Water supply in developing countries: The Game

Bachelor assignment

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List of acronyms and abbreviations

VEI	-	Vitens-Evides International
UNESCO-IHE (UNESCO)	-	United Nations Educational, Scientific and Cultural Organisation
IHE	-	International Institute for Hydraulic and Environmental Engineering
NHL	-	Noorderlijke Hogeschool Leeuwarden
KPI	-	Key Performance Indicator
DF	-	Decision factor
GOM	-	Government of Mozambique
DMF	-	Delegated Management Framework
FIPAG	-	Fundo de Investimento e Património de Abastecimento de Água
CRA	-	Regulaqzo do Abastecimento de Aguas
MOPH	-	Ministry of Public Works and Housing
DNA	-	National Directorate of Water
CMS	-	Construction and management simulations
SMART	-	Simple Multi Attribute Rating Technique
WHO	-	World Health Organization
ESA	-	External Support Agency
AfDB	-	African Development Bank
NDC	-	Netherlands 'Development Cooperation
MTn/MZN	-	Mozambiquan metical (1 euro = 27,59 MTn)
IWA	-	International Water Association
NRW	-	Non revenue water

1. Introduction & background

This bachelor thesis is about the simulation of a water enterprise in a development country as a virtual management game. In this case, the developing country is Mozambique that ended the prolonged civil war in 1992. Mozambique can be seen as a Third World country, but in a relatively stable environment. This stable environment is quite essential because it gives opportunities for huge developments, which can be converted into a game.

Vitens and evides, a Dutch water company, came up with the idea to create a simulation game about water enterprises in developing countries, in which managers (the game players) can learn from certain decisions and can discuss about it with their colleagues (teammates). Thus, the communication between the different kinds of managers would be improved and the consequences of the strategic and tactic decisions (on the short-term as well as on the long term) can be experienced.

The organisation of a water enterprise has to be analysed, to create a model for the game. A water enterprise is very different compared to other companies. It has other objectives than normal profit and non-profit organisations and for managers it is more difficult to get grip on the objectives and to achieve them. The objectives and the way the organisation of a water enterprise tries to achieve these objectives provide principles for a simulation model. First, the theoretical basics of effectiveness in water supply and the organisation of a water enterprise will be described. Then, literature about 'effectiveness' will be discussed and applied in the context of a water enterprise. These theories will be used to analyse the case of Mozambique. Thus, a clear understanding will be given about water enterprises in a developing country like Mozambique. Although it is a simulation game, it is impossible to copy the exact reality. Therefore, the next step will be the transformation from the reality to the simulation game, such as what kinds of choices are made and what lacks the prototype of the game. Eventually conclusions about the game and the process are stated and recommendations are given for further progression on this prototype. The main practical results are stated in the appendixes.

What a water enterprise exactly is will become more clear during this report. For the simulation game some adjustments are made: In reality the water enterprise is the 'operator' (the organization that provides the water to the people), but in this simulation game it has more 'rights', like the asset holder (the agency responsible for among others the pipeline network) and the agency who determines the water tariffs. In reality, these roles are often split up; government determines the tariffs and an organisation between the government and the operator keeps track on the assets (water network, pumps etc.).

1.1. Occupational parties and interests

The Dutch water companies Vitens and Evides, the two largest water companies in The Netherlands, set up this ambitious project in 2007 Both companies joined a group called *Vintens-Evides International* (VEI). VEI gives management support in developing countries and helps with technical and operational business tasks. (Vitens-Evides Annual Report, 2007)
Aside of the initiator VEI, more parties are involved in this project: To create a game based on knowledge, accurate information and experience *UNESCO-IHE* (IHE) joined the project. IHE carries out research, education and capacity building activities in the field of water, environment and infrastructure. IHE is the largest postgraduate water faculty in the world and the only institution in

the UN system authorised to confer accredited MSc degrees and the promotion of PhD's. (UNESCO-IHE Annual Report, 2008)
The knowledge and manpower for the actual design and creation of the game is found at the *Noorderlijke Hogeschool Leeuwarden* (NHL), a university of applied sciences, where students combined their minor courses with this challenging project.
My part in the project is focussed on the model side of the game. To create some structure and clearness, the development of the game is split up in a *model-side* and a *design-side*. The model behind the game is set-up by IHE, where NHL takes care of the design and VEI has a controlling and coordinating role.

With a broad and versatile project group, there are many different interests for the creation of this game. The main purpose of the game is dual:

- The game is supposed to be a learning tool for managers of water utilities in development countries.
- It will be used as a marketing tool to give attention to the water sector as an employer.

These purposes are mainly the interest of VEI, but the interest of the other parties is:

- The creation of a learning tool in which students can play the same simulation game all over the world, considering IHE wants to create a connection between students in different cultures all over the world.
- NHL wants to use the game as a project where students can experience what is needed to set up a real computer game and connect it with several 'minor' courses.

1.2. General structure of the game

It is necessary to give a global impression of the game (as build so far) to make the reading of this report easier and more understandable. The game is played on top-management level of a particular water utility in a development country (in this case Xai-Xai, Mozambique, see appendix 1). Four managers of water enterprises are the players of the game and will constitute a team and compete against (an) other team(s). The four different roles of the players are General manager, Operational manager, Financial manager and Commercial manager. They have to work together to make the right investment decisions and the results can be noticed after each round in the form of a set of 'Key Performance Indicators' (KPI's). The *overall KPI* will eventually give the overall performance of the team. Each round represents a period of one year, the managers have to spend their budget wisely, and after about ten rounds, the team with the highest overall KPI wins. It is important to have a focus on planning, cooperation and doing business with limited resources to win the game.

1.3. Learning objectives

VEI experienced several problems in projects in Mozambique and in other developing countries as well. VEI stated two general learning objectives for the game to cover these problems, assuming that these learning objectives will improve the performance of water enterprises in developing countries. The main objectives are:

1) *Stimulate discussion and negotiation between the different managerial positions in the water utility in order to make decisions.*
   In a typical functional organizational structure employees work for their own (division). This can lead to poor horizontal coordination among departments and decisions may pile on top, which causes a hierarchy overload. (Daft, 2007) Everybody has his own objectives and

interests in this game, but to play the game successfully the managers have to work together.

2) *Allow participants to test the consequences of their decisions as managers in a water utility.* You can spend the money only once in this game. This is not very different in developed countries than in developing countries. The player can test investment and can see what the results are on the short-term and on the long-term. This way, the player learns what is best for the water enterprise and is able to discuss this with its teammates. After a couple of rounds, the result will also be discussed with a teacher and the other teams.

1.4. Research question

The questions that need to be answered are based on a 'design problem'. This design problem is to simulate a water enterprise in a developing country in the form of a virtual simulation game. Three steps need to be taken to solve this design problem:

1. The transition from the design problem to the scientific literature.
2. The transition from literature to reality. (The case of Mozambique)
3. The transition from reality to a virtual simulation game (model).

In the first stage, relevant literature will be used to get a better understanding about a water enterprise in a developing country. Literature about how a water enterprise is organized and how the water system works is necessary to get a good understanding of such an organization. Only a description of a water enterprise is not enough to base a simulation game on. Like in other organizations, objectives need to be achieved to satisfy the different stakeholders (for example customers, financers and government). A water enterprise has other objectives than 'normal' profit organizations. (Daft, 2007).

When the organization and water distribution system of a water enterprise in a developing country is discussed, the second stage will be the transition from the theory to reality. The 'reality' in this case is a water enterprise in Mozambique, a developing country in southeast Africa. This case has been chosen because VEI had a lot of experience here. In the last decade, a lot of progression is acquired, but there is still a lot to accomplish; for example, the coverage is not 100%, which means that not every Mozambiquan citizen has access to water.

Once the organization, the system and the effectiveness of Mozambiquan water enterprises are discussed, the last step will be to transform this case to a virtual simulation game. In the third stage, the simulation game will be discussed; what kind of decisions are made why and what the shortcomings are in the prototype of the game. Prvious to this discussion, the structure of the game will be explained. In the fourth chapter, the important factors in the game and the gameplay will be explained. Finally, conclusions and recommendation will be given about the current state of the game and the future possibilities.

These three transition steps can be expressed in the research question. This main research question is:

- How could a water enterprise in a developing country be simulated into a virtual management game?

Sub-questions:

First, it is important to get a good understanding how a water enterprise is organized and how the system works. Then, there will be a discussion about the objectives and the degree up to which these objectives are achieved in a water enterprise:

- What are the relevant organizational factors in water enterprises and systems in a developing country?
- How is 'effectiveness' defined in a water enterprise in a developing country?

The third sub-question will be the transition to the case of Mozambique:

- How are the organizational factors and the effectiveness in a water enterprise applicable for the water enterprises in Mozambique?

The last transition will be the case of Mozambique into the virtual simulation game.

- What kinds of decisions have to be made to transform a water enterprise in Mozambique into a virtual simulation game?

2. Theoretical framework

The theoretical framework consists of two parts: The first part describes the scientific literature about the water distribution system and the organization of a water enterprise. The second part discusses the literature about objectives in a non-profit organization, especially in water enterprise, and the effectiveness in achieving these objectives. We will start by getting a better understanding of a water enterprise. What are the basics of water supply and what does the organisation look like:

2.1. Water enterprise: The water supply system and the organization

There is not much variation in water enterprises, but a water enterprise differs from 'normal' non-profit organizations. This gives a water enterprise a unique character. Public water supply plays an important role in the general welfare, collective security, public health of the population, but also for economic activities and environmental preservation. Therefore, it is an essential service for the community and is a so-called 'service of general interest'. These kinds of services apply to major economies of scale. Besides those major scale economies, there is also a significant scope for efficiency, where the production costs tend to decrease as similar activities are integrated. This can be accomplished by synergies in the management of human resources, equipment and facilities. (Alegre, et al., 2006)

A distinction can be made between different markets. The most important one is the transaction market between the water company and the final user, which is a natural monopoly. This market form contributes to limitation of competition with regard to the service to customers. This is not only the case when a government regulates the water supply, but a natural monopoly can occur as well whenever the costs of the production average marginal costs decreases and the productive system develops (due to the existence of scale economies). A result is that in water enterprises there is no similar stimulus like in profit-companies to increase efficiency and effectiveness. This is a notable weakness of this sector. (Alegre, et al., 2006) However, this does not mean that there is no stimulus at all to increase efficiency and effectiveness. This stimulus comes from an external factor, like government, customers, and funders (like the African Development Bank (AfDB), VEI and government funds). (Alegre, et al., 2006)

The water supply sector faces major challenges, not only for the developing countries, but also for developed countries. The sector has to keep up with the population growth, ensuring sustainability of current and new services and improving the quality of the services. Maintaining a truly sustainable system in the water supply sector is as difficult and important as making the initial capital investment. The provision of safe water is a service and requires a service-orientated attitude. Water services may normally be set at an affordable level for the customer, managed, and operated in accordance with the principles of good business practice and with the regulations, which are intended to protect the customer and the environment.

The form of management will vary according to the local situation and can be public, private or a partnership between both. In any case, the continuous improvement of the quality of service is an essential target to be achieved. (Alegre, et al., 2006)

In the next paragraphs, the water supply system (the technical system) and organisation (organizational system) will be discussed. First, it starts with the water supply system, as mentioned, this is a system with not much variation: The raw water must be *extracted*, *treated* if necessary,

distributed and the system has to be *financed*. (Hoffer, 1995) Hoffer made this distinction and is followed by the description of the organisation of a water enterprise:

2.1.1. Production and treatment of water

Ground water and surface water are the two main sources for raw water. In some cases, there is an intermediate source, called infiltrated water. This surface water is infiltrated and the soil is being used as 'natural' filtration. Big cities often depend on surface water, because the availability of sufficient sustainable groundwater is limited. Nevertheless, (deep) ground water is usually preferred, because it is filtrated in a natural way over long periods of time. Not all ground water is proper for making drinking water, because it may contain elements that need to be removed, like fluoride, magnesium and iron. When the water is contaminated, it needs full treatment and in developing countries 'disinfection' is the most common way. Even if the source is safe, it needs treatment, because there is also a risk that the water will be contaminated during distribution.

Surface water is the most common source for raw water and can be taken from lakes, rivers and canals. The use of surface water allows for much bigger production units than ground water. The treatment process depends on the quality of the raw water, but disinfection is always necessary, followed by slow sand filtration, rapid sand filtration with or without coagulation, activated coal treatment. This is the customary method, but as mentioned the steps depends on the level of pollution in the raw water. (Hoffer, 1995)

2.1.2. Quality of water

The World Health Organisation (WHO) provides *minimal* standards, presented as guideline values. It represents the level of a certain concentration or amount of a constituent that ensures aesthetically pleasing water and does not result in any significant risk for health of the user. Nevertheless, safe drinking water is a relative concept. (Premazzi, 1989) In a lot of countries national standards are applied, but Premazzi (1989)argued that the selection of a national standard at a level that is somewhat higher than the guideline values do not necessary imply that the water would not be safe enough. The safety (or uncertainty) factors incorporated in the guideline value may be more than enough to accommodate some compromise for the sake of practicality, without having an effect on public health. The removal of magnesia and iron does not solve health problems, but is desirable for discolouring the water. (Premazzi, 1989)

The safety of water is not only determined at the source. It is a matter of money and priority to what extent the standards are met and set. There are also big risks for contamination during the production, storage and distribution, especially in hot climates. Practical examples are leakages, too long held in storage reservoirs and unhygienic materials. (Hoffer, 1995)

2.1.3. Distribution of water

The most common way of distributing water is via a piped water supply system, especially in urban areas. This system provides every a connection to every house, but when this option becomes too expensive, the use of public taps is a good solution. (Other words used for public taps are standpipes or faucets.) Another option is that public or private vendors sell the water (per bottle) to the local customers.

The use of a piped water supply system requires a network of a certain quality. This quality depends on the age of the network, maintenance of the network and the materials used. As mentioned in the

paragraph above poor quality of the network does not only mean wasting of the water but also a decrease in quality when the polluted soil or groundwater contacts the clear water in the pipes. This problem is huge in developing countries and is called 'unaccounted for water' (UfW) (appendix2). UfW is the total amount of produced water minus the total amount of metered consumed water plus the estimated non-metered consumption. Especially this last part is hard to assess, because of illegal connections, bad condition of meters and/or simply not metering at all. This number has to be assessed and results in contrary interest. The water supply managers tend to overestimate consumption to cover up excessive UfW, while policy makers underestimate the consumption to reduce the need for capital investments in the system. (Hoffer, 1995)

2.1.4. Financial system

A regular accounting system is not enough for a water enterprise, besides a regular accounting system the enterprise needs a comprehensive financial-administrative system that includes billing and collection money and meter reading.

The water supply system itself can be financed in many ways. Most of the time the government plays the most important role, but in developing countries, external (international) organisations also provide funds, loans and subsidies. The prize of water is also very important, because it eventually determines the main incomes. Consumption charges can be set up in different ways. When meters are missing, flat rates are commonly used, this is often based on the number of the people living in the house or the number of rooms.

Important to mention are the different perceptions for the pavement of water. Many people consider water a free commodity, where Moslem societies even contend that water is a religious right and Socialists state that this social commodity has to be provided free of charge. In the end the customer is the one where the costs are originated and this needs to be paid either direct or indirect (taxes). Hence, water should be considered as an economic good, because costs are originated by the customer. These tariffs are most of the time a political issue, and politicians use the water tariffs to attract and keep voters. Eventually this results in a poor level of service (by lack of funds) or all kinds of subsidiaries that needs to be paid by the customer anyway. (Hoffer, 1995)

2.1.5. Organisation of a water enterprise

As mentioned in the introduction, a water enterprise is a good example of a functional organization: "In a functional structure activities are grouped together by common function from the bottom to the top of the organisation" (Daft, 2007). Following Daft, this structure works best with one product, which is undoubtedly the case in a water enterprise in a development country. This allows economies of scale within functional departments and enables in-depth knowledge and skill development. It is a good structure when an organization wants to accomplish functional goals and maximize profits.

Another distinctive characteristic of a water enterprise is its non-profit character. Tulsian & Tulsian (2000) distinguish eight different kinds of non-profit organisations, based on the service they provided. A water enterprise is stated as *municipal organisations*, which are formed for providing water, electricity, sanitation and other essential services. Daft (2007) mentionsthat the primary difference is that managers in non-profit organisations direct their offers toward the generation of some kind of social impact, instead of a more financial impact like profit organisations. These unique characteristics and necessities of non-profit organisations create challenges for managers. Daft also mentioned that financial resources typically come from government appropriations, grants and

donations rather than from the sale of products or services to customers. (Daft, 2007) As mentioned in the paragraph above, this is not totally true. A lot of income comes from the customer, but especially in developing countries a lot of income comes from government and external (international) organisations as well. Daft continues that non-profit managers committed to customers with limited funds, must keep the organisational costs as low as possible and demonstrate a highly efficient use of resources. Non-profit organisations do not have a conventional bottom-line like profit organizations, which creates another problem:

"Managers often struggle with the question of what constitutes organizational effectiveness."

It is much more difficult to measure intangible goals (like 'improve service level') than to just measure just the 'tangible' financials. (Daft, 2007) Without a clear direction, it could result in slow response time to environmental changes, less innovation and involves a restricted view of the organizational goals. This results in the next chapter we will discuss extensively the 'effectiveness' in a water enterprise.

Managers of non-profit organizations also deal with many diverse stakeholders and must market their services to attract not only customers, but also volunteers and donors. This sometimes create conflicts and power struggles among organizations. (Daft, 2007) Following Alegre et al. (2006) the important stakeholders in water supply are (see figure on the right):

- *The water enterprises*; can be public, private or combines organisations who manage the water supply system.
- *Customer*; direct user.
- *Indirect stakeholders*; not a direct connection to the system, but may be affected by it or its impact on the surrounding environment.
- *Pro-active stakeholders*; for example environment organisations, consumer protection agencies and other pressure groups
- *Policy-making bodies*; can be on local, regional and national level
- *Regulatory agencies*; responsible for economical and quality of service regulation and for setting up and verifying compliance with statutory and other obligations.
- *Financing agencies*; very important in such a capital-intensive sector as the water industry
- *Others*; international agencies (from humanitarian associations to political organisations and multi-national companies)

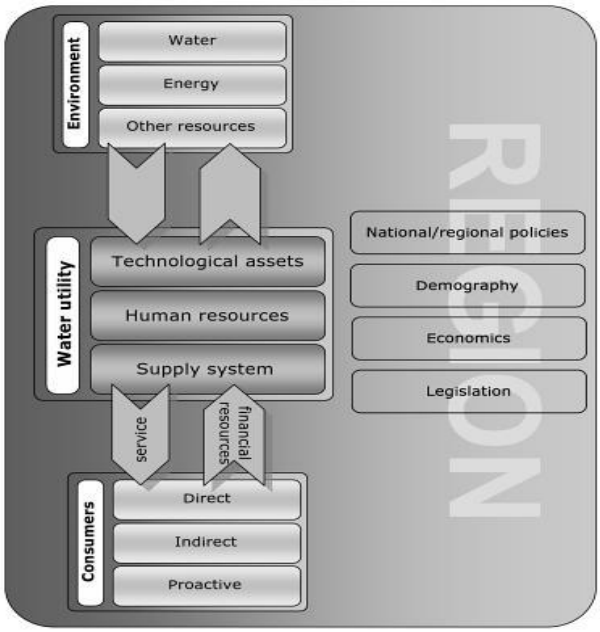


Figure 1. Water undertaking context.

Figure 1: Water undertaking context (Alegre et al. 2006)

2.2. Effectiveness within a water enterprise

Effectiveness can be described in various ways. Daft's (2007) definition is: "the degree up to which contemplated objectives are achieved". Two factors in the definition of 'effectiveness' are mentioned clearly, 'the objectives' and 'the achievement' (of these objectives). This will be discussed in the next subchapters.

2.2.1. Objectives

Irrespective of the nature (public, private of combined) or geographical extent, it may be presumed that all water supply enterprises share a common purpose and management objectives, which may be stated as: *"The achievement of the biggest level of customer satisfaction and service quality in line with the prevailing regulatory framework, whilst making best use of available resources."* (Faria & Alegre, 1996)

By taking into consideration the relationship between stakeholder, resources and values, Alegre et al. (2006) identified five types of management objectives:

- Provide an appropriate level of service to customers
- Obtain the highest possible productivity from human resources
- Protect and ensure sustainable use of water and other natural resources
- Achieve the most efficient use of financial resources
- Plan, construct, maintain and operate the enterprise's physical assets as efficiently and effectively as possible (Alegre, et al., 2006)

The day-to-day business at a water enterprise in developing countries is to get closer to these objectives. A large share of the population does not have *clean* drinking water, does not have a *connection* and does not have the *financial* resources to buy the water. Managers focus on the increase of coverage (more people can get water), quality and affordability (reduces costs; decrease UfW, cross-subsidiaries etc.). The day-to-day focus on these objectives and the pressure from international organisations and government on these topics make it a useful and clear objective for a water enterprise and is useful as well in a simulation game. It fits in well with the first learning goal of the game, described in the first chapter: What are the consequences of the decisions based on this objectives by the management team?

