backlash from customers and may reduce their willingness to pay their bills.

Continuity of Water Supply

The continuity of water supply is used to measure the ability of the utility to supply water throughout the day. The indicator also represents the proportion of the time that the system is pressurized. The indicator is calculated by expressing the number of hours water is being supplied at appropriate service levels within the day (usually averaged out per year).

To gauge the extent to which an intervention will affect the continuity of supply, the player is advised to analyse whether the potential intervention would affect:

1. The capacity of the distribution system to maintain adequate pressure, i.e. enough water running through the distribution system throughout the day. If this increases due to the intervention, the value of this KPI will increase indicating improved performance.

Water Quality

Water quality refers to the ability of the utility to supply water that meets drinking water quality standards set forth in the country. Water utility's assess the quality of the water through varying tests (aesthetic and/or microbiological and/or physical-chemical and/or radioactivity). In UMSG, water quality is inferred by proxy based on the conditions of the water supply system.

To gauge the extent to which an intervention will affect the quality of water supplied, the player is advised to analyse whether the potential intervention would affect:

1. the quality of water drawn from the resource
2. the quality of water after treatment
3. the quality of water in the distribution system

If the quality of drinking water in the distribution system increases as a result of the intervention, the value of this KPI will increase indicating improved performance.

Service Coverage

The service coverage is used to measure the ability of the utility to supply water to all residents in the supply area. The indicator represents the percentage of the total resident population that has adequate access to water services provided by the utility. Access may be considered adequate if defined standards, such as maximum numbers of users per public tap or maximum walking distance are complied with. The percentage is calculated by expressing the number of residents that have adequate access as a percentage of the total population covered by existing services.

To gauge the extent to which an intervention will affect the service coverage, the player is advised to analyse how the potential intervention would affect:

1. the number of people to each connection with adequate service
2. the growing population

Utility Efficiency

The Utility Efficiency (UE) ratio, reflects how efficient the staff dynamics and the utility's processes are, providing a boost or a penalty on several of the activities carried out. As such, the UE is composed of various components that impact the efficiency of both staff and processes. It is worth noting that each component has an optimal possible efficiency, after which further investments will not produce any more efficiency gains.

To gauge the extent to which an intervention will affect the UE, the player is advised to analyse how the potential intervention would affect:

1. the balance between staff members and management.
2. the necessary staff members in each job category required to fulfil the various processes.
3. the capacity development investments necessary, and their periodicity, to ensure staff members are adequately prepared for their tasks.

Management Decisions Form		Unit	Initial Value	Turn 1
1 Financial Decisions				
1.1	Subsidy on connection fee	%	40%	
1.2	In-house Tariff	US$/m^3	0.61	
1.3	Water Kiosk Tariff	US$/m^3	1.04	
1.4	Un-metered Connection Tariff	US$/Connection	150.21	
2 Infrastructural Decisions				
2.1	Additional Water Kiosks	No. Of WK	626	
2.2	Additional Distribution Network	km network	1,051	
2.3	Additional Water Treatment Capacity	m^3	34,936,340	
2.4	Additional Water Resources Abstracted	m^3	34,936,340	
2.5	Additional Number of Meters Type A	No. A Meters	0	
	Additional Number of Meters Type B	No. B Meters	0	
	Additional Number of Meters Type C	No. C Meters	16,711	
3 Human Resources Decisions				
3.1	Additional Director	No. Directors	19	
3.2	Additional Manager	No. Managers	65	
3.3	Additional Operational Staff	No. Op Staff	130	
3.4	Additional Bill Collectors	No. Bill. Col	26	
3.5	Additional Costumer Services Staff	No. Cost. Serv.	91	
4 Maintenance Decisions				
4.1	Rehabilitated Network	Km	0	
4.2	Treatment Maintenance	m^3	0	
4.3	Resources Maintenance	m^3	0	
4.4	Additional Meter Calibration Program	No. meters	0	
5 Capacity Development Decisions				
5.1	Additional Leakage Trainees	No. Trainees	0	
5.2	Additional Staff Trainings	No. Trainees	0	
5.3	Additional Office technology	Package	0	
5.4	Standard Operating Procedures	Procedure	0	
5.5	Awareness Campaigns	Procedure	0	
A	Water distribution - In-house / Kiosks	%	88% / 12%	

Turn 2	Turn 3	Turn 4	Turn 5	Turn 6	Turn 7	Turn 8	Turn 9	Turn 10

Notes

Notes

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BEWOP

Supporting the implementation of

SUSTAINABLE DEVELOPMENT GOALS

IMPLEMENTING THE NEW URBAN AGENDA

GWOPA Global Water Operators' Partnerships Alliance

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