Management objectives of a water enterprise:

1. *Provide an appropriate level of service to customers*: Briefly, this is actually the organizational objective, but what needs to be added is an appropriate level of service for new costumers, thus expand your network and an increase of coverage. This is an important objective in the enterprise and the game because it serves the main objective and gives attention to the customer. Everything can be done well within the enterprise (the team), but eventually the customers have to profit from it.
2. *Obtain the highest possible productivity from human resources*: Because the objective of a water enterprise is not the same as a profit organisation, objectives are not always clear to everybody. It is important to share common goals, especially in a functional organisation where, following Daft (2007) it could otherwise result in slow response time to environmental changes, less innovation and involves a restricted view of the organizational goals.

3. *Protect and ensure sustainable use of water and other natural resource:* Although the raw water is often free, it is important to protect and ensure it to guarantee the safety (quality of water) and the availability of water. A lot of surface water (for example lakes) is shared with other countries and they have to keep an eye on pollution.
4. *Achieve the most efficient use of financial resources*: Although profit is not the focus in water enterprise, the way of using your money is very important. This is especially the case in developing countries where large shares of the financial resources are loans from the government and external (international) organisations.
5. *Plan, construct, maintain, and operate the enterprise's physical assets as efficiently and effectively as possible:* In combination with the previous point, this is one of the main starting points of the game. Planning and maintaining are aspects that can be further developed in developing countries. With minimal financial resources, it could be attractive to invest and obtain short-term goals, but this could result in poor condition of the assets (like network, pumps and meters).

2.2.2. Effectiveness in a water enterprise

Effectiveness is more difficult to define in non-profit organisations than for profit organisations. It is useful to explain the different dimensions of 'effectiveness' and how this relates to a water enterprise. Quinn and Rohrbaugh (1981) set up the 'competing values framework' to analyse organizational effectiveness and discover two major dimensions underlying conceptions of effectiveness. The horizontal dimension is the *organizational focus*: There can be an emphasis on the well-being and development of people or a more external focus on the well-being of the development of the organization itself. The vertical dimension is focused on the *organizational preferences for structure*: This could be the emphasis on stability and control or flexibility and change. The dimensions seem to be in conflict with each other, it creates a paradox where an organization needs to be 'externally focused and flexible' and 'internally focuses and controlled' at the same time. This results in four quadrants with their own means and ends (figured on the left):

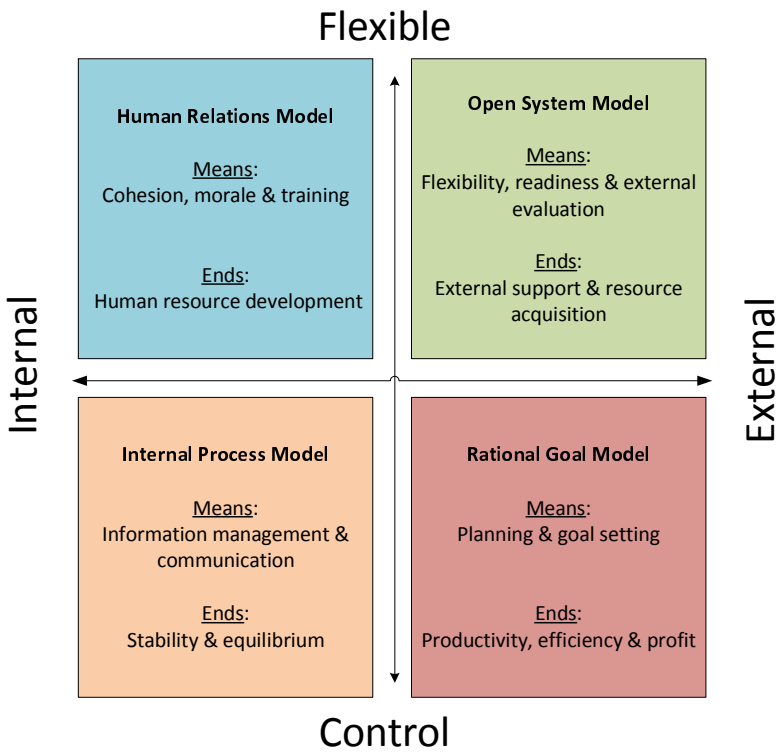


Figure 2: Competing values framework (Quinn & Rohrbaugh, 1981)

- *Human relations quadrant*: "Incorporates the value of an internal focus and a flexible structure. Hence, management concern is for the development of human resources. Employees are given opportunities for autonomy and development. Management works toward the sub goals of cohesion, morale, and training

opportunities. Organizations adopting this emphasis are more concerned with employees than with the environment." (Quinn & Rohrbaugh, 1981)

- *Open system quadrant*: "Is a combination of external focus and flexible structure. Management's primary goals are growth and resource acquisition. The organization accomplishes these goals through the sub goals of flexibility, readiness, and a positive external evaluation. The dominant value is establishing a good relationship with the environment to acquire resources and grow. This emphasis is similar in some ways to the resource-based approach." (Quinn & Rohrbaugh, 1981)
- *Internal process quadrant*: "It reflects the values of internal focus and structural control. The primary outcome is a stable organizational setting that maintains itself in an orderly way. Organizations that are well established in the environment and simply want to maintain their current position would reflect this emphasis. Sub goals include mechanisms for efficient communication, information management and decision-making. Although this part of the competing values model is similar in some ways to the internal process approach, it is less concerned with human resources than with other internal processes that leads to efficiency." (Quinn & Rohrbaugh, 1981)
- *Rational goal quadrant*: "Represents management values of structural control and external focus. The primary goals are productivity, efficiency, and profit. The organization wants to achieve output goals in a controlled way. Sub goals that facilitate these outcomes are internally planning and goal setting, which are rational management tools. The rational goal emphasis is similar to the goal approach." (Quinn & Rohrbaugh, 1981)

Hoffer (1995) transformed these four quadrants into an *Integrated Model of Effectiveness* and split up the four quadrants into concrete variables that are applicable for water enterprises. The 'transformation' of the model of Quinn and Rohrbaugh represented below. (The colours of Hoffers' model (below) correspond to the colours of the model of Quinn and Rohrbaugh on the previous page)

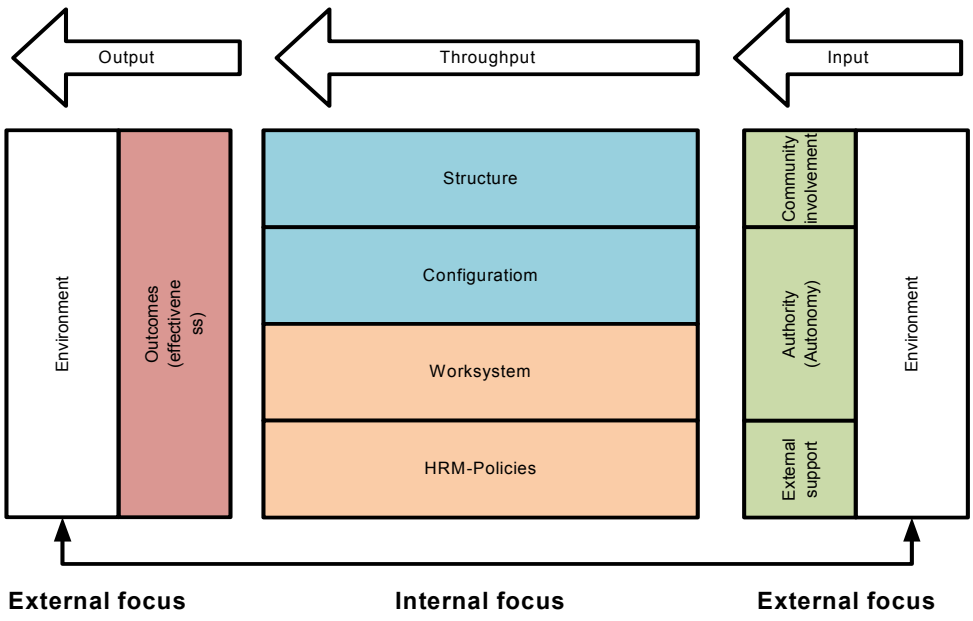


Figure 3: Integrated model of effectiveness (Hoffer, 1995)

Hoffer defined two variables for the *Open system quadrant* (*green coloured*):

- *Authority/Autonomy*: The ability for acquisition of resources. (Important resources are: Raw water, human resources and financial resources.)
    - *Legal authority*: The ability for acquisition of resources.
    - *Sustainability*: The ability to maintain an adequate level of net benefits (World Bank, 1990)
- *External support*: The ability to obtain external support to pursue its policies. This is intertwined with the acquisition of resources and will eventually determine the ability to acquire the necessary resources. This can be divided into:
    - *Inter-organisational network*: A social structure that connects a collective (group, community, agency, organization, etc.).
    - *Community involvement*: The degree of local community participation in companies activities.
    - *Expectations consistency*: When the external authority is divided among actors, the expectations towards and the demand on the organisation will be many, often not consistent and sometimes even contradictory.

The ends for effectiveness in an 'open model system' are an acquisition of resources and external support. The variables autonomy and external support are used to analyse effectiveness for this emphasis. When there is a high level of autonomy a company does not have to depend on external support or the other way around. When there is a low level of autonomy, a company depends much more on external support. (Hoffer, 1995)

The vertical dimension of the diagram of Quinn and Rohrbaugh (1981) is divided into the 'internal process quadrant' and the' Human recourses emphasis'. Hoffer (1995) split up both quadrants in the following variables. For the *Internal process quadrant* (*blue coloured*):

- *Structure*: The way labour is divided within an organisation and coordination is achieved. (Keuning & Eppink, 1979)
    - *Organisational chart*: The way in which in an organisation the labour is divided and coordination is achieved (Jägers & Jansen, 1991)
    - *Formalization*: The written fixation of arrangements concerning the form and the means for communication between organisation members (Kieser & Kubicek, 1992)
- *Configuration*: Division of labour about components and coordination between these components by means of the decision-making system.
    - *Division of labour:* How direct supervision in an organisation is executed. (Mintzberg, 1979)
    - *Decision making system:* Control over actions, more than over decisions. (Mintzberg, 1979)

The criteria for effectiveness of the 'internal process quadrant' are stability and control. The formal organisational structure represents how an organisation tries to achieve stability and control, where the division of labour tells something about the content of the structure. The decision-making system and the formalization stress how this formal structure works in practice and communication. (Hoffer, 1995)

The Human resources emphasis (*orange coloured*) is defined by the following two variables:

- *Work system*: The technical system of an organization as the instruments used in the operating core to transform inputs intro outputs. (Mintzberg, 1979)
- *HRM-policies*: A set of policies, which contribute significantly to the development of a workforce, that is skilled, flexible and motivated. (MacDuffie, 1989)

The end for effectiveness in a human resource model is the value of the human resources. The variables account for the policies that are pursued to affect commitment and motivation of the workforce. The work system has to match the human resource policies and the other way around. (Hoffer, 1995)

The rational goal emphasis (*red coloured*) is measured by its outcomes, which is also the key characteristic of this model. By using Hoffer's variables in the 'integrated model of effectiveness' a picture will be created of the effectiveness in a water enterprise in Mozambique.

3. The case of Mozambique – From theory to reality

3.1. The Mozambiquan water system and the organization

In the next sections, the water distribution system and organization of a water enterprise in Xai-Xai (Mozambique, see appendix 1) will be explained. In the fourth chapter, the effectiveness in such a water enterprise will be discussed based on the Integrated model of effectiveness of Hoffer (1995).

3.1.1. Production & treatment

In Mozambique most of the raw water is surface water (97 cubic km/year) and much less ground water (17 cubic km/year). There is an overlap of 15 cubic meters per year. Overlap is the volume of water resources common to both surface and groundwater. Two types of exchanges create overlap: contribution of aquifers to surface flow, and recharge of aquifers by surface run-off. (earthtrends.wri.org, 2006) An aquifer is an underground bed or layer of permeable rock, sediment, or soil that yields water. This leads to the following problems in Mozambique:

- 52% of the Mozambique territory is located in international river basins, and Mozambique represents only 20% of the total area of these basins.
- More than 50% of the surface water of the country flows in at the border.
- Almost 50% of the surface water resources are concentrated in the Zambezi (international) river basin.

These problems are more on government level and are not involved in the game, but for the water enterprise it is rather important that the government gives priority to these problems and reaches agreements with the 'ripian countries' on water sharing and integrated water resources management. (Tauacale, 2002)

3.1.2. Quality of water

Despite huge increases in the Key Performance Indicator 'compliance with WHO standard' (94% now, in Mozambique) there are also huge losses in water (Unaccounted for Water, UfW, see appendix 2), which could mean that, except for the commercial losses, there are a lot of leakages and illegal interceptions. This implies that the quality of the water is measured at the source and not at the end user, because the leakages are a major threat to the quality of water. The water may be exposed to contaminated soil and other external threats. In a warm climate together with low general hygienic standards, this KPI implies that drinking water is not without risk. With help from government and international organisations, the materials are of a higher quality and the losses are reduced. The increase of quality of the source water in combination with the increase of material quality and the decrease of losses make drinking water safer. Nevertheless, it is one of the most important factors to increase public health and to serve the objectives of the water enterprise as well. Premazzi (1989) mentioned: "The microbiological quality of water is of the greatest importance, and must never be compromised."

3.1.3. Distribution of water

UfW is one of the most serious problems in Mozambique considering this sector. Despite serious decreases for this KPI, a lot of water continues to be spilled and not metered. As mentioned before, the past few years the government and international organisations invested in the network and management skills, which resulted to a decrease in UfW. On the other hand, the illegal tapping of water is still a big problem. People sell the tapped water to others, but also dig their own public taps. Special teams are formed to search for illegal connections and vendors to solve this problem. These

illegal drawers are given the opportunity to turn their illegal connection into a legal connection, otherwise the connection will be removed. The 'coverage' will increase by adding connections and public taps. Coverage is the main indicator that describe the number of people served in a certain area. This indicator increased during the last years in Mozambique as well, but it should be pointed out that mainly the amount of public taps is increased. One public tap serves about 500 people, but the 'service level' is much lower; for example queues, distance to walk, a limited amount etc. At the same time the 'continuity of water' is often far from 24 hours a day, and this could result in social problems. This 'continuity of water' is an underestimated problem, for the people have to focus on the moments when the water is available. A woman in Mozambique says: "I rather pay more for water than having to wait for it all day. I could be earning money instead of waiting the whole time."

Coverage is namely much easier to increase by installing public taps than by expanding the water network. Another disadvantage for the water enterprise is that water of a public tap is cheaper than of a network connection, because people get a discount on it. The customer with a network connection pays indirectly for the discount on the public tap water.

	Start 2005	2007	2008	Plan 2009
UfW:	60%	60%	50%	30%
Collection efficiency	70%	90%	90%	95%
Coverage:	25%	34%	68%	95%
No. Of customers	35.700	56.800	79.100	112.500
Continuity (h/day)	8	11	17	24

3.1.4. Financial system

In Mozambique, the collection of water bills happen very innovative; customers can pay their bills at agents, butthis is also possible by mobile phone, at a bank or at an ATM. This way, the enterprise try to increase their collection efficiency. The water tariff is a big political issue in Mozambique. The government determines the water prices. Water enterprises can only propose a water tariff. In this proposal, a couple of different tariffs are mentioned and substantiated with arguments. The water tariffs have to be increased every year by almost twenty percent to cover the costs and investments in the network, but the last year it did not increase, due to upcoming elections.

3.2. Effectiveness of a Mozambiquan water enterprise

The objectives described in the theoretical framework (chapter 2.2) are quite similar to the objectives of a water enterprise in Mozambique. The actual objectives of the water enterprise in Xai-Xai (Mozambique) are described in appendix 3. In the next subchapters, the variables of the model of Hoffer will be applied on the situation in Mozambique and linked back to the model of Quinn & Rorhbaugh in the end of the chapter.

3.2.1. Autonomy – Open systems quadrant

Legal authority

Autonomy of an organization refers to three different areas:

- Administrative independence
- Asset ownership
- Financial independence

Administrative independence
Administrative independence means that nobody may interfere with the business of an organization. It enables the company to manage itself, rather than be managed by others. The work field in the water sector is different from other sectors. The water enterprises, also called operators, are part of a Delegated Management Framework (DMF). The DMF is a coordinated series of bodies and legal mechanisms in which the participation of private entities are structured in the management of the public water supply service. There are five functional areas in the DMF:

1. Leadership, planning, promotion and regulations
2. The regulatory area and guarantees for the interests of consumers
3. Liaison with the local authorities
4. Implementation, management, execution and control
5. Participation, consultation and extension of the DMF

The following bodies and entities are part of the DMF and related to the five functional areas:

The Minister of Public Works and Housing (1)	FIPAG (4a)
The Minister of Planning and Finance (1)	CRA (2)
The Minister of State Administration (3)	Local authorities (3 & 5)
The National Water Board (1)	Operators (4b)
The Delegated Management Coordinating Forum (5)	

As the word framework implies, the different institutes form a unity. The operators are responsible for the management and operation of the water supply service. Important issues for the operations of the companies are the *tariffs* and the *investments*, which lies in the hands of other institutes within the framework. Full administrative autonomy for the water enterprises will not be realized within the coming years, because of significant influence of decisions made by other institutes within the Delegated Management Framework. (Van der Horn & Donker, 2006)

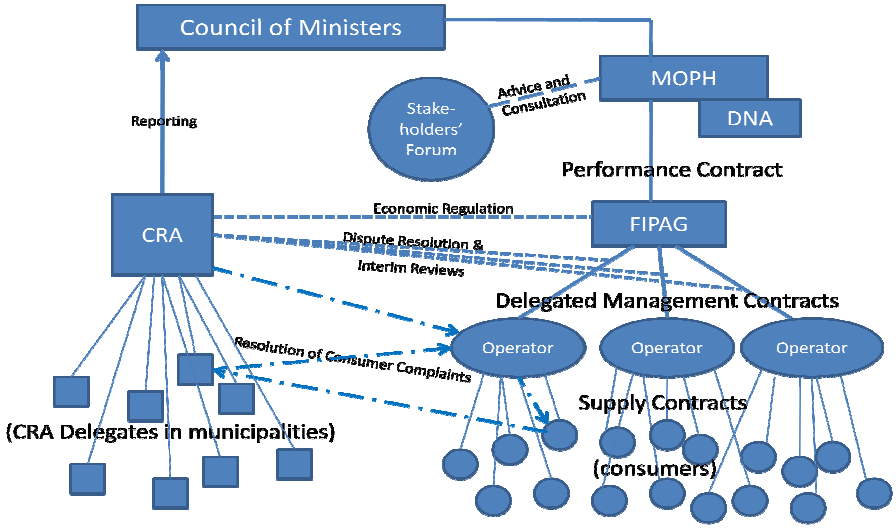
Asset ownership
Assets can be defined as goods that can be used to create economic value. The operator owns part of the goods that the water companies use to create economic value. The other part is owned by FIPAG (Water Supply Asset Holding and Investment Fund). *Operator assets*, assets owned by the operators are:

- Assets used for operation of the water supply system (e.g. cars, motorcycles, tractors, filter sand, pumps, radio/communication system, equipment GPS and GIS, office equipment)
- House connections (water meters, pipes)
- Secondary network

FIPAG assets
Assets owned by FIPAG comprise the required infrastructure for the operation of the water supply system:

Pumping stations/ boreholes	Softening plants
Water treatment plants	Water towers and treated-water boosters
Treated-water reservoirs	Production property
Raw-water pipes	Office buildings and property

Asset ownership of the water enterprises is divided between FIPAG and the operators. Until 2011, this is not expected to change. Full autonomy in asset ownership will therefore not be realized. As assets are used to create economic value, the operators need to make sure that they have the required assets at their disposal at the right time. (Van der Horn & Donker, 2006)



Sustainability

Financial independence can be defined as the ability to cover operational costs independently with the revenues. No external funding is required for the organization to do its daily business.

The main issue is that the revenues need to cover the operational costs. The water enterprises need yearly tariff increases (19.1%), even though it is still challenging to realize the calculated revenues. It is too ambitious to strive for fully autonomous water supply systems. Furthermore, part of the assets are owned by FIPAG, so full asset ownership will not be achieved. The operators could be financially fully independent in its responsible area. This depends on the possibility to make agreements about water tariff increases. The importance of striving for autonomy is that the operators need to guarantee the sustainability of the water supply service and prevent the domination of sub-optimal political decisions. (Van der Horn & Donker, 2006) The main external support agencies for water enterprises in Mozambique, like in Xai-Xai, are:

- African Development Bank (AfDB)
- Vitens-Evides International (VEI)
- Netherlands 'Development Cooperation (NDC)
- Small investment programs, like 'Water for Life' and 'Aqua for all'. (Van Haren, 2008)

3.2.2. External support – Open systems quadrant

Inter-organisational context

After the prolonged civil war in 1992, the water supply network was severely deteriorated and aside of a few investments, the first reform was made in 1998. The Government of Mozambique (GOM) adopted a comprehensive institutional reform for the development, delivering and regulation of urban water supply services in large cities. The new framework, known as the Delegated Management Framework (DMF), was inaugurated with the creation of two autonomous public bodies: An asset management agency (FIPAG) with the authority to contract operators and an independent regulator (CRA). The National Directorate of Water (DNA) in the Ministry of Public Works and Housing (MOPH) continues to exercise policy oversight for the services. (Triche, 2009)

In this reform, the role of the Government of Mozambique reduces to policy-making, legislation and regulation in order to overcome the overly centralized organization of the sector and foster accountability, responsibility, initiative and efficiency. (Van der Horn & Donker, 2006)

After the reform initiated by the government of Mozambique, three different stages in the management of the water systems can be identified:

1. Transitory management of the systems by FIPAG (with technical assistance).
2. Management of the systems by participation of private sector (Private Sector Participation).
3. Management of the systems by the local authorities.

These three stages are expected to be consecutive. At the moment, the systems are managed by FIPAG, while technical assistance is given by Vitens and can be categorized in the beginning of the second stage (where participation lies within the private sector). The timing of the next stages depend on the sustainability of the systems and if the municipalities are prepared to receive the resources needed to pursue their attributes. (Van der Horn & Donker, 2006)

Community involvement

There is not a lot of useful information concerning this subject. Neither in strategic business plans nor the narrative reports, any information is available on this subject. The most salient aspect is the awareness campaign, in which the water enterprise want to make the people aware of the waste of water. Together with important people from all kinds of sectors in the society (religions, communities, villages etc.), the water enterprise set up plans and makes the leaders aware of the waste of water and the consequences. The lack of attention in the different kinds of reports shows the low degree of community involvement.

Expectations consistency

Strategic plans are made by the management of the water utilities and reviewed by the directors of the mother company, the project sponsors and managers of FIPAG and VEI to avoid expectations inconsistency among different management levels. (Van der Horn & Donker, 2006) Performance indicators monitor the outcomes. These KPI's are the same for every water utility, which results in a benchmark tool. These indicators are mentioned in appendix 6. The consultation, control and advantage in combination with the monitoring during the year(s) make(s) it very unlikely to have large inconsistency among the expectations.

3.2.3. Structure – Internal process quadrant

Organisational chart

As mentioned in the introduction the organizational structure is typically functional in water enterprises. Similar organisational structures appear in Mozambique. At the moment, regional managers doubt the spam of control and the set-up of the structure. They choose to combine four smaller cities (like Xai-Xai) to save overhead costs and consistent expectations. This results in the following organisational charge (see figure on the next page). As can been seen it is a typical functional structure, with the departments Production (produção), Distribution (distribuição), Commercial (vendas) and Financial (DAF), and on top a board (direcção) with members of the different water utilities. Here the operators work independently, but under the control of a regional board with a large share of the asset holder FIPAG. In the implementation of the Private Sector

Participation it is important that the stakeholders supervise the strategic policy of the management and the business activities and these stakeholders should advise the management. This executive board consists of representative of FIPAG, representatives of the local authorities and the director of the water supply systems.

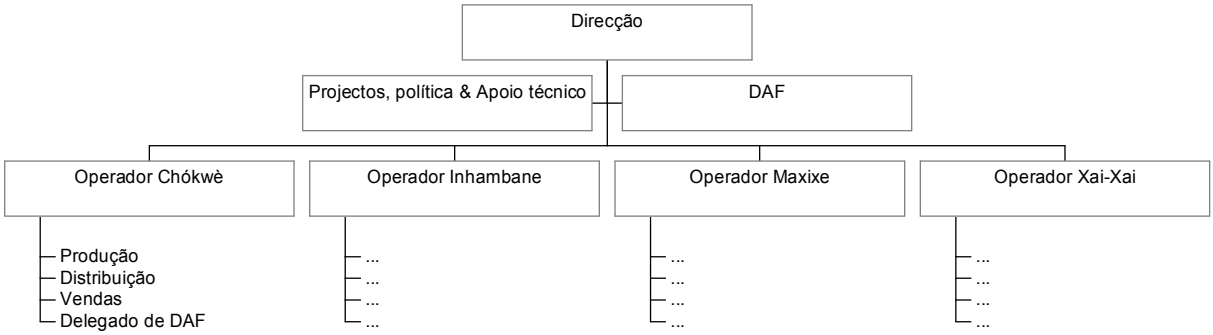


Figure 5: Organisational chart water enterprises southern region of Mozambique

FIPAG and the local authorities participate in the executive board to provide an official structure to execute their competencies. The transfer of the competencies should be accompanied by a definition of the role in the executive board of FIPAG, the operator and the local authorities over time. This contributes to the successful transition to the third phase, management by the local authorities. (Van der Horn & Donker, 2006)

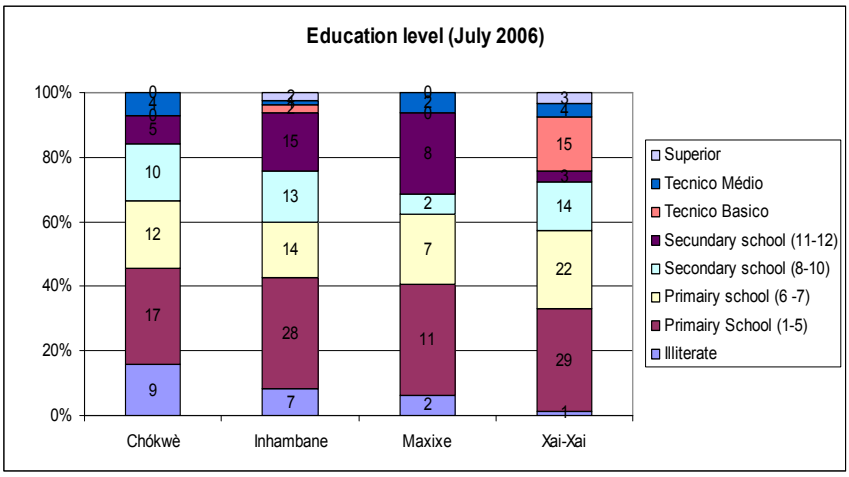
Formalization

There is a high degree of formalization within the water enterprises. A reason can be found in the inter-organisational context and the low degree of autonomy. Therefore, the operators have to keep track of a lot of data, which eventually result in the outcomes (KPI's, reports and financial documents).

3.2.4. Configuration – Internal process quadrant

Division of labour

The division of labour in a water enterprise in Xai-Xai is configured in the right table and the division of labour concerning the level of education is stated in the figure on the left:



Board	**6**
Workers administrative area	
Administration	14
Accounting	0
Commercial	21
HRM	1
	36
Workers technical area	
Production	25
Distribution	24
Projects / investments	0
	49
Total No. of employees	**91**

Those figures illustrate the division of labour. More than 50% of the workers are working in the

'operating core', which is a similar percentage of the people who have had only a primary school education. This situation results in a centralized decision making system (see next paragraph) and the need for clear and dominating procedures, so called Standard Operating Procedures (SOP's). Clear SOP's will save a lot of time and potential mistakes and eventually safe money.

Decision making system

In the strategic business plan of the water utilities in the southern region of Mozambique, decision factors have been developed to construct a well thought-out decision about the possible (de)centralisation of certain business activities.

One of the most decisive factors is whether the activity is *location bound,* for example water production, distribution and sales. Moreover, the operators consider the participation of local entities and clients as important in its activities. Therefore, activities that are bound to a physical location will continue to be executed decentralised. For activities that are not bound to a physical location, it can be considered to organize it centrally. (Van der Horn & Donker, 2006) An overview of advantages and disadvantages of (de)centralization are given in appendix 4 and the aspects that can be centralized. The following processes need to be executed in the operating area of the water supply systems (locally): Production process, distribution process and sales process. It appeared that the following processes have the potential to be organized on inter-company level (centrally): General process, project development process and general/ technical support process (Van der Horn & Donker, 2006)

The decision-making system is highly centralized. Not only on operator level the decisions are made centrally, but also on inter-organisational level. The operators manage the daily business (production, distribution and sales) while the level above (FIPAG and CRA) manage the more strategic level (general processes, investments etc.)

3.2.5. HRM-policies – Human relations quadrant

The human resource policies made a huge progression the last years and are now a key factor in the daily business of the water companies. The company and the clients profit when employees are motivated to apply their skills and knowledge in their daily activities. However, the operators should have motivated, professional employees at their disposal to ensure a satisfying water supply service.

A well-organized human resource department is important to motivate the human resources. At the moment, a human resource management plan is developed. This plan comprises the following elements:

Salary policy	Career ladder
Job descriptions	Pension plan
Evaluation instrument	Internal procedures
Employee development plan	Collective agreement

(Van der Horn & Donker, 2006)

Motivation

With the current limited size of the water supply systems, it has become a challenge to use human resource instruments to motivate the employees. Beside the human resource department, the management should alsoactively work on the motivation of the employees. (Van der Horn & Donker, 2006)

Professionalism
The current professionalism within the organizations is too low. The average education level should be improved to stimulate professionalism and practical skills. The education level represented within the water companies is represented in §3.2.5. It appears that less than 25% of the employees is higher educated than secondary school. At the moment, FIPAG and Vitens pay the salaries of four of the five educated managers on superior level or higher. The water companies themselves plan to bear these costs in the future.

The actual education level indicates a serious limitation on attaining professionalism in the execution of the required business activities. There are two solutions for this issue: First, to train the current staff and second, to attract higher educated staff. An individual employee development program is implemented in 2008, which is part of the human resource management plan. At the moment, yearly 15 percent of the employees receive knowledge and/or skill training. The technical assistance given to the operators by FIPAG and Vitens should improve the knowledge and skills of the staff of the operators. (Van der Horn & Donker, 2006)

3.2.6. Work system – Human relations quadrant

There is not a lot of information about the work systems within a water enterprise. The functional setting allows only teamwork within the functional department, but mainly employees work on their own. As mentioned above, the work system of a water utility in Mozambique is during an early stage, but the strong focus on the development of the human resources makes people more aware, more motivated and professional, which may eventually result in a more 'advantaged' HR work system. Now it is mainly based on standardization and control.

3.2.7. Outcomes – Rational goal quadrant

The outcomes are very important in a highly centralized organisation with a strong focus on standardization and control. All the performance indicators are mentioned that need to be sent to the asset holder (FIPAG) in appendix 6. In total, this means 113 (!) performance indicators in six different categories. (Technical indicators, Trade indicators, Reliability and quality service indicators, Rehabilitation and extension of service indicators, water quality indicators and Human resources indicators). The most important indicators for a water utility in a developing country are: Water losses, coverage, continuity, water quality and collection efficiency and operational cash flow. Detailed information about the performance indicators and which indicators are used in the management game are stated in chapter 4 and 5.

	Xai Xai	
KPI	**Dec. 2004**	**Dec. 2008**
Coverage	<30	68
Population served	35.700	79.200
Water Quality	Bact. unsafe	Bact. safe
Hours water supply	´4-10	16-24
Unaccounted for Water	>60	50
Water Metering Rate	<25	80
Collections Rate	<75	95
Operational cash flow	<0	30.000

What stands out is the number of HRM performance indicators with respect to the total number of performance indicators. Despite the fast growing attention to the development of the human resources, there are only two indicators in the category. These indicators only measure the number of employees, and do not say anything about the training, development or any kind of progression at all. Positive developments are abundant as can be noticed in the table above: Huge increases in

coverage, continuity, collection and metering and operational cash flow and a decrease of the UfW. Still there is a lot to gain and this makes a water enterprise like Xai-Xai attractive to use as a sample case.

3.2.8. Conclusion

The water enterprise in Xai-Xai is not autonomous. The Delegated Management Framework restricts its authority. The water enterprise is not able to maintain an adequate level of net benefits and depends highly on financial and management support of external support agencies. Lack of funds and undereducated employees are the main reasons for failure and so the autonomy directly affects the outcomes. The management of external funds is very important, because a lack of financial resources put extra pressure on a deliberate distribution of the resources. This happens not only at the top level of the DMF, but also on the water enterprise level. The various ways of control and dialogue do not result in inconsistent expectations, which have a positive effect on the effectiveness. The community involvement is low. People are busy with facilitating their own family and well-being. The leaders of different communities are involved, especially in 'water saving' processes.

Structure and configuration were determined by centralization. Centralization tendencies were enforced by external authorities and agencies to keep control on the financial resources and the developments. The degree of standardization and supervision is becoming higher, more standard operational procedures (sop's) are developed to effectively use the abilities of the low educated employees. There has been a strong focus on HRM the last years, which results in trainings and HR policies. It is difficult to get high and well-educated personnel and good trainings and HR policies will positively affect the outcomes.

The lack of autonomy is an important negative effect on the effectiveness of the water enterprise, but the final goal of the DMF is the realization of an autonomous water enterprise. In combination with financial and management support this had already resulted in huge progressions. As mentioned earlier, there is still a lot to gain, important aspects what is done and needs to be continued to be an effective water enterprise, are:

- Customer (service) focused mission and goals.
- Deliberate choice of the distribution and planning of the limited financial resources.
- Development of HR policies and training (HRM)
- Consultation between different functional departments
- Strong focus on outcomes (control)

The findings in this chapter can be applied in the model of Quinn and Rohrbaugh (1983) as mentioned on the next page. There is a strong rational goal emphasis, which represents management values of structural control and external focus. The primary goals are productivity, efficiency and profit. Despite 'profit' this model matches to the utmost extent with the profile described in this chapter. Because of this, profit can be replaced with costs.
The HR policies are approaching, but still on a basic level. This human relations emphasis is on a minimum level to make sure that the low educated employees have sufficient knowledge (by trainings) and understand the purpose of the enterprise. The human relations emphasizes on the development of human resources, where employees are given opportunities for autonomy and development. The organisation is more concerned with employees than with the environment. This is in particular not the case in water enterprises in developing countries.

The emphasis on the internal process model is stronger. The model primary outcome is a stable organisational setting that maintains itself in an orderly way. This can be observed by the creation of SOP's, better communication systems and information systems. Despite the external focus there are internal process emphasis present, but (still) on a basic level.
The emphasis of the Open system model is very limited. This model focuses on growth and resource acquisition, by flexibility, readiness and a positive external evaluation. Although growth and readiness for unexpected events are important in this context, the emphasis is not in this direction. The growth is realized by stability and control and the readiness for unexpected events is of low.

The benefits of this structure (rational goal model) are that it is cheap (low costs), focuses on the productivity and efficiency and can be handled by low-educated employees. With support of a basis level of HRM and a supporting internal system (SOP's, communication and information), it is possible to work with low-educated employees to realize the primary goals. The external factors have a strong influence on the 'productivity and efficiency and costs' emphasis.

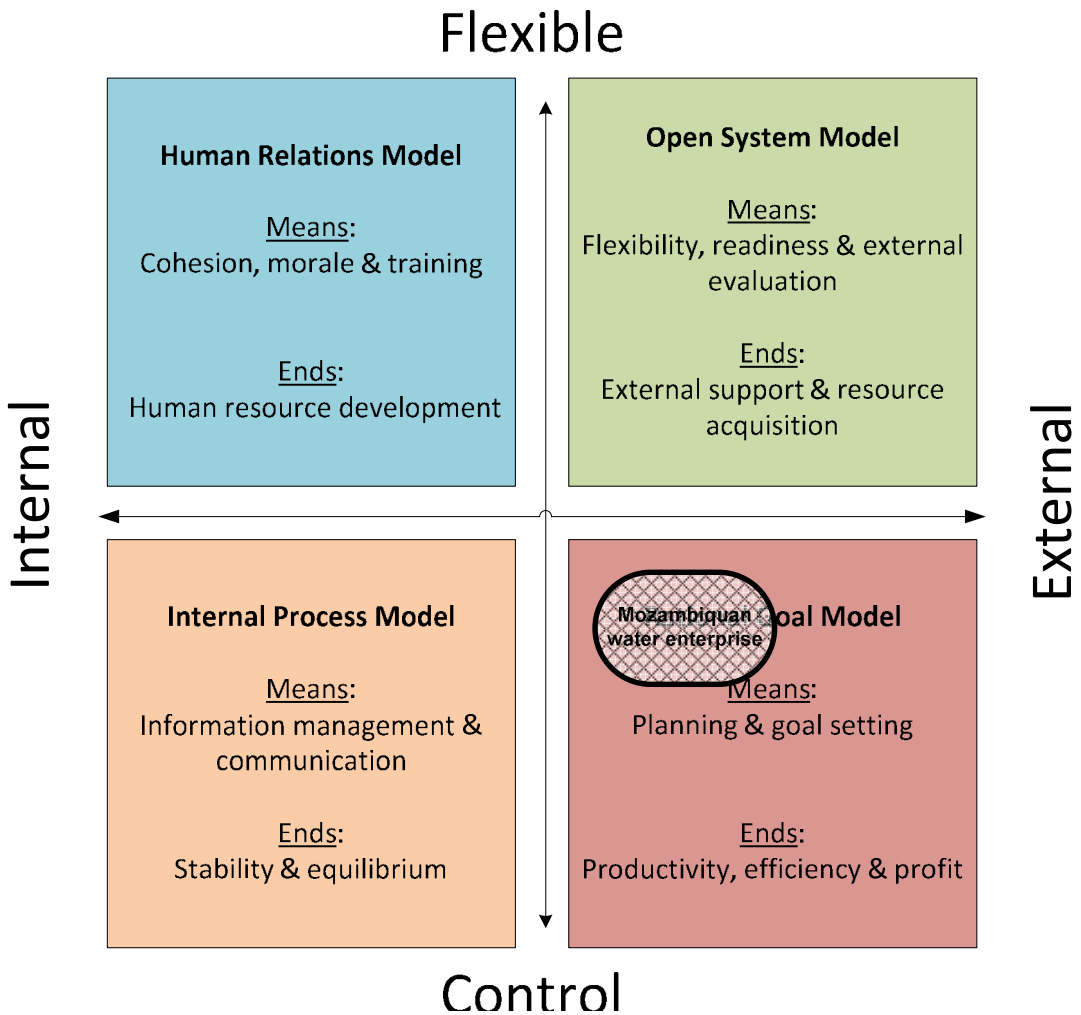


Figure 6: Competing values framework (Quinn & Rohrbaugh, 1981)

In the fifth chapter the
(effectiveness) variables indicated by Hoffer will be explained and described how to use these aspects to be adopted in the game.

4. The simulation model of a water utility

4.1. The model

The strong focus on outcomes as described in the previous chapter, is realized by using *key performance indicators*, which are in these days a well-known management measurement tool in water enterprises and are used all over the world. The players (the managers) have to make certain decisions that can affect the KPI's positively or negatively. The decisions are named 'decision factors' (DF's). These DF's and KPI's will be discussed in this chapter.

4.1.1. The Key Performance Indicators in the game

The KPI's are centrally stated in the game. Alegre (2006) noticed a list of benefits of the use of KPI's. Kaplan and Norton who set up the well-known 'balanced scorecard' also notice some of these benefits. The lack of (continuous) incentives to increase effectiveness and efficiency is one of the main reasons why a performance system is used in this sector. Also in developing countries, like Mozambique, managers use the performance measurement system for many reasons. A performance measurement system is a necessary tool in any company. A good system will provide information on the current performance of the company and may even anticipate future events. The ultimate aim of any performance assessment system is to provide information as opposed to data. Consequently, the data collected and processed within a performance measurement system must be related to the goals and interests of the company and its managers. A proper performance indicators system must be understood as part of a wider entity that links objectives, strategies, critical success factors within the company and the indicators themselves. The integration of performance assessment within all management activities is one of the foundations of the system such as the Balanced Scorecard (Kaplan & Norton, 1996) which aim to show that the main perspectives (financial, customer, processes and learning & growth) within a company are interconnected and consequently must be considered as a whole. (Alegre, et al., 2006)

"The Balanced Scorecard complements financial measures of past performance with measures of the drivers of the future. The objectives and measures of the scorecard are derived from an organization's vision and strategy. The objectives and measures view organizational performance from four perspectives: financial, customer, internal business process and learning & growth. These four perspectives provide the framework for the balanced scorecard." (Kaplan & Norton, 1996)

The players have to determine which objectives they want to realize (setting targets). Finally, the way to get there has to be discussed, in other words; which initiatives will be taken to reach these targets? This procedure needs to be done by the whole team every round to adapt changes.

There are a lot of different KPI's. The fifteen KPI's that have been chosen are stated in the next chapter as well as the reasons for adopting these KPI's.

4.1.2. The 'Overall KPI'

The team with the highest overall KPI wins. The overall KPI is the weighted average of fifteen KPI's. Therefore, actually a good score on one of the KPI's compensates a bad score on another KPI.

For example: It is not realistic that a team scores very well on all the KPI's, except 'Water losses', which they score almost 100% (everything floats away), this would make the game very unrealistic. The solution is to introduce thresholds and be critical with relationships between different KPI's. The

threshold can be a certain percentage that the player may not cross; otherwise, the player will get a warning or is game over.

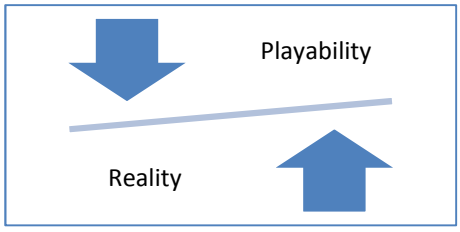
Another (very different) problem as mentioned earlier is the environmental influences in the game. The combination of those two problems gives a solution: Working with *scenarios.* The team has to focus depending on a specific scenario. In case the political focus is 'clean drinking water for everybody ' the focus will be coverage & quality, but decrease of water losses and affordability is also important. There can be many different scenarios, but it is important to be critical with the set up of a scenario. In practice, this means that the team will get a mission. This mission depends on the direction of the external parties. This will give the game more direction and dimension, and makes it easier to give weight to the KPI's as well. In one scenario, the weight of a KPI can by more than in other scenarios. It could be that (after 5 years) the mission of the perspective of the government is changed and there will be another focus in the game. Therefore, the scenarios give direction to the team, make the game more dynamic and result in a solution for the 'weight' of a KPI.

The focus of the first version of the game is not to determine different kinds of scenario's, but for the future versions of the game, it is important that there will be a(n) (easy) system to implement different scenarios.

4.1.3. The decision factors (DF's)

The different kinds of input in the game are the decisions the players make in the game. These decisions have to be realistic and recognizable. Many decisions are made every day from small operational decisions to big strategic decisions in an organisation. The game focuses on the management level of a water enterprise for a longer period (around ten years), so the decisions will be made on tactical and strategic level. Many decisions are made during a year and this results in the paradox of playability and realistic simulation:

If it would be even possible to map out exactly all the different kinds of decisions made during ten years, it would be far too complex for the players and the game will be unplayable. On the other hand, if there are a couple of simplistic decisions, the game will not be realistic and it will not be a real simulation game. It is very important to find the right balance between these two.



By setting up 'problem trees' and 'objective trees' based on the KPI's the decisions factors are traced. B. Jackson (1997) mentioned that a problem tree could be used in the analysis phase of the project design. Jackson describes two phases in his 'logical framework approach' two phases: 1. The analysis phase and 2. The planning phase. This approach can be used for planning, designing, implementing and evaluating projects. This method brings the 'problem' back to manageable problems. This is necessary, because the results will be transformed into decision factors (which off course could be affected by the players). This method is also quite easy to understand, which is important for the communication in such a large project group and the amount of KPI's need to be analysed.

The first step is to transform the KPI into a problem. This is quite easy, because a bad score on a certain KPI results automatically in a problem. For example the KPI 'Water losses': The problem would be 'high physical water losses'. This will be the main problem and the next step will be to

search for general causes of this problem. The main cause will be 'poor condition of the network'. (For more information, see appendix 2.) The different causes for the poor condition of the network are; poor maintenance & rehabilitation, poor quality of the construction and/or poor quality of the pipes (material). This process has to be continued until concrete adjustable causes can be found, like the lack of standard operational procedures, inadequate equipment, wrong pressure management etc. etc. This eventually creates a problem tree that can be found in appendix 7 until 14 for the KPI's: Water losses, coverage, quality and continuity.

The problem tree is transformed into an objectives tree by restating the problems as objectives. ITAD (1996) describe the objectives tree as the positive mirror image of the problem tree. The objectives tree can also be considered as an 'ends - means' diagram. The top of the tree is the end that is desired and the lower levels are the means to achieve the end. The transformation from problem trees to objective trees can be found in appendix 7 until 14 for all the KPI's. (Jackson, 2000)

This process results in a set of DF's which all influence one or more KPI's in the model. A distinction can be made between the DF's based on the functional position in the company (as in the KPI's). This creates a set of decisions that can be taken by every manager separately, but are all based on financial resources. Despite that every player has his own focus (on their 'own' KPI's) and goals, they have to work together to divide the financial resources and to make sure that everybody agrees with it. All the DF's affects more than one KPI and most of the time the KPI's of colleagues.
The set of 28 DF's is very diverse and vary from operational decisions to more tactical/strategic decisions. After a lot of discussions and adding and chafing, the following 28 DF's are the input for the game:

Commercial manager:

- *Connection fee reduction for lower income households*: This decision allows the lower households to get a fee to be able to pay for the water. It stimulates the affordability and the amount of people can be connected in some way.
- *Customer awareness campaign*: This decision is about campaign to make people aware of the use of water, for example waste or safety.
- *Fire personnel*: In some water enterprises, there is an overload of employees and these results in more costs and bureaucracy. I do not agree with this DF, because (if you add this DF) you should also include 'hire personnel'. It is also difficult to justify why an employee needs to be fired and what the positive and negative consequences are on the long term in an investment simulation game like this. It does not tell anything about what kind of personnel will be fired either.
- *Illegal connections detection program*: There are many illegal connections. The detection of these connections will result in less UfW and more legal connections, because most of the illegal connections will be transformed into legal connections.
- *Increase number of bill collectors*: The investment in this DF will stimulate people to pay for their water bills.
- *Customer GIS system*: This is a geographical information system and describes a lot about the network, for example leakages or other problems. The system is expensive and in most of the underdeveloped regions, there is no money for a system like this.

- *Increase flexibility of bill payments*: This DF will make it easier for costumer to pay later or in another way.
- *Invest in adequate SOP's*: Within a functional organisation with a large share of undereducated employees, it is important to create Standard Operating Procedures. Here employees can work more on their own and need less supervision and explanation.
- *Invest in office, computer hard- and software, technology, etc*: This DF creates a better working environment for employees and can make the work more efficient.
- *Meter calibration program*: This DF stimulates the calibration of the meters. In developing countries many meters are of a bad quality and do not measure the amount of water that is actually used. This results in many commercial water losses. The calibration of the meter is important to solve this problem.
- Training program: There are different kinds of trainings for commercial managers and employees. It creates better skilled personnel that eventually result in better results. In appendix 5 all kind of trainings are described.

Financial manager:

- *Cut-off non-paying customers*: People that do not pay their bill only cost money. People who do not pay their bill several times will be cut-off to save costs.
- *Fire personnel*: See same point above for Commercial manager.
- *Invest in adequate SOP's*: See same point above for Commercial manager.
- *Invest in other office, computer hard- and software, technology, etc*: See same point above for Commercial manager.
- *Increase tariff*: The tariff of water is very important for a water enterprise. It determines if a water enterprise can invest in the network or other important issues. Tariffs are in most cases a political issue and cannot be determined by the water enterprise, but are determined by the government. When elections are coming, water tariffs will not go up.
- *Tariff structure set to cross-subsidize poor households*: This decision creates a structure whereby 'the rich' will pay for 'the poor'. If you have more money you will pay more and if you have less money, you will pay less. In Mozambique, people with a house connection pay a standard start tariff for a certain amount of water. Even if they do not use the water, they have to pay it as well. This way, the people who get their water from standpipes can get a discount.
- *Training program*: See same point above for Commercial manager.

Operational manager:

- *Fire staff*: See same point above for Commercial manager.
- *Invest in additional (water) sources*: Water sources are the input of the water supply system. If there is not enough water to serve the people the whole day, the sources could be scarce.
- *Invest in adequate SOP's*: See same point above for Commercial manager.
- *Invest in distribution network capacity*: Capacity of the network is not only important to serve every person throughout the entire day, but an over capacitated network is also much more sensible for leakages.
- *Invest in increasing maintenance:* Frequent and accurate maintenance is very important to avoid huge water losses and safety problems (quality of water). In developing countries,

maintenance is most often underestimated, because it does not result in clear results on the short term and it is quite expensive.

- *Invest in increasing water production capacity*: This DF will increase the capacity. New pumps and production plans are examples of this DF.
- *Invest in office, computer hard- and software, technology, et*c: See same point above for Commercial manager.
- *Leakage reduction program*: These are all kind of measures that can be taken to reduce leakage. This can mean teams who are specialized in repairing leakages, but also ways to address leakages (by a system or by residents).
- *Training program*: See same point above for Commercial manager.

More about the formula's and excel-model behind the game is described in appendix 15.

5. From reality to a simulation game

5.1. The integration of the 'integrated model of effectiveness' into the game

Most of the decisions that are made during the development of the simulation game came up during brainstorm sessions, meetings, and interviews with experts. Experts (associate professors from IHE) attended central meetings from Vitens International and students (University of Twente and IHE). In perspective of the *Integrated model of effectiveness (chapter 2 and 3),* the management game will be discussed. When a factor of the 'integrated model of effectiveness' is discussed, the main pros and cons will be summed up about how this factor is integrated in the game. The KPI's that are adopted in the game are stated as last (see: 'outcomes').

Legal authority: As described in the last chapter the water enterprise does not have a high level of authority. If this level of authority was implemented in the game very strictly, the game would only be on operational level. A more tactical and strategic choice has been adopted into the game This means that the game will be played on the level of the asset holder (FIPAG) in combination with the operational level (the water enterprise itself). The reason behind this decision is that managers (players of the game) will get a broader understanding of what is going on at both levels. Another, more practical, reason is that it will make the game more interesting and challenging. Besides these decisions, the political influences are not noticeable in the game. This aspect needs to be developed further. Examples could be: Tariff setting by the government or legislation changes.
+ *Broader level of authority to gain insight in the inter-organisational network and make the game more exciting*
- *No political influences noticeable in the game, which makes it less realistic.*

Sustainability (ability to maintain an adequate level of net benefits): The focus on sustainability is not very high in the game. The teams will get a loan (from the AfDB, for example) that needs to be managed well. Besides this loan a relatively large amount of financial performance, indicators are adopted in the game, including 'cost recovery', which is close to sustainability. The focus on sustainability could be further developed if the game would include a financial system besides the loan and the financial indicators. This way, the players could focus on how sustainable the organisation is. For the first version, the use of a loan in combination with the financial performance indicators will be enough.
+ *Work with loan instead of budget and many financial performance indicators. A loan creates an emphasis on the costs (much more than a budget), because interest is involved and a certain instalment.*
- *No financial system to get a good overview of the financial situation, like balance sheets and profit and loss account.*

Community involvement: Besides one decision factor ('invest in water saving campaign'), there is no attention for community involvement in the game. With respect to the learning goals (described in the first chapter) the community involvement does not have much priority in the game. In further developed versions, this could be more accentuated.
+ *DF 'invest in water saving campaign' adopted into the game, which gives some attention to the community involvement.*
- *No real attention for community involvement.*

Inter-organisational network: Here, the same story as described by 'legal authority' is applicable. In the game, the focus is more on the customer than on the upper levels of the inter-organisational level, like the asset holder and the government agencies. The customer is also central in the objectives of the water enterprise. This will contribute to the interests of the external authorities and agencies, by achieving these objectives.
+ *Very customer focused, according to the goals of the water enterprise.*
- *No direct accountability towards higher-level organization and external organisations, but indirect* by doing well.

Expectation consistency: It is difficult to adopt expectation consistency (the consistency in expectations among different levels in the organization and on inter-organisational level), because the players work together in one team on the same management level (and not on different level along the network). However, the expectations between the players in one team need to be consistent. The players each have a different role and interests, but each of them to come to a joined decision.
+ *Expectation consistency among the players (managers), thus on team level. (Horizontal consistency)*
- *No link to other government authorities or external support agencies. (No vertical consistency adopted)*

Organisational chart: The players will play on the same management level divided in four management roles: General manager, financial manager, commercial manager and operational manager. This is not the same in every water enterprise, but the roles are clear and understandable. Sometimes the operations are divided in production and distribution, but this has no direct contribution to the game. It is a conscious choice to keep the functional division, because a functional division can be found in nearly all the water enterprises. This benefits the generalizability of the game. The lower levels in the organisational chart do not get a lot of attention in the game.
+ *Four different roles with their own interest and division, which reflects the functional chart of the enterprise.*
- *No link to the (large) operational part of the organisation. (Only horizontal and not vertical)*

Formalization: A high degree of formalization appears in centralized organisation with a lot of influence from government and external support agencies. This is difficult to adopt into the game, but there are plans to increase the formalization by working with contracts and incoming paperwork *besides* the computer game. Although it plays an important role in real life, it does not directly connect with the learning objectives described in the first chapter of the game.
+ *General manager has to formalize the agreements made in the game between the managers.*
- *No focus on formalization.*

Division of labour: The game is on management level and the operational level is not integrated into the game. Although the operational level functions as a large and important part of the organization it is impossible to adopt this well (teams would be too large) and the game is more focused on investment decisions. It could be considered to add a representative of the workers. This can be the outsider (for example the game operator) who represents the workers and comes along when decisions are made (or will be made) where the employees are involved.
+ *Decision factors are adopted in the game that affects operational level employees (training, SOP's, working environment)*

- Effects are not measured in the KPI, except for 'staff satisfaction'.
- No 'real' representative of the workers

Decision making system: The decisions are made centrally; this is also the case in the game. In the first version, the decision making 'stops' at the level described by *legal authority*, but in the newer versions 'unexpected events' will happen that are dedicated from high level, like a decline of the tariff raise. The financial, commercial and operational managers receive all their own KPI's to care for and their own interest. It is the task of the general manager to manage his team and come up with shared solutions and budgets. The general manager is also the one who receives the information and it is his task to communicate this information well. This information could be the mission, goals and focus of the game and the virtual water enterprise, but also the unexpected events described above.
+ Centralized decision making by the four managers.
- No influence from lower level (operational employees) or higher level. (See paragraph above)

HRM policies: Like in the water enterprise in Xai-Xai many KPI's are measured, but no KPI's within HRM perspective. The HR function is mainly adopted in de decision factors of the game, (like training, SOP's, work environment), but the only KPI is 'staff satisfaction'. As mentioned before, most of the employees work on operational level and most of the people are undereducated. This is an important aspect to mention, because these employees have to execute the decisions made on management level. If these people do not have the right knowledge and/or they are not satisfied, the execution could become in danger. This could have negative effects on (other) important KPI's like water losses of customer complaints. Although there is attention for HRM, the effects are not well measured in the game and in real life as well. Performance indicators could be, besides the staff satisfaction; the "total training": (hours/employee/year): Number of training hours per employee and year. (Alegre, et al., 2006)
+ Decision factors are adopted in the game that affects operational level employees (training, SOP's, working environment). These DF's contribute to stability and control of the organisation.
- Effects are not measured in the KPI, except for 'staff satisfaction'.

Work systems (The technical system of an organization as the instrument used in the operating core to transform inputs intro outputs): No real focus on work systems, because the game is focused on customers and is played on management level of a water enterprise. Work systems are important in the water enterprises, but do not fit well into the game. Maybe in future versions this could be adopted to make a more complete simulation game on different levels. Work systems are important because the organisation is focused on productivity, efficiency and costs. These work systems contribute to the primary objectives and make it easier to deal with lower educated employees. Work systems are a way of realization of stability and control. They are important, but there is no solution to implement this into the game.
- No attention for work system; further research is needed to investigate how to implement this well.

Outcomes: There is a strong focus on KPI's. The KPI's measure the result of the decisions, and these KPI's can be compared with other teams. This is also the way to give direction to the game. In Xai-Xai, 113 performance indicators are measured. This would be too much for a simulation game. The game would become too messy and unclear for the players were the focus would be. Eventually 15 KPI's came up after a lot of meeting and discussion. The exact meaning of the KPI's and why the KPI's are chosen, is described below. Every manager has four KPI's except for the general manager who has to

manage his team. It was quite difficult to get a good set of KPI's, because KPI can be nuanced. For example, the KPI 'coverage' can be split up in people who has a house connection or people that life in an area with a standpipe. In perspective of the playability of the game as well as the development of the game, we have chosen for a basic set op KPI's, for the following reasons:

General manager:

1. *Asset Value* - Gross Fixed Assets-water (€/ W pop served): Total gross fixed assets per population served for water (W). (IBNET.org): the general manager has to keep an eye on the asset value of the water enterprise to prevent the neglecting of the most valuable aspect of the enterprise. A decrease of the value (despite all the investments) would mean a dilapidation of the assets (network, pumps etc.).
2. *Loan utilization* - Percentage (%) of the loan used: Actually this is the 'money meter'. It tells how much money is available to make the decisions. Most of the money for development in this sector is made available by a loan. That is why there is chosen for 'loan' except for 'budget'.
3. *Staff satisfaction* - A measure of how happy workers are with their job and working environment. (%): The only KPI that measures HR aspects. In water enterprise like Xai-Xai the most important daily task of the general manager is to motivate, control and help the employees.

Financial manager:

4. *Working ratio* - A ratio used to measure a company's ability to recover operating costs from annual revenue. This ratio is calculated by taking the company's total annual expenses (excluding depreciation and debt-related expenses) and dividing it by the annual gross income. (investopedia.com): The Working ratio, operating ratio and full cost recovery ratio (described below) are too much of the same. They all tell something about the costs with respect to the incomes. By other KPI's (like coverage'), these kinds of nuances are not made. Only cost recovery will be enough to tell something about how the costs are compared to the incomes.
5. *Operating ratio* - Operating cost coverage ratio (-): Ratio between the total revenues and running costs. (Alegre, et al., 2006): Idem
6. *Full cost recovery ratio* - Total cost coverage ratio (-): Ratio between the total revenues and the total costs. (Alegre, et al., 2006): It can tell something about how sustainable a water enterprise is and this is important with respect to the autonomy of the water enterprise.
7. *Cash ratio* - Current ratio (-): Ratio between current assets and current liabilities. (Alegre, et al., 2006): This financial indicator is more focus on the assets in combination with the liabilities. As described in the second chapter; the assets are where it is all about in a water enterprise, without good assets, a good service level is impossible.

Commercial manager:

8. *Commercial Non-Revenue Water (NRW)* - Non-revenue water by cost (%): Percentage of the system input volume that corresponds to the valuation of non-revenue water components. (Alegre, et al., 2006): This KPI measures the water that is not paid. This can be for several reasons, for example bad/no metering or administrative mistakes. This KPI and the KPI 'water

losses' are together the indicator Unaccounted for water (UfW) and cannot be together more than 100% of course.

9. *Number of customer complaints* - Service complaints per connection (No. complaints/1000 connection/year): Average number of complaints of quality of service per 1000 service connections and per year. This indicator is adequate for distribution systems. (Alegre, et al., 2006): Describes how the customers value the service level created by the water enterprise.
10. *Affordability of tariffs* - Annual water bill for a household consuming 6m3 of water per month through a household or shared yard tap (but excluding the use of stand posts) (IBNET.org): An important indicator; although people have different opinions about the right of water, it needs to be paid somehow. If the tariff is too low it effects the operations of the water enterprise (low maintenance, low quality etc.), but if the tariff is too high it is not affordable for many people. In reality, the water enterprise can only propose a tariff and the government eventually decide. The indicator is important, but this important political effect needs to be made clearer in the game.
11. *Collection efficiency* - Cash income / Billed revenue as a % (IBNET.org): This indicator focuses on how the enterprise will receive the money for the water consumed. It needs to find ways to collect the money and to stimulate people to pay the bill (by them self). If a water enterprise wants to be more autonomous in the future, this is an important indicator.

Commercial manager:

12. *Water Losses* - Apparent losses (%): Percentage of the water provided to the system (system input volume minus exported water) that corresponds to apparent losses. This indicator is adequate for urban distribution systems. (Alegre, et al., 2006): Water losses are a big problem. In developing countries, UfW is more than 50%. This is not only a problem for the water enterprise (financial losses), but it tells something about the condition of the network as well. This could result in the pollution of water and illegal tapping. These indicators (including the other operational indicators below) have extra weight in the game, because they directly influence the service level of the customer and thus the goals of the water enterprise.
13. *Continuity* - Continuity of supply (%): Percentage of hours when the (intermittent supply) system is pressurized. (Alegre, et al., 2006): Where the water losses tell something about the condition of the network, the continuity tells more about the capacity of the network. It can have economic and social consequences (described earlier) for the customer if there is no water during a part of the day. This indicator influences the service level also directly.
14. *Quality* - Tests carried out (%): Percentage of the total number of treated water tests performed that comply with the applicable standards or legislation. (Alegre, et al., 2006): Very important for public health and can cause major problems if the drinking water is not of a sufficient quality. Quality of water in Western Europe is something else than quality of water in Mozambique or other developing countries (even in Western Europe this is different), in the game it is not well stated what quality really means (in the game itself).
15. *Coverage* - Households and businesses supply coverage (%): Percentage of households and businesses that are connected to the public network. (Alegre, et al., 2006): Like all the three indicators described above this is also a very important indicator. It reflects the amount of people in a certain area that have access to water. This can be a house connection or a standpipe. A negative point is that it does not distinguish both options, this because it is a

major difference in the service level to the customers.

+ Focus on customer by important KPI's.
+ Recognizable KPI's that cover the most of the divisions.
+ Gives a good representation of the average used KPI's within a water enterprise.
+ Focuses on stability and control, which is in line with the model of Quinn & Rohrbaugh.
- Tariffs are not set by a water enterprise or asset holder, but by government.
- No focus on HRM.
- Not consistent with making nuances.
- Some overlap between KPI's

5.2. The results and future plans

The result is a so-called 1.0 version of the water management game, which needed to be tested many times. The testing sessions were highly needed, because there were no references or any kind of information that can ensure a good model in the first place. The whole model and the game are tested by trial-and-error. The game is played many times with students from the IHE, people from Vitens and specialists to create a realistic, but also, an instructive game. The game is now used for learning purposes. For example it is adopted in courses at UNESCO-IHE.

This is the first working version of the game and during the creation of the game participants came up with many ideas. Many ideas are not integrated in the game; this does not mean that they are not important. However, it is important to keep them in mind and use them for the development of future versions of the game. Sometimes the ideas fit well with the recommendations that are given in the next chapter and sometimes it is used to make the game more attractive.

- (Information/email) inbox for the general manager (working with warning/information messages) – To stimulate the general manager to communicate well with his colleagues and give him some kind of information power'.
- Doing proposals for tariffs (so 'the government' can decide if they accept it or decline it) – In real life the water enterprise cannot decide to raise the tariffs, but the government can. This is quite essential to make the game more realistic and teaches players how to set up proposals for tariff setting.
- Game over (being fired) during the game when ignoring the warnings and performing badly. – It will put more pressure on the game and it integrates in a small sense the power of higher parties (asset holder or government). This will result in a more realistic level of autonomy.
- Nuance KPI's/DF (coverage intro connections and standpipes, quality of water etc.)
- Adapting the information database & the historical statistics of other players into the game – The team can play against team that played the game earlier. This creates possibilities to play against teams in other countries and its increases the competitive character of the game (by different kind of rankings).
- Different currencies – To get the sense of the value of money for players all over the world.
- More languages or a translation tool – To make it understandable for everybody in world.
- Introducing 'publicity' into the game – Kind of a rewarding tool if you are doing well – If you are doing well or something popular you will published in virtual papers or TV-programs as a kind of reward.

- Unexpected events/disasters and other external effects – The deal with crisis management or reconstruction management a disaster can occur so that the game will totally be shaken up.
- Scale differences, play with different scale of companies – In scale of the water enterprise varies from thousands to a couple of millions. This creates scale of economy and other advantages and disadvantages. It gives a new look on the game and will make the game more realistic and instructive.
- Website with results of the games played and other information – This is for publicity and creates more competition between teams in different countries or regions.
- The players choose their own KPI's – This results in a lot more freedom of strategic focus and will need more cooperation between the team members. In gives the game another dimension, but it has huge practical consequences, because it is very difficult to integrate in the game and it will make it much more difficult to compare with other teams.
- The possibility to play it in different counties (at the same time) – This will connect people all over the world with the same interests and will make the game more dynamic. This could eventually result in perspectives of different cultures towards water supply.

Some ideas are more difficult to adopt than others and it depends on financial resources and the success of the game to what extent the game will be extended. At the moment, it is an attractive, but quite basic game where managers can invest in certain decisions and can see the results. The interactive part of the game is set outside the computer game and needs to be stimulated by an external teacher of operator.

A screenshot of the actual game can be found in Appendix 17. On the top, the role of the manager is stated and the timeline of the game. The grey dot represents the current round (or year). In the left box, the KPI's are stated which are linked to the role of the managers. When the players clicks on the decisions-button, the player can check all the decisions made by all the players of the team.

In the overview, the player can read all the result of the decisions the player has made in the last four rounds. Underneath the overview the scenario is stated which gives the player leads to make the right decision. When the player wants to know more about the scenario, the player can consult the document files. On the bottom of the page, the team composition is stated which gives the link to the other team players and their results.

6. Conclusion & recommendations

6.1. Conclusions

A water enterprise is a special kind of business. The key element of this unique character is the product what they sell: Water. Hoffer (1995) mentioned that many people consider water as a free commodity, where Moslem societies even intend that water is a religious right and Socialists intend that this social commodity have to be provided free from charge. In the end the customer is the one where the costs are originated and this needs to be paid either direct or indirect (taxes). Hence, water should be considered as an economic good, where the customer provides costs. These tariffs are most of the time a political issue, where politicians use the water tariff to attract and keep voters. (Hoffer, 1995) Addressing water as an economic good does not mean that water enterprises are profit-focused; the opposite is true. Water enterprises are not seen as profit organisations, but as non-profit organisations. Daft stated that non-profit managers are committed to customers with limited funds, must keep the organisational costs as low as possible and demonstrate a highly efficient use of resources. Non-profit organisations do not have a 'financial' conventional bottom-line, which creates another problem: Managers often struggle with the question of what constitutes organizational effectiveness. Daft (2007) describes effectiveness as "the degree up to which contemplated objectives are achieved". Quinn and Rohrbaugh (1983) set up the 'competing values framework' to analyze organizational effectiveness and discover two major dimensions underlying conceptions of effectiveness: The *organizational focus* of the organization and the *organizational preferences for structure*, which result in four quadrants. Hoffer (1995) translated these four quadrants into an *Integrated Model of Effectiveness* and split up the quadrants into variables that are more concrete and applied for water enterprises.

A typical general organizational objective of a water enterprise is: *"Production of reliable drinking water, for an acceptable price, that is available for the whole population of the region that has to be served".* The application of the Integrated Model of Effectiveness results in an organisation that prefers stability and control and with a mainly external focus. Stability and control is characterized by a high degree of formalization, a functional organisational structure, a high degree of standardization. A low degree of autonomy and sustainability results also in control from external and government parties and the need for stability. This external focus is not only on inter-organisation level, the customers play a very important role as well.

This external focus and stability & control are adopted into a model for a management simulation game, where managers can make investment decisions that influences the performance of a water enterprise. Using different kinds of Key Performance Indicators, the control is simulated. The KPI's, even as the decisions that can be made in the game are selected in a way that it gives a all-round and good presentation of a water enterprise in a development country with the focus on realizing a good service level for customers. Of course, there are some critical points, but these will be mentioned in the recommendations in the next chapter, and it is important to keep in mind that this is the first version of the game. The interactive part 'outside' the computer game should result in a discussions, agreements and good communication between the players (managers). By this way, the managers can learn from each other, work together towards the general objective, and create a better understanding of the different kind of facets within a water enterprise and a better understanding of the job of colleagues. These expectations connect well with the learning goals that are set up in the starting phase of the game creation.

6.2. Recommendations

As mentioned in the conclusion there are always things that could be improved. It is split up into three categories: The model behind the game, the development process of the game for next versions and general recommendations.

Model content:

- Further research on *authority* aspects in the game – The political and other external influences are not that strongly presented in the game as they are in real life. Very basal aspects like water tariff are now determined by the water enterprise.
- Further research on the *HRM* aspects in the game – Despite that there are some DF's that focus on the operational level of the organisation, there is no attention to what the effect is of these DF's on the KPI's regarding HRM. This is striking, because there is a large operational part with a low education level in the enterprise. How to handle these employees can have huge effects on the performance of the firm.
- Further research on *community involvement* – An aspect that is not well handled in the development of the model. More attention to this aspect can maybe enrich the game.
- Further research on *relations* between different DF's and relations between different KPI's. – The game is based on the principle that a certain DF influences a certain KPI in a certain way. There is paid no real attention to the fact that DF can mutually influence each other. For example: If the players invest in 'leakage detection program' and not in 'maintenance', it is not realistic that the KPI 'Water losses' decreases. Further research has to make clear what the critical relations are between the DF's and this is the same story for the KPI's.
- Further research on the way a DF *influences* a KPI. - Effects in the effects. In this model, the effect on the KPI and the amount of money you invest is proportional. This means that the higher the investment, the higher the effect will be in the same proportion. This is not obvious, because sometime a small investment results in huge benefits and sometimes you need to invest a lot of money to reach any effect at all.
- Review the *decision factors* – Some decision factors are very doubtful or unclear. To be critical towards the DF's it will make the game more understandable and playable, for example 'firing employees'.
- Review on how the *KPI's* can be nuanced. – In some cases the KPI's are to general, for example 'quality of water' and 'service coverage', this does not give a realistic picture of what kind of decisions a manager faces in a water enterprise.

Development process:

- It is important to keep in mind that the first stage of the developing process is very important. Define very well what the scope is for the new version and who is responsible for which part. Especially when you work with groups, of different interests, a leader is very important and everybody needs to one who that is. Leadership is important to keep everybody focused and informed. More about the development process of the first version of the game in the reflection (next chapter).

General:

- Use the prototype version for learning purposes, not directly to learn from the game, but to learn to make game better. The first version can be instructive and can learn the basics of the decision-making in a water enterprise, but is even more instructive to be critical towards the game. This way, the student will also learn a lot about the practice of water supply.

6.3. Reflection

Overall, it was a very instructive and challenging experience to create the model for a simulation game. I learned a lot in various dimensions; to function in a mixed project team, the organisation and system behind water supply, writing a paper about it and about cultural differences between development en developing countries, not only on water supply level.

The development of a simulation game in this sector was a very new idea and had never been done before. It was also new for the parties involved. The different interest, priorities and distance sometimes caused some problems with the concordance between the team members. This resulted in misunderstandings or topics that were discussed repeatedly. This did not cause social friction between the team members, but resulted in time losses and losing interest in the development. From my point of view, this was all caused by a willingness to start as soon as possible with the project. Here, the focus of the game was not clear and tasks and especially leadership was poorly defined. Good communication and leadership is necessary to make the game successful with many different parties all over the country. This lack of leadership and focus resulted especially in the beginning for a lot of time losses and pointless discussions. Eventually people who stand up, take leadership, by narrowing down the team, and by time pressure solve this. I have often (especially in the beginning) doubted the fact to take more leadership, but the people around me had much more experience and knowledge about this sector, so from my point of view this was not my role. I do not blame anyone, but a more targeted focus, clearer roles and leadership and a more structured way of communication would have helped a lot. The ironic part is that this is exactly what we want to learn the players in the game. To work together with people in other fields and create a targeted focus, which eventually results benefits for the 'customer'. I mentioned this ironic part when I went to Mozambique. Many people where working hard to build up the country. Water supply is essential in this process and with a lot of financial and management support from different parties (including Vitens), the achieved huge progress the last years. I realised that it was somewhat arrogant to set up a game to learn managers how to manage in these companies. Of course, they can use the experience of managers from foreign countries with a longer history in water supply, but to solve this with a game was a utopia. Now it is used as a learning tool for students at UNESO-IHE and this is the best place for a game like this, I think. It would be great if it connects students all over the world and get a better understanding of water supply in the future. The concrete things I learned from this bachelor assignment are:

- Make better agreements about guidance and the practical issues.
- Create a clear demarcation of the research and targeted research questions.
- Ask and be more critical about the state of affairs.
- Do not combine too much things at the same time, but focus on what is important.

Nevertheless, it was a great and instructive experience with a lot of ups and downs. I learned a lot about water supply and the organisation behind it, but maybe even more about myself...

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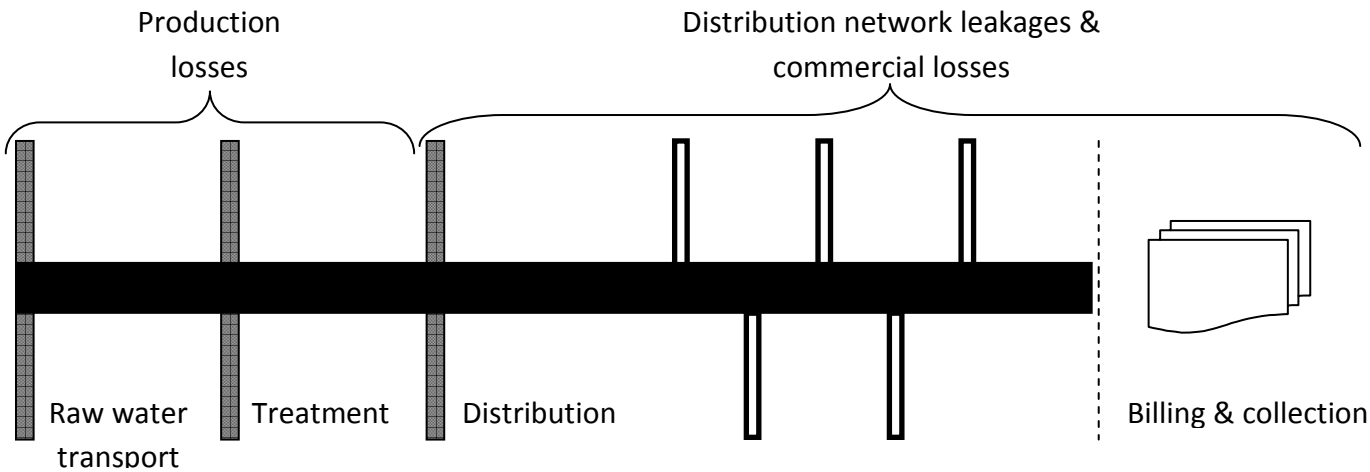
Appendix 1: Map Mozambique

Map No. 3706 Rev. 6 UNITED NATIONS
June 2004

Department of Peacekeeping Operations
Cartographic Section

Appendix 2: Unaccounted for water



<u>Technical losses</u>

- Production losses
- Distribution network

<u>Commercial losses</u>

- Deficient collection
- Deficient billing
  - Illegal connections
  - No water meter
  - Inaccurate water meter

Appendix 3: Vision and goals

A vision is a shared and ambitious image of the future defining the ambition and direction of the company. A vision is what the company will be in 5 years time.

According to the management, the **ambitious image of the company** is:

> *"We want to be a reliable water supply system operator, which is prepared for the future, has motivated and professional employees, continuously increases its coverage, covers at least the costs of operations and maintenance, makes efficient use of its assets, is safeguarding the environment and is being recognised by the clients and public in general"*

To realise these challenging objectives, an integral approach is required, which is supported by all employees. The vision covers the following objectives:

- Reliable water supply service
- Prepared for the future
- Motivated and professional employees
- Continuous increase of coverage
- Cover costs of operations and maintenance
- Efficient use of assets
- Due regard to environment
- Recognised by clients and public in general

Reliable

In the previous paragraph 3.1 about the mission was described how the operators define reliability and how they want to achieve this.

Prepared for the future

The organizations must be prepared for the future. With the organization of the activities, human resources and assets, it should be able to easily adapt to changes of the internal and external context. The solution is a close collaboration of the different water supply systems. In this way, it should be possible to attract higher educated staff that can work for the four cities, while the salary costs are shared. For continuation of the daily business, the operators and clients will not depend on a single employee. Furthermore, it also creates more space for employees to make a career within the organization, which means retaining valuable skills and knowledge within the organization. Moreover, a legal entity of significant size is better able to raise funds for improving service level to the clients and cope with financial risks. This means improved financial capacity.

Motivated and professional employees

The human resources are a key factor in the daily business of the water companies. Clients and the company itself profit when employees are motivated to apply their skills and knowledge in their daily activities. To ensure a satisfying water supply service, the operators should have, beside motivated also, professional employees at their disposal. Human resource instruments will be implemented to motivate the staff. Training the staff and hiring well-educated staff is planned to improve the professionalism.

Continuous increase of coverage

The water supply in Mozambique is characterised by low coverage. This situation contributes to poor health conditions and a general degradation of the quality of life, in particular for the poor population. One of the objectives of the National Water Policy is; increasing coverage of water supply, particularly for rural and low-income groups. The operators share this objective. They consider the creation of additional connections as their social responsibility and a way to improve the financial sustainability of the company. The planning is an

increase of at least 50% of connections for the water supply systems in the four cities until 2011. An important issue in the current situation is that the operators have difficulty to meet the population growth with the creation of new connections. Additional investments are required to significantly improve the coverage. Furthermore, the definition of the population in the service area and units used to calculate population served need to be reconsidered.

Covering costs of operations and maintenance

The National Water Policy (1995) promotes full cost recovery in the sector and simultaneously the recognition of water as an economic as well as a social good. It must be clear that there is a tension between full cost recovery and the social role of the water supply services. Significant investments are required to fulfil the social role, while revenues hardly cover salary and energy costs. Currently, the operators are heavily depending on FIPAG and other donors to cover investment costs and even some operational costs. In the scope of the business plan, a periodic correction of the tariffs is required to cover the cost of operations and maintenance.

Efficient use of assets

Considering the social value the water supply systems can generate in society, operational excellence should be taken seriously by the operators. Water should be recognised as an economic as well as a social good. The operator should strive for a continuous supply of good quality water for a fair price, which is accompanied by good customer service. This implies an efficient use of resources, which can be attained by cost control. Several cost categories offer good opportunities for benchmarking. Moreover, the organisation should actively capture the opportunities to generate additional income.

Due regard to environment

The interfaces between the business activities of the water supply services and the environment are the use of the scarce resource water, contamination and energy consumption. In 2007, FIPAG and Vitens will develop an environmental management plan.

Recognised by clients and public in general

The operators want to be recognized by their clients and the public in general for the way they fulfil their primary function; *contribute to the well being of the population in their service areas*. Key topics in the image that the operators at least should send out are: reliability of the service, safety of the water, justness of the water price. Other topics can be communicated for certain business reasons. The message being communicated depends on the objective of the specific situation and target group.

Autonomous

For the scope of the business plan, it is too ambitious to strive for fully autonomous water supply systems. Therefore, it is not incorporated in the vision. The operators function in a framework, which means that they will experience influence of the other institutes in the framework in the administration of the organizations. Furthermore, part of the assets is owned by FIPAG, so full asset ownership will not be achieved. The operators could be financially fully independent in its responsible area. This depends on the possibility to make an agreement on (yearly) tariff increases. The importance of striving for autonomy is that the operators need to guarantee the sustainability of the water supply service and prevent the domination of sub optimal political decisions. A more detailed explanation is given in annex A.

Appendix 4: (de)centralization (dis)advantages

Centralization (Van der Horn & Donker, 2006)

Advantages	**Disadvantages**
1. Hiring and developing people	1. Communication costs
2. Use of assets and human resources	2. Transport costs
3. Negotiation position	3. Flexibility in organizational change
4. Acquisition of external funds	4. Discharging people
5. Investment barriers	5. Interpersonal relationships
6. Financial risks	6. Dilution of responsibilities
7. Cross subsidization	
8. Knowledge exchange	
9. Standardisation of procedures	
10. Addition of new water supply systems	

Decentralization (Van der Horn & Donker, 2006)

Advantages	**Disadvantages**
1. Organizational flexibility	1. Negotiation position
2. Knowledge of the water supply systems	2. Investment barriers
3. Internal communication	3. Financial risks
	4. Cross subsidization
	5. Knowledge exchange
	6. Standardisation of procedures
	7. Autonomy
	8. Susceptibility for fraud

Possibilities for centralization (Van der Horn & Donker, 2006).

In a seminar with the management of the organisations appeared that the following activities could be centralized:

- Drafting policy and solving policy issues for all business processes can be centralised
- Developing strategic policy
- Marketing and Public Relations activities (excl. carrying campaigns)
- Recruiting and human resource management
- Managing financial and economic affairs (excl. Administering and managing the ledger, Operating the accounts payable system, Administering projects and assets, Cash, bank and giro administration)
- Maintenance of boreholes
- Maintenance of water meters
- Managing water abstraction & water protection areas
- Water quality analysis
- Computerisation and automation (excl. Operational maintenance and management of existing office automation systems for data processing and data storage)
- Procurement
- Dealing with legal issues
- Retirement of staff
- Project development and realisation (excl. execution and supervision of projects)

Appendix 5: Training content

	FIPAG HEAD OFFICE	
OTHER TRAINING INSTITUTIONS IN MOZAMBIQUE	**OUTPUTS**	**CONTENTS**
Diploma in Project Planning and Management		
Customer Services Management	Improved standards of customer services, enhancement and maintenance of close relationship with the customers and increase the competitiveness of the water company	Characteristics of service; How to improve the service level?; Creating a customer-driven organization; Approaches to Customer Care; Negotiation skills; Effective communication; Best Practices in Customer service programme; Measuring customer needs and sa
	DRINKING WATER COMPANIES OF CHÓKWÈ, XAI-XAI, INHAMBANE AND MAXIXE	
TRAINING INSTITUTE FOR WATER AND SANITATION (CFPAS) IN MOZAMBIQUE	**OUTPUTS**	**CONTENTS**
Leadership	Improved management skills for the management	The role of the leader; The development of leadership styles in organizations; Individual and group motivation; Results and objectives for individuals and groups; How to conduct a meeting; Processes of problem analysis and decision-making.
Network construction	Improved know-how and skills to ensure proper performance of corrective and preventive maintenance of water supply networks, as well as to assure the transfer of skills in the preparation of situation reports about the problems taking place in the network	Design of network, the use of different types of materials; construction of connections; testing of networks; curving of galvanized pipe; repair and maintenance of valves and taps.
Public Relations (PR)	Improved organizational communication by enhancing corporate image, identity and personality as well as social responsibility. Improved internal communication system in order to have a more customer centred approach with the public.	Historical overview of PR; definition of PR; the functions of PR (communicative, management and interpretative, etc.); distinguish PR from advertising and propaganda; develop and execute PR plans and campaigns for water companies.
TRAINING INSTITUTE FOR WATER AND SANITATION (CFPAS) IN MOZAMBIQUE	**OUTPUTS**	**CONTENTS**
Electricity	Acquired knowledge of the techniques in electricity	Electric energy and the effects of electric current; utilize materials; Electric component; Continuous current and alternating current; Electronic components; Transformers and motors; Three- phase systems, Power electronics and digital electronic; Safety
Human Resources (HR)	Acquired knowledge of concepts, techniques and models of HR management as well as the development of proper policies for HR development.	Core competences; Policies of HR management, Recruitment and selection, analyse and description of functions, Career Planning, performance evaluation and administration of salaries
Operation and Maintenance of Electrical Pumps	Acquired knowledge of maintenance of electric pumps of the water supply systems and efficient use.	Operations, maintenance and reparation of electrical water pumps, diagnose breakdown of water pumps, operation correctly.
Maintenance and reparation of Hydromecanic Equipment	Acquired knowledge to maintain the water supply systems secure, operational and efficient.	Operations, maintenance and repair of water pumps and electric control panels, maintenance of different types of valves, cleaning and disinfections of water deposits.
Management of Small Water Systems	Knowledge for an efficient and effective water supply service in Small Water Sistems	Operation and maintenance of small water sistems, Financial and commercial organization and management; different kind of modalities of management and perspectives; planning and analysis of performance indicators.
Secretary	Acquired know-how about the role of a secretary within an organization as well as the planning and organization of tasks, filing and correspondence management.	The secretarial function in the company; Communication; Develop skills of personal and telephone contact; Organization of work, time management and information management; Organization and management of files
Customer Services	Improved service level and increased capacity to identify the needs of the customers	Customer relations management, Structure of conversations with Customers, Resolve complaints, Communication skills as feedback and non verbal communication, Etiquette, Communication Problems
OTHER TRAINING INSTITUTIONS IN MOZAMBIQUE	**OUTPUTS**	**CONTENTS**
Word, Excel	Basic knowledge of Word and Excel	**Word**: Introduction to word processors; Presentation of word 2000;Creation and editing documents; Functions and tools of word 2000; management of documents and tables, Printing documents. **Excel:** Introduction to spreadsheets; Presentation of Excel 2000;Crea
Commercial software (PHC)	Improved knowledge of commercial software	Customer services (contracts and complaints), execution of billing procedure (pre - billing analyse); management of debits (clients notice, desconnections, reconnections), executions of collection process; report analyse.
Commercial software advanced (PHC)	Improved knowledge of commercial advanced software	Control of the commercial system, control of results, analyse of query; the use of database; introduce corrective actions;
TRAINING ABROAD	**OUTPUTS**	**CONTENTS**
General Management (higher level)	Improved management skills for the directors	The role of the leader; The development of leadership styles in organizations; Individual and group motivation; Results and objectives for individuals and groups; How to conduct a meeting; Processes of problem analysis and decision-making.
Training in water company South Africa	Improve know-how about working procedures and manners, by exchange of experiences.	Training depends on personal needs of worker in technical, commercial or management areas. The practical training is focused on the application of theoretical knowledge in water companies.
Performance Indicators and Result-based Management	Result based management	Relationship between logical framework and indicators; results based management and development of project indicators; Measurement of performance and data collection; Indicators and monitoring.
Project Design: Identification, Preparation and Assessment	Implementation of a systematic and logical approach in projects design	Project preparation context; Need of analysis and project description; Financial and economic analysis; Logical framework and definition of indicators.

Appendix 6: Performance indicators Xai-Xai- 2008

PERFORMANCE INDICATORS XAI-XAI-2008				
INFORMATION REQUESTED	**Units**	**July 2008**	**Total**	**Average**
TECHNICAL INDICATORS				
Volume of water abstracted	m3	280.915	2959280	328808,9
Volume of Water Treated	m3	280.010	2897591	321954,6
Volume of water distributed	m3	258.501	2733548	303727,6
Losses in water treatment	%	0%	0,020846	0,020846
Technical losses (Treatment, Transmission Center & Distributor)	%	8%	0,076279	0,076279
Small Systems	m3	24.593		
Total production	m3	304.603	3120232	346692,5
Consumption of electricity (Production)	KWh	144.099	1142070	163152,9
Consumption of electricity (distribution center)	KWh		0	0
Consumption of electricity per m3 of water abstracted	kwh/m3	0,51	0,385928	0,385928
Consumption of electricity per m3 of water distributed	kwh/m3	0,00	0,417798	0,417798
Total energy consumed	Kwh	144.099	1142070	163152,9
Total energy consumed per m3 of treated water	kwh/m3	0,51	0,394145	0,394145
Consumption of chemicals				
Calcium hypochlorite (HTH)	Kg	110	1361	151,2222
Calcium hypochlorite (HTH)	g/m3	0,39	0,4697	0,4697
Gaseous Chlorine	Kg	0,00		
Gaseous Chlorine	g/m3	0,00		
Aluminum Sulphate	Kg	0,00		
Aluminum Sulphate	g/m3	0,00		

Lime	Kg	0,00		
Lime	g/m3	0,00		
TRADE INDICATORS				
Illegal connections regularized	no	0	0	0
New Links	no	264	1423	158,1111
Links deactivated	no	0	0	0
Cut Links	no	98	783	87
Number of religações	no	35	302	33,55556
Total active connections by legal categories				
Domestic connections	no	6.212	52945	5882,778
Institutional links (public)	no	153	1321	146,7778
Trade links	no	103	899	99,88889
Industrial Links	no	6	52	5,777778
Fontenários	no	60	464	25
Total number of connections and active legal	no	6.534	55681	6186,778
No. of connections billed based on the reading of the meter	no	5.320	43057	4784,111
Percentage of connections billed based on actual readings	%	81%	0,77328	0,77328
Billing				
Volume billed				
Links home	m3	115.706	1128504	125389,3
Institutional links	m3	9.481	114066	12674
Business Links	m3	3.899	46392	5154,667
Industrial Links	m3	408	4269	474,3333
Fontenários	m3	4.763	45318,38	5035,375

Total	m3	134.257	1338549	148727,7
Not invoiced water (UFW)	%	52%	0,538048	0,538048
Volume invoiced based on actual reading of meters	m3	99.676	1032056	114672,9
Average volume per active connection invoiced	m3	21	24,03961	24,03961
Average volume charged for the domestic active	m3	19	21,31465	21,31465
Billing ratio	%	52%		
Invoice value				
Links home	10^3 Mzm	1.357.355	13695388	1521710
Institutional links	10^3 Mzm	6.932	1240524	137836
Business Links	10^3 Mzm	66.856	787431	87492,33
Industrial Links	10^3 Mzm	160.840	746100	82900
Fontenários	10^3 Mzm	24.520	274405	30489,44
Total	10^3 Mzm	1.616.503	16743848	1860428
Canceled or revised billing	10^3 Mzm	40.469	155188	12932,33
Actual invoice	10^3 Mzm	1.576.034	16588660	1843184
Average turnover by binding legal	MZM	247.399	300710,3	300710,3
Average household bill by binding legal	MZM	218.505	258672	258672
Amount Charged				
Links home	10^3 Mzm	1.356.953	12496276	1388475
Institutional links	10^3 Mzm	8.786	1075371	119485,7
Business Links	10^3 Mzm	86.505	790867	87874,11
Industrial Links	10^3 Mzm	193.598	564716	62746,22
Fontenários	10^3 Mzm	14.494	185515	20612,78
Total	10^3 Mzm	1.660.336	15112745	1679194

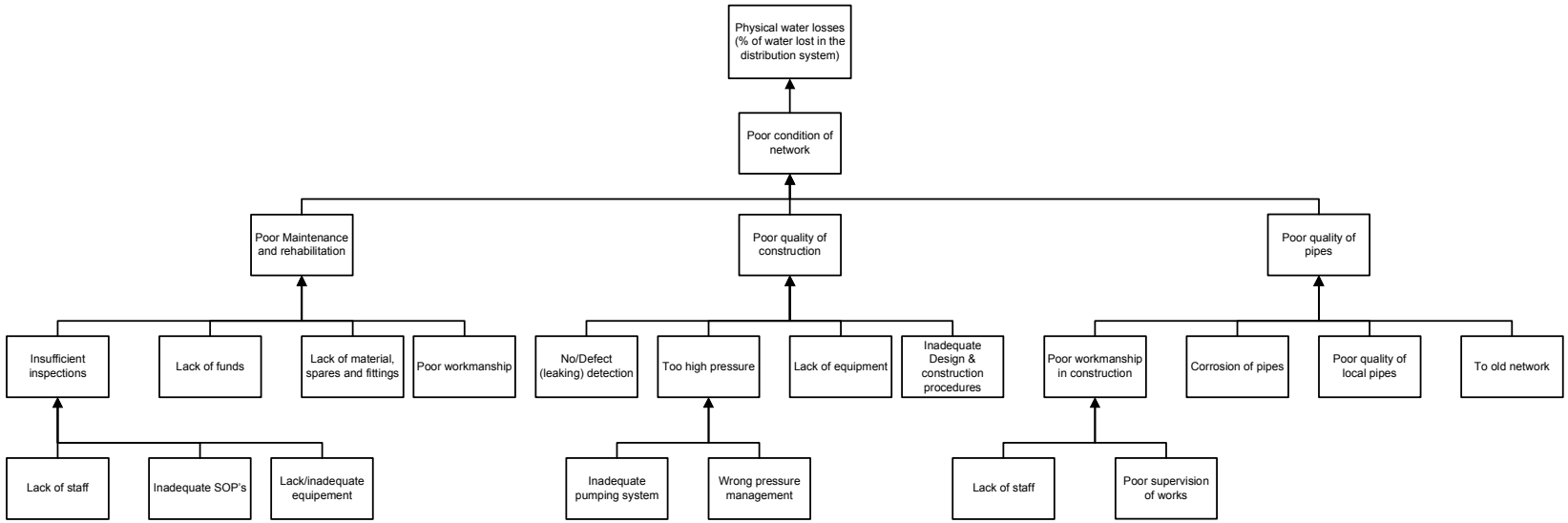
Ratio (MTS)		103%	0,902585	0,902585
Charged Volume				
Links home	m3	106.591	972470	108052,2
Institutional links	m3	461	55322	6146,889
Business Links	m3	4.514	41574	4619,333
Industrial Links	m3	10.161	29651	3294,556
Fontenários	m3	1.860	18448	2049,778
Total	m3	123.587	1117465	124162,8
Ratio (m3)		92%	0,834833	0,834833
RELIABILITY AND QUALITY OF SERVICES				
Production Hours per day	hrs/day	19	154	17,11111
Average number of hours per day distribution	hrs/day	20	153	17
Number average of the whole system	hrs/day	20	159	17,66667
Interruptions in the system caused by lack of electricity	hrs/day	12,0	192	21,33333
Interruptions in the system caused by other reasons	hrs/day	45,0	257	28,55556
Total hours of interruption in the system	hrs/day	57,0	449	49,88889
Average number of days to respond to new connections	day	15	135	15
Average number of days between entry of the complaint and the response to the client (claimant) by the operator	day	15	135	15
Number of complaints	no	79	1111	123,4444
REHABILITATION AND EXTENSION OF SERVICES				
Returns the adductor	no	3	16	1,777778
Repairs on the network	no	0	256	32
Repair service in branches	no	133	1047	116,3333

Number of repairs electromechanical	no	0	0	0
Length of the adductor	Km	0	0	0
Length of network	Km	0	0	0
Length of branches	Km	65	556,81	61,86778
Number of rapações by 100 km of the adductor	no		0	0
Number of rapações by 100 km of network	no		0	0
Number of rapações by 100 km of feeder lines	no	204	1592,335	176,9261
Replacement of pipes	m	0	0	0
New links	no	264	1423	158,1111
Substitution of links	m	56	358	39,77778
Substiuição of fontenarios or repair	no	0	19	2,111111
Meters Replaced	no	0	22	2,444444
Hydrants replaced	no	0	0	0
WATER QUALITY				
Parameters required for testing	no	3	27	3
Parameters required microbilológicos	no	2	18	2
Parameters not required microbilológicos	no	12	86	9,555556
Parameters tested	no	0	103	11,44444
Microbiological parameters tested	no	0	13	1,444444
Microbiological parameters not tested	no		90	11,25
Total samples	no	36	238	26,44444
Total samples collected in the production	no	17	104	11,55556
Total samples in Centros Distributor	no	19	134	14,88889
Total samples that do not meet the standardized parameters	no	14	48	5,333333
Total% of samples that do not meet the standardized parameters	%	39%	0,201681	0,201681
Total production in the samples that do not meet the	no	0	6	0,666667

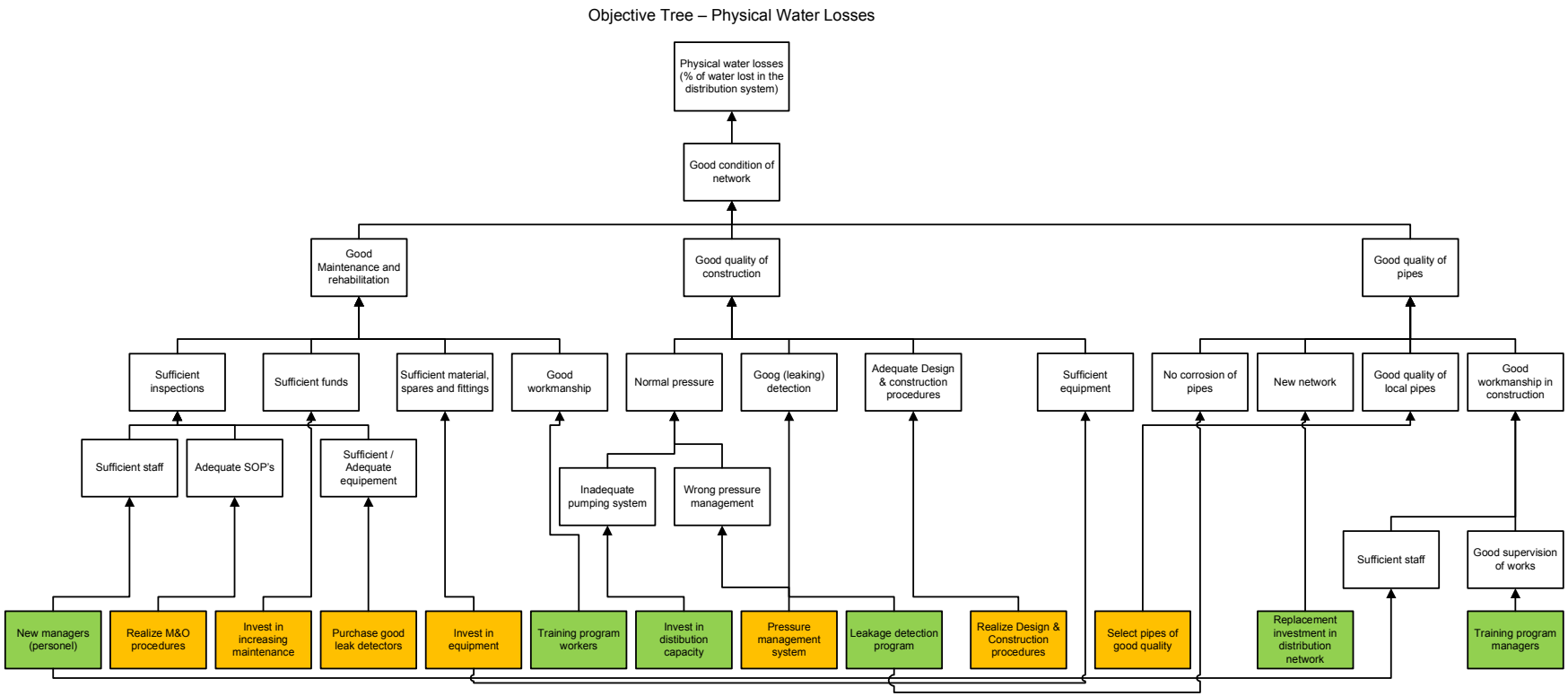
standardized parameters				
Total% of samples in production that do not meet the standardized parameters	%	0%	0,057692	0,057692
Number of samples collected in Centers Distributors and are not in accordance with the standardized parameters	no	19	126	14
% Of samples collected in the Centers Distributors and are not in accordance with the standardized parameters	%	100%	0,940299	0,940299
Raw water				
Parameters required	no	0	0	0
Parameters tested	no	0	0	0
INDICATORS D HUMAN RESOURCES				
Total number of employees	no	107	963	107
Total number of employees per 1000 connections	no	16	17,29495	1,921661

Appendix 7: Problem Tree – Physical water losses

Problem Tree – Physical Water Losses

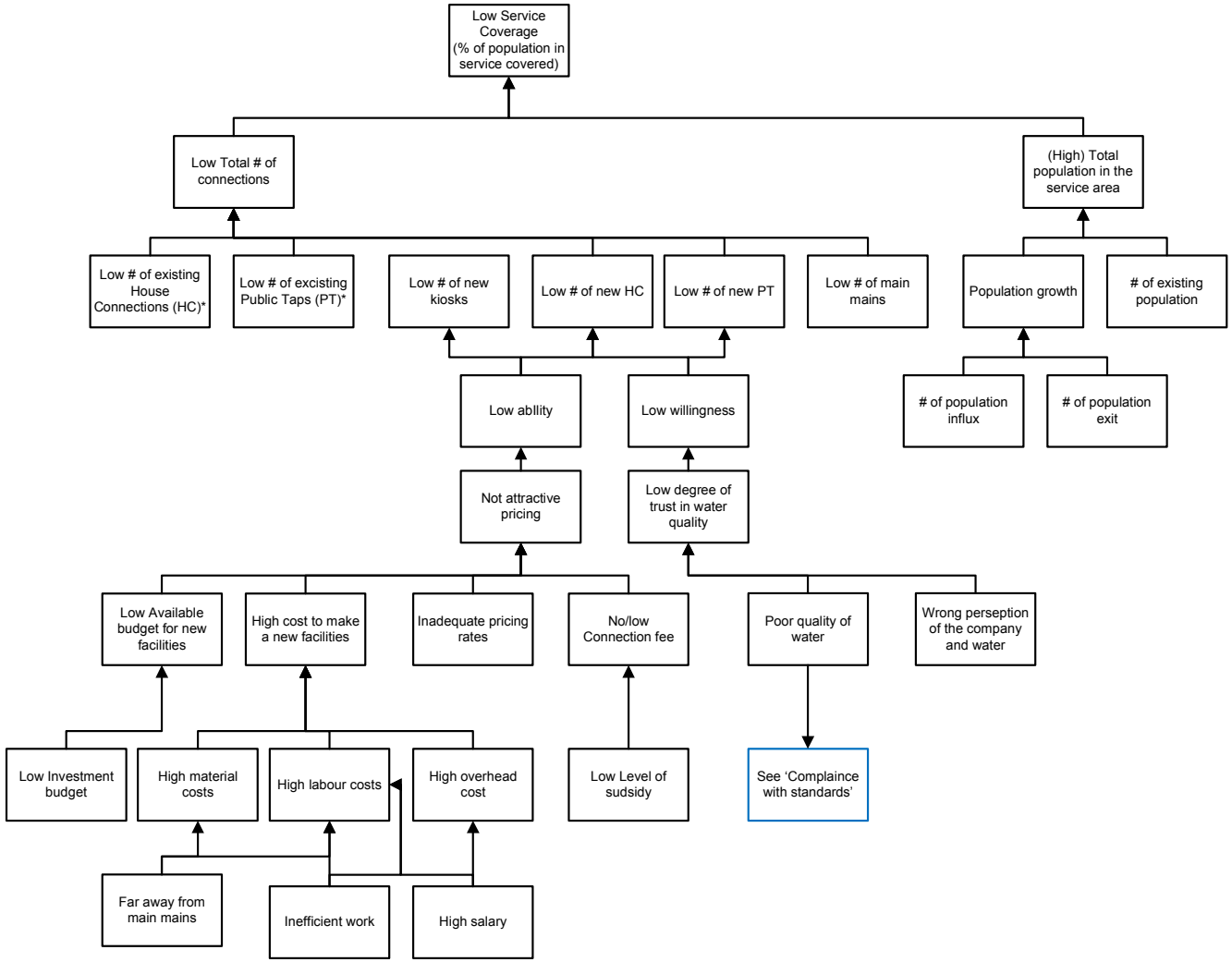


Appendix 8: Objective tree - Physical water losses



Appendix 9: Problem tree – Service coverage

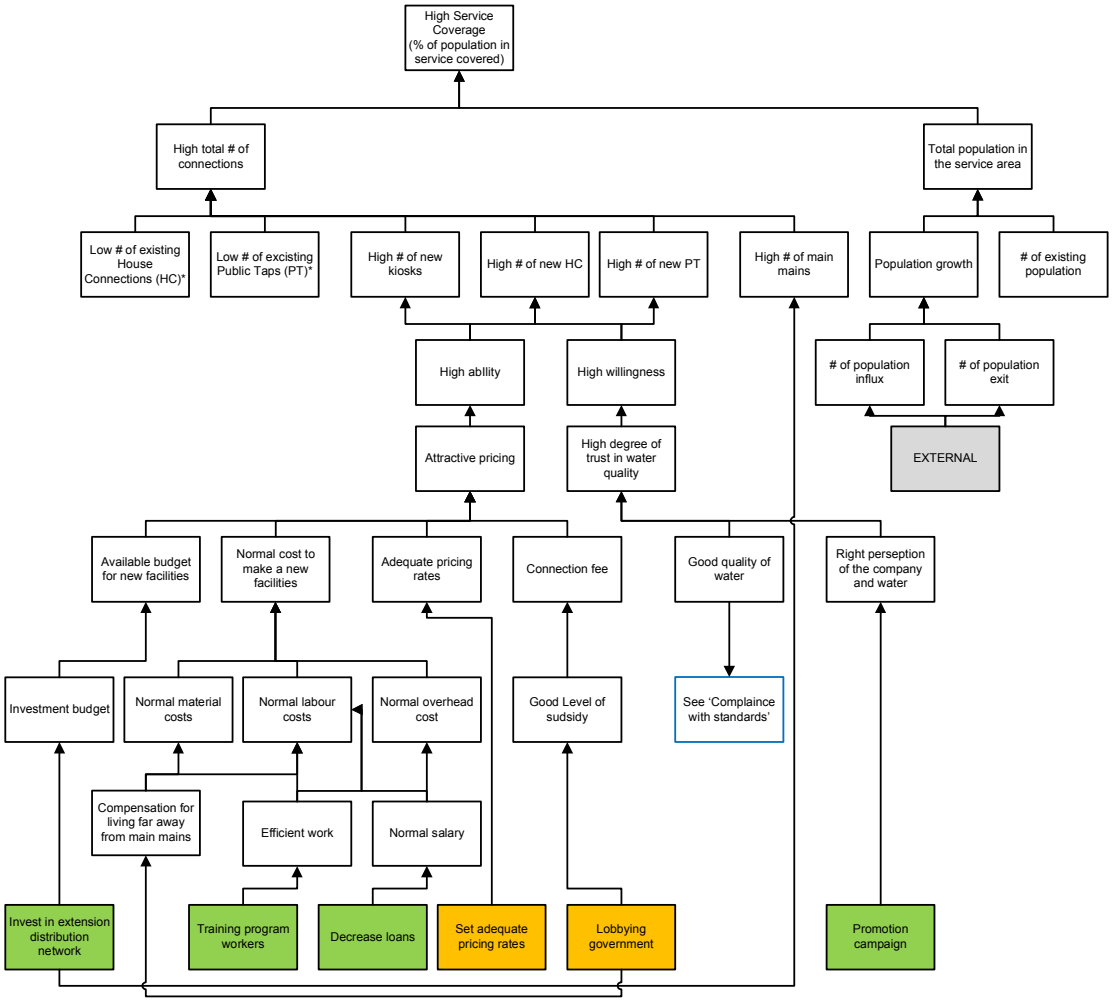
Problem Tree – Service Coverage



* times the people served by PT or HC (estimated)

Appendix 10: Objective tree – Service coverage

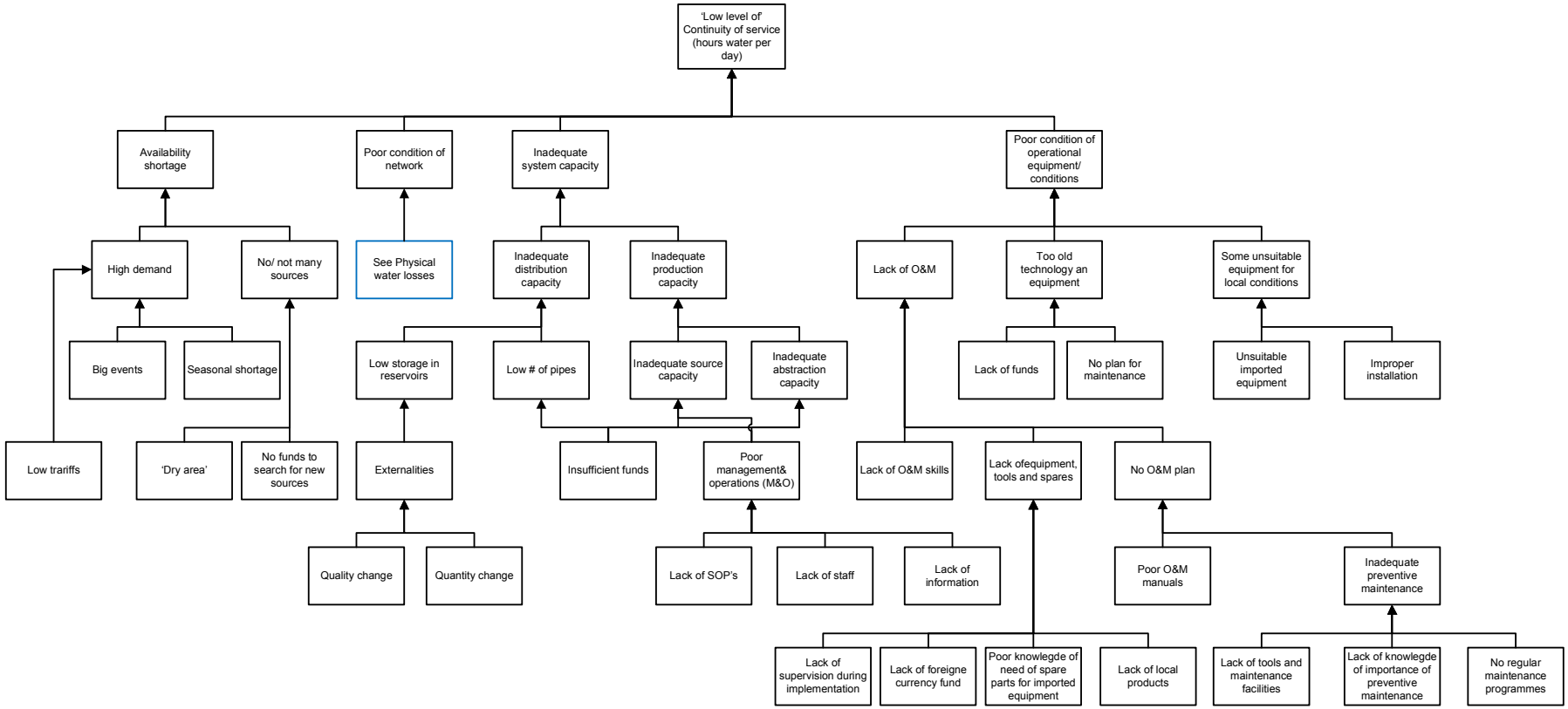
Problem Tree – Service Coverage



* times the people served by PT or HC (estimated)

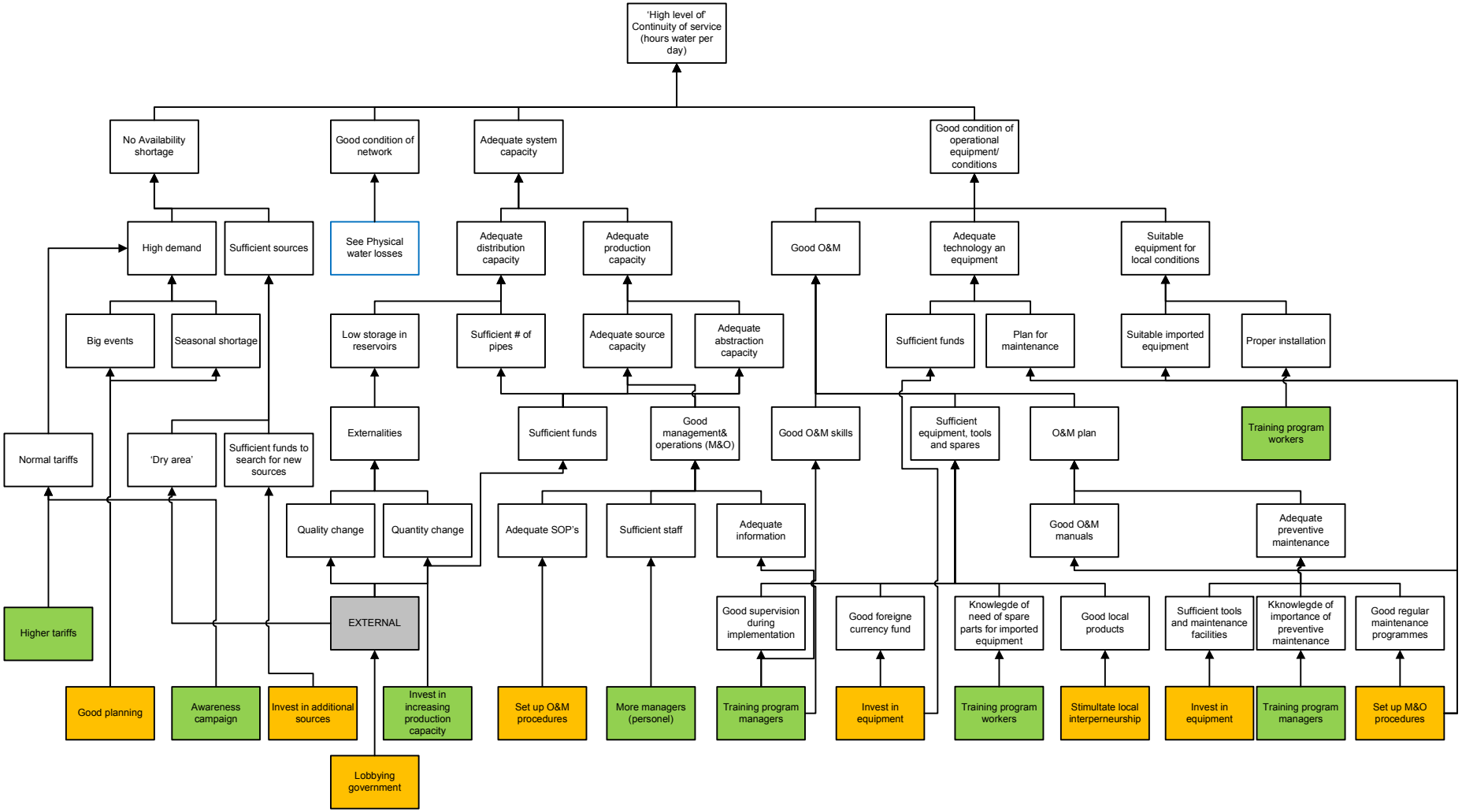
Appendix 11: Problem tree – Continuity of service

Problem Tree – Continuity of service



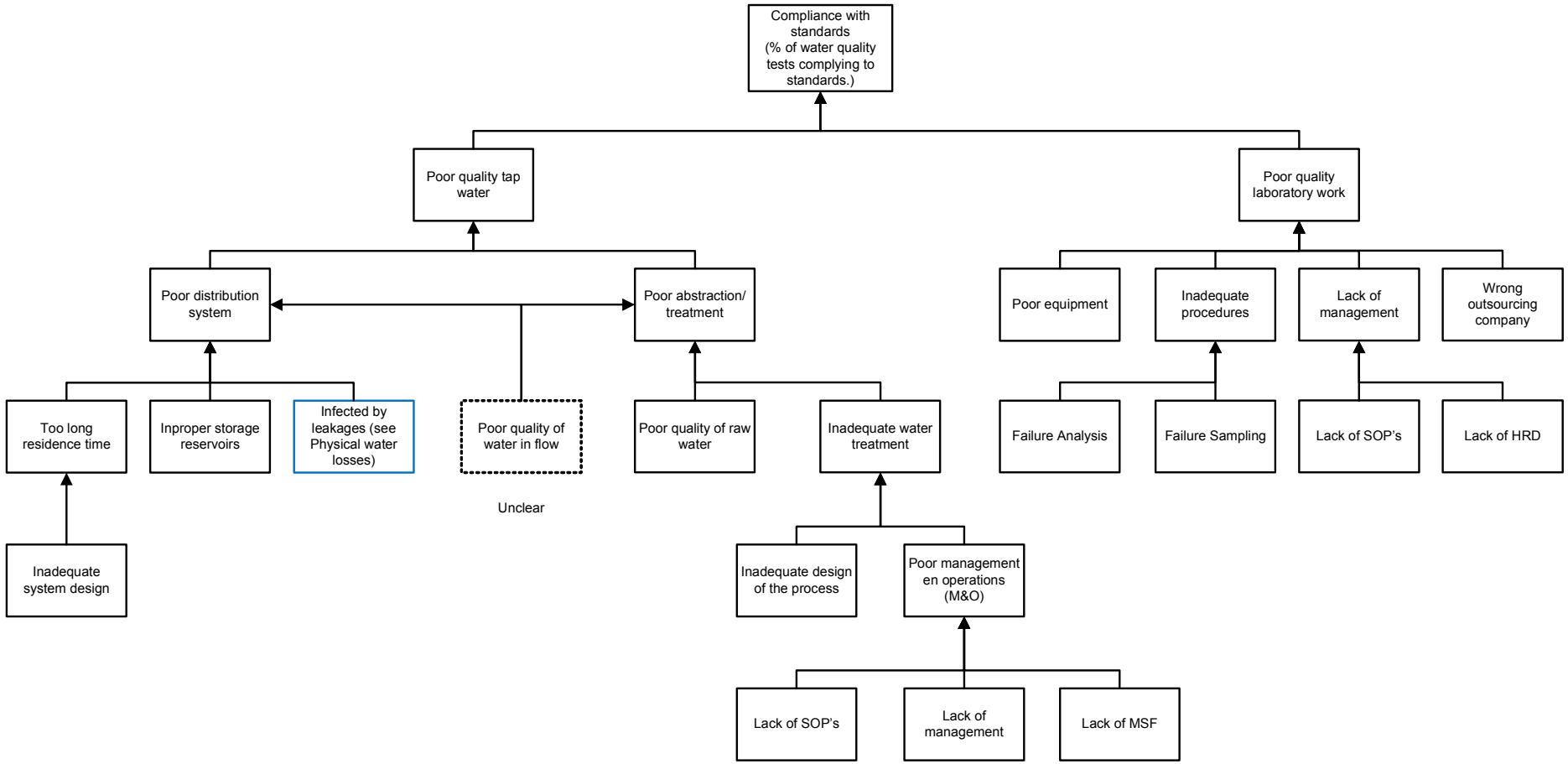
Appendix 12: Objective tree – Continuity of service

Objective Tree – Continuity of service



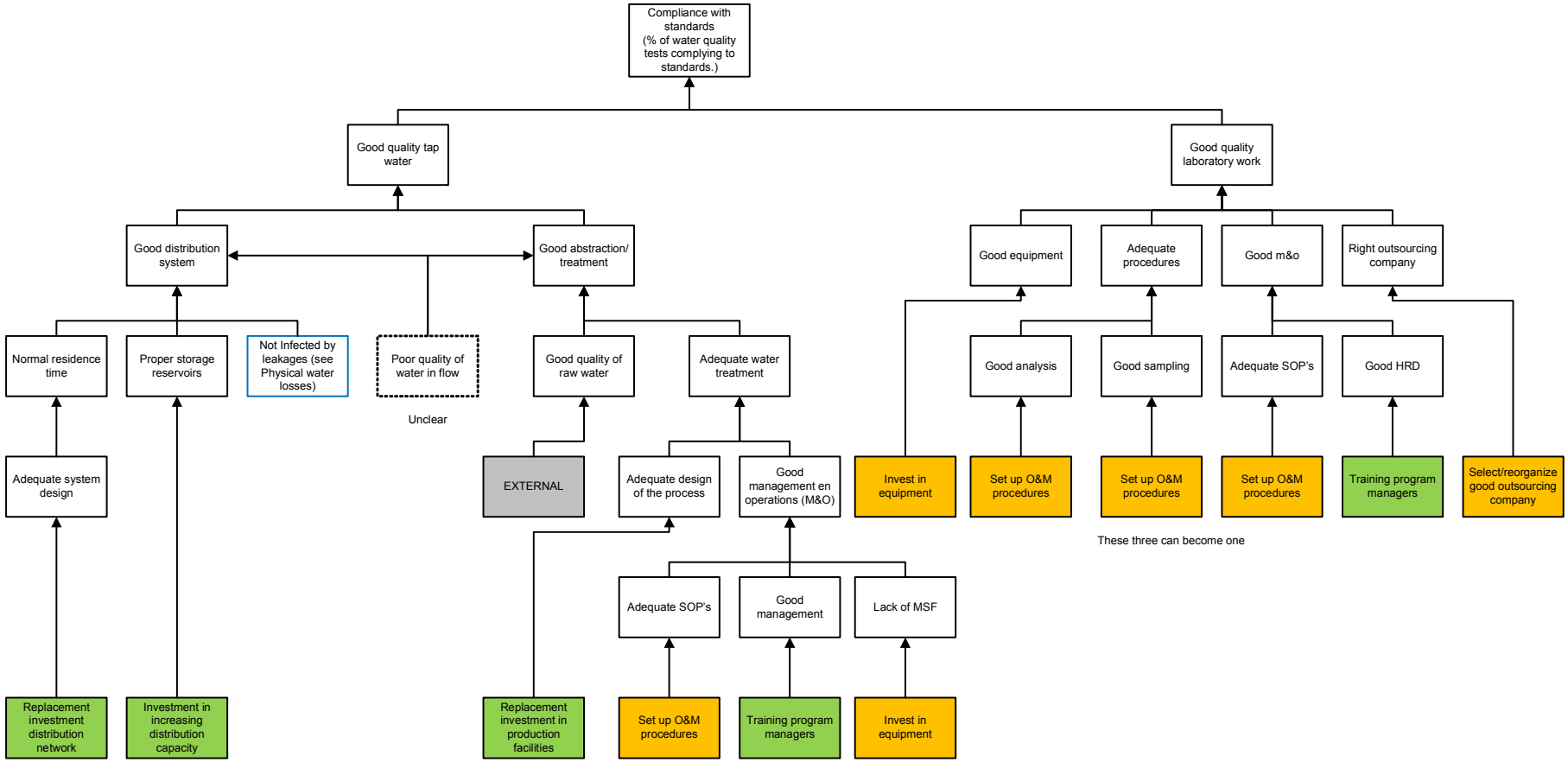
Appendix 13: Problem tree – Compliance with standards

Problem Tree – Compliance with standards



Appendix 14: Objective tree – Compliance with standards

Objective tree – Compliance with standards



Appendix 15: The Matrix-model behind the game

The determined KPI's and decision factors can be visualized in a matrix, where all the relationships between the DF's and KPI's are expressed. The matrix is shown in appendix 15. Horizontally the KPI's are expressed and vertically the DF's. In the first version only the relationships are visible, but to make a usable matrix to extract formula's out of it, this is far from useful. Three important variables need to be determined first:

1) The size of the effect of the DF on the KPI.
2) The range in which a decision can be taken.
3) The timing of the effect of the DF on the KPI.

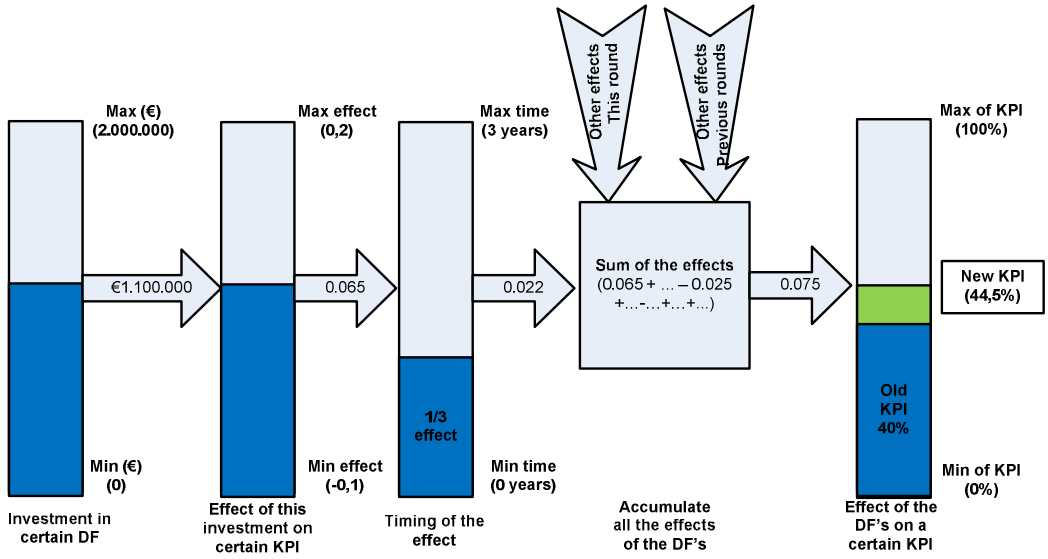
1. There is no literature of the exact influences of certain decision on certain KPI's. The only way to determine this influence is approximate this influence by experts of the IHE and VEI. The following step will be taken to test it comprehensively by 'trial and error'. As mentioned in §3.1.1. most of the KPI are in percentages, which can be decomposed in (a lot of) different variables. To work with that amount of different variables is impossible and does not have added value for the model. We choose to keep the percentages of the KPI's and determine the way the DF's influences this KPI.
The first step will be the estimation of the *maximum* effect that a certain DF can have on a certain KPI. In other words: If you invest the maximum amount stated for this DF (see point 2) than the effect will be on his positive maximum.
The second step will be the estimation of the minimum effect that a certain DF can have on a certain KPI. In other words: If you invest the minimum amount stated for this DF (means investing nothing at all) than there will be a negative effect on the KPI's (or there will be no effect if the DF does not (negatively) affect the KPI).
Between these extremes, there will be a sliding scale of the effect.

2. This scale is determined by the range in which a decision can be taken. In other words, the maximum amount of money that has to be invested to reach the maximum effect. The minimum is always zero, but the maximum needs to be estimated using information from the water enterprise in Mozambique.

3. The last point is the timing of the effect. It's possible that effects are directly noticeable (within one year = one round), but also over a longer period (over a couple of years/rounds). In addition, this effect can be gradually evolving or can be abrupt.

The sum of all the decisions (also when there is no action) on a certain KPI will be the total effect of the DF"s on the KPI. This applies for every KPI, so 15 times. In the following, picture this calculation process in virtualized of one DF on one KPI. Where the first stage is the investment of the team (€1.100.000), this result in an effect (of 0.065 = 6,5%) which will be realized over three years (every year a positive effect of almost 2.2%). The sums of all the (positive and negative) effects together

result in a total effect on the certain KPI (0.075) and realize a new KPI (for the new round) of 44, 5%.



The formula's:

The formula's can be found in the appendix 16. They are formulated as the way described and pictured in the previous paragraph and are linear. The 'new' KPI will be calculated on the KPI of previous rounds plus the effects of the decisions made in that round. To avoid huge ups and downs in the KPI's it is only possible to affect the range that could be improved. For example: If the KPI 'Service coverage' is 70% is only possible to affect the 30% that is left to develop. In addition, this range can decrease the KPI. In that way, there are no big fluctuations. Another advantage is that it is easier to increase a KPI that is performing badly and it is much more difficult to increase a KPI that is almost perfect, which is similar in reality. For water utilities it is much easier (if they have the financial resources) to increase coverage from 40% to 50% than increase coverage from 98% to 100%. Furthermore, the minimum and maximum effects are adopted in the formula as well as the time factor and the maximum amount that can be invested.

Appendix 16: The Matrix

General performance indicators (General manager)

Decision maker		Possible decisions	cost of decisio		General Performance Indicators															
					1)Asset value					2)Loan utilization				3)Staff satisfaction						
					Effect					Effect				Effect						
					Size		Timing			Size		Timing		Size		Timing				
						min	max	1st	full		min	max	1st	full		min	max	1st	full	
F/C/O			indication	value (0-1000 units)	effect					effect					effect					
C	1	Connection fee reduction for lower income households	=	200	=					=	0	-200	0	1	=					
C	2	Customer awareness campaign	-	100	=					-	0	-100	0	1	=					
C	3	Fire personnel	=	100	=					=	0	-100	0	1	-	0	-0.1	0	1	
C	4	Illegal connections detection program	-	100	+	0	0	0	0	-	0	-100	0	1	=					
C	5	Implement a customer caring service	-	200	=					-	0	-200	0	1	=					
C	6	Increase no of bill collectors	-	10	=					-	0	-10	0	1	=					
C	7	Customer GIS system	-	300	=					-	0	-300	0	1	=					
C	8	Increase flexibility of bill payments	-	**10**	=					-			0	1	=					
C	9	Invest in adequate SOP's	-	100	=					-	0	-100	0	1	+	0	0.05	0	1	
C	10	Invest in office, computer hard- and software, technology, et	-	200	+	-33	200	0	1	-	0	-200	0	1	+	0	0.1	0	1	
C	11	Meter calibration program	-	400	=					-	0	-400	0	1	=					
C	12	Training program	-	100	=					-	0	-100	0	1	+	0	0.05	0	1	
F	13	Cutoff non paying customers	=	10	=					=	0	-10	0	1	=					
F	14	Fire personnel	=	100	=					=	0	-100	0	1	-	0	-0.1	0	1	
F	15	Invest in adequate SOP's	-	100	=					-	0	-100	0	1	+	0	0.05	0	1	
F	16	Invest in other office, computer hard- and software, technolo	-	200	+	-33	200	0	1	-	0	-200	0	1	+	0	0.1	0	1	
F	17	Increase tariff	=	**10**	=					=			0	1	=					
F	18	Tariff structure set to cross-subsidize poor hh	=	**10**	=					=			0	1	=					
F	19	Training program (HRD)	-	100	=					-	0	-100	0	1	+	0	0.05	0	1	
O	20	Fire staff	=	200	=					=	0	-200	0	1	-	0	-0.2	0	1	
O	21	Invest in additional (water) sources	-	1000	+	-5	1000	0	1	-	0	-1000	0	1	=					
O	22	Invest in adequate SOP's	-	200	=					-	0	-200	0	1	+	0	0.1	0	1	
O	23	Invest in distribution network capacity	-	1000	+	-2	1000	0	1	-	0	-1000	0	1	=					
O	24	Invest in increasing maintenance	-	100	+	0	0	0	0	-	0	-100	0	1	=					
O	25	Invest in increasing water production capacity	-	1000	+	-5	1000	0	1	-	0	-1000	0	1	=					
O	26	Invest in office, computer hard- and software, technology)	-	300	+	-33	300	0	1	-	0	-300	0	1	+	0	0.2	0	1	
O	27	Leakage reduction program	-	300	=					-	0	-300	0	1	=					
O	28	Training program (HRD)	-	200	=					-	0	-200	0	1	+	0	0.1	0	1	
		# of positive and negative effects			8					21					12					
		maximum effect (cumulative effect of positives)				##	3700					-6620				0	0.8			
		maximum investment		6650																
STARTING KPI (CHOKWE) in %																				

Financial performance indicators (Financial manager)

Decision maker		Possible decisions	cost of decisio		Financial Performance Indicators																			
					4)Working ratio					5)Operating ratio					6)Full cost recovery ratio					7)Cash ratio				
					Effect					Effect					Effect					Effect				
					Size		Timing			Size		Timing			Size		Timing			Size		Timing		
						min	max	1st	full		min	max	1st	full		min	max	1st	full		min	max	1st	full
F/C/O			indication	value (0-1000 units)	effect					effect					effect					effect				
C	1	Connection fee reduction for lower income households	=	200	-	0	-0.1	0	3	-	0	-0.07	0	3	-	0	-0.05	0	3	-	0	-0.05	0	1
C	2	Customer awareness campaign	-	100	=	0	0	0	0	=	0	0	0	0	=	0	0	0	0	-	0	-0.05	0	1
C	3	Fire personnel	=	100	+	0	0.15	1	2	+	0	0.1	1	2	+	0	0.05	1	2	+	0	0.1	0	1
C	4	Illegal connections detection program	-	100	+	0	0.05	0	1	+	0	0.04	0	1	+	0	0.03	0	1	+	0	0.05	0	1
C	5	Implement a customer caring service	-	200	-	0	-0.05	0	5	-	0	-0.03	0	1	-	0	-0.02	0	1	-	0	-0.15	0	1
C	6	Increase no of bill collectors	-	10	-	0	-0.15	0	1	-	0	-0.1	0	1	-	0	-0.05	0	1	+	0	0.1	0	1
C	7	Customer GIS system	-	300	-	0	-0.15	0	1	-	0	-0.1	0	1	-	0	-0.05	0	1	-	0	-0.15	0	1
C	8	Increase flexibility of bill payments	-	**10**	+	0	0.08	0	2	+	0	0.06	0	2	+	0	0.04	0	2	+	0	0.05	0	2
C	9	Invest in adequate SOP's	-	100	+	0	0.2	0	3	+	0	0.15	0	3	+	0	0.1	0	3	+	0	0.05	0	3
C	10	Invest in office, computer hard- and software, technology, et	-	200	-	0	-0.01	0	1	-	0	-0.06	0	1	-	0	-0.08	0	1	-	0	-0.15	0	1
C	11	Meter calibration program	-	400	+	0	0.1	0	2	+	0	0.05	0	2	+	0	0.02	0	2	+	0	0.05	0	2
C	12	Training program	-	100	-	-0.02	0.1	0	3	-	-0.01	0.08	0	3	-	-0.01	0.06	0	3	-	0	-0.1	0	1
F	13	Cutoff non paying customers	=	10	=	0	0	0	0	=	0	0	0	0	=	0	0	0	0	=	0	0	0	0
F	14	Fire personnel	=	100	+	0	0.1	1	2	+	0	0.07	1	2	+	0	0.03	1	2	+	0	-0.1	0	1
F	15	Invest in adequate SOP's	-	100	+	0	0.15	0	3	+	0	0.1	0	3	+	0	0.05	0	3	+	0	0.1	0	1
F	16	Invest in other office, computer hard- and software, technolo	-	200	-	0	-0.03	0	1	-	0	-0.2	0	1	-	0	-0.01	0	1	-	0	-0.15	0	3
F	17	Increase tariff	=	**10**	+	0	0.5	0	1	+	0	0.4	0	1	+	0	0.3	0	1	+	0	0.4	0	2
F	18	Tariff structure set to cross-subsidize poor hh	=	**10**	-	0	-0.1	0	1	-	0	-0.08	0	1	-	0	-0.06	0	1	-	0	-0.2	0	1
F	19	Training program (HRD)	-	100	-	-0.02	0.1	0	3	-	-0.01	0.08	0	3	-	-0.01	0.06	0	3	-	0	-0.1	0	1
O	20	Fire staff	=	200	+	0	0.25	1	2	+	0	0.2	1	2	+	0	0.15	1	2	+	0	0.15	0	1
O	21	Invest in additional (water) sources	-	1000	-	0	-0.1	0	10	-	0	-0.3	0	10	-	0	-0.5	0	10	-	0	-0.3	0	1
O	22	Invest in adequate SOP's	-	200	+	0	0.25	0	2	+	0	0.2	0	2	+	0	0.15	0	2	+	0	0.15	0	1
O	23	Invest in distribution network capacity	-	1000	-	0	-0.1	0	10	-	0	-0.3	0	10	-	0	-0.5	0	10	-	0	-0.3	0	1
O	24	Invest in increasing maintenance	-	100	-	-0.03	-0.1	0	2	-	-0.02	-0.08	0	2	-	-0.01	-0.06	0	2	-	0	-0.35	0	1
O	25	Invest in increasing water production capacity	-	1000	-	0	-0.1	0	10	-	0	-0.3	0	10	-	0	-0.5	0	10	-	0	-0.3	0	1
O	26	Invest in office, computer hard- and software, technology)	-	300	-	0	-0.05	0	1	-	0	-0.03	0	1	-	0	-0.1	0	1	-	0	-0.15	0	3
O	27	Leakage reduction program	-	300	-	0	0.2	0	1	-	0	0.15	0	1	-	0	0.1	0	1	-	0	-0.2	0	1
O	28	Training program (HRD)	-	200	-	-0.05	0.25	0	3	-	-0.04	0.2	0	3	-	-0.02	0.22	0	3	-	0	-0.15	0	1
		# of positive and negative effects			26					26					26					27				
		maximum effect (cumulative effect of positives)				-0.12	1.44				**-0.1**	**0.23**				**-0.1**	**-0.62**				**0**	**-1.75**		
		maximum investment		**6650**		0	100				**0**	**100**				**0**	**100**				**0**	**100**		
STARTING KPI (CHOKWE) in %							**40%**					**60%**					**30%**					**80%**		

Commercial performance indicators (Commercial manager)

Decision maker		Possible decisions	cost of decisio		Commercial Performance Indicators																									
					8)Commercial NRW					9)Nr. of customer complaints					10)Affordability of tariffs					11)Collection efficiency				
						Effect					Effect					Effect					Effect			
						Size		Timing			Size		Timing			Size		Timing			Size		Timing	
						min	max	1st	full		min	max	1st	full		min	max	1st	full		min	max	1st	full
F/C/O			indication	value (0-1000 units)	effect					effect					effect					effect				
C	1	Connection fee reduction for lower income households	=	200	+	0	0.05	0	1	+	0	0.15	0	1	+	0	0.25	0	1	+	0	0.08	0	1
C	2	Customer awareness campaign	-	100	=					+	0	0.08	0	1	=					+	0	0.1	0	1
C	3	Fire personnel	=	100	=					-	0	0.1	0	1	=					-	0	-0.05	0	1
C	4	Illegal connections detection program	-	100	+	0	0.15	0	1	=					=					=				
C	5	Implement a customer caring service	-	200	=					+	0	0.15	0	2	=					+	0	0.1	0	1
C	6	Increase no of bill collectors	-	10	=					=					=					+	0	0.15	0	1
C	7	Customer GIS system	-	300	+	0	0.15	0	2	+	0	0.1	0	2	=					=				
C	8	Increase flexibility of bill payments	-	**10**	=					+	0	0.15	0	1	+	0	0.1	0	1	+	0	0.1	0	1
C	9	Invest in adequate SOP's	-	100	+	0	0.1	0	3	+	0	0.1	0	3	=					=				
C	10	Invest in office, computer hard- and software, technology, et	-	200	+	0	0.15	0	1	+	0	0.12	0	1	=					+	0	0.08	0	1
C	11	Meter calibration program	-	400	+	0	0.15	0	2	+	0	0.1	0	2	=					=				
C	12	Training program	-	100	+	-0.02	0.1	0	2	+	-0.02	0.1	0	2	=					+	-0.02	0.08	0	2
F	13	Cutoff non paying customers	=	10	+	-0.02	0.25	0	1	-	0	-0.3	0	1	=					+	-0.02	0.25	0	1
F	14	Fire personnel	=	100	=					=					=					=				
F	15	Invest in adequate SOP's	-	100	=					=					=					=				
F	16	Invest in other office, computer hard- and software, technolo	-	200	=					=					=					=				
F	17	Increase tariff	=	**10**	-	0	-0.3	0	1	-	0	-0.4	0	1	-	0	-0.4	0	1	-	0	-0.25	0	1
F	18	Tariff structure set to cross-subsidize poor hh	=	**10**	+	0	0.08	0	1	+	0	0.1	0	1	+	0	0.15	0	1	-	0	-0.1	0	1
F	19	Training program (HRD)	-	100	=					=					=					=				
O	20	Fire staff	=	200	=					-	0	0.05	0	1	=					=				
O	21	Invest in additional (water) sources	-	1000	=					+	0	0.05	1	3	=					=				
O	22	Invest in adequate SOP's	-	200	=					+	0	0.03	0	1	=					=				
O	23	Invest in distribution network capacity	-	1000	=					+	0	0.1	1	3	=					=				
O	24	Invest in increasing maintenance	-	100	=					+	-0.1	0.1	0	1	=					=				
O	25	Invest in increasing water production capacity	-	1000	=					+	0	0.1	1	3	=					=				
O	26	Invest in office, computer hard- and software, technology)	-	300	=					+	0	0.05	0	1	=					=				
O	27	Leakage reduction program	-	300	=					+	-0.01	0.1	1	2	=					=				
O	28	Training program (HRD)	-	200	=					+	-0.02	0.05	0	1	=					=				
		# of positive and negative effects			10					22					4					11				
		maximum effect (cumulative effect of positives)				-0.04	0.88				-0.15	1.18				0	0.1				-0.04	0.54		
		maximum investment		6650																				
STARTING KPI (CHOKWE) in %							**20%**					**50%**					**80%**					**60%**		

Operational performance indicators (Operational manager)

Decision maker		Possible decisions	cost of decisio		Operational Performance Indicators																			
					12)Water Losses					13)Continuity					14)Quality					15)Coverage				
						Effect					Effect					Effect					Effect			
						Size		Timing			Size		Timing			Size		Timing			Size		Timing	
						min	max	1st	full		min	max	1st	full		min	max	1st	full		min	max	1st	full
F/C/O			indication	value (0-1000 units)	effect					effect					effect					effect				
C	1	Connection fee reduction for lower income households	=	200	=					=					=					+	0	0.2	0	1
C	2	Customer awareness campaign	-	100	+	-0.1	0.2	0	1	+	-0.1	0.2	0	1	=					+	0	0.2	1	2
C	3	Fire personnel	=	100	=					=					=					=				
C	**4**	**Illegal connections detection program**	**-**	**100**	**=**					**=**					**=**					**+**	**-0**	**0.2**	**0**	**2**
C	5	Implement a customer caring service	-	200	=					=					=					=				
C	6	Increase no of bill collectors	-	10	=					=					=					=				
C	7	Customer GIS system	-	300	+	0	0	0	0	=					=					=				
C	8	Increase flexibility of bill payments	-	**10**	=					=					=					+	0	0.2	0	2
C	9	Invest in adequate SOP's	-	100	=					=					=					=				
C	10	Invest in office, computer hard- and software, technology, et	-	200	=					=					=					=				
C	11	Meter calibration program	-	400	=					=					=					=				
C	12	Training program	-	100	=					=					=					=				
F	13	Cutoff non paying customers	=	10	=					=					=					=				
F	14	Fire personnel	=	100	=					=					=					=				
F	15	Invest in adequate SOP's	-	100	=					=					=					=				
F	16	Invest in other office, computer hard- and software, technolo	-	200	=					=					=					=				
F	17	Increase tariff	=	**10**	=					+	0	0.2	0	1	=					-	0	-0.2	0	1
F	18	Tariff structure set to cross-subsidize poor hh	=	**10**	=					=					=					=				
F	19	Training program (HRD)	-	100	=					=					=					=				
O	20	Fire staff	=	200	-	0	-0.2	0	1	-	0	-0.2	0	1	-	0	-0.2	0	1	-	0	0	0	0
O	**#**	**Invest in additional (water) sources**	**-**	**1000**	**=**					**+**	**0**	**0.4**	**1**	**3**	**=**					**+**				
O	22	Invest in adequate SOP's	-	200	+	0	0.2	0	1	+	0	0.2	0	1	+	0	0.2	0	1	=				
O	23	Invest in distribution network capacity	-	1000	+	0	0.2	1	3	-	0	-0.4	1	3	-	0	0	0	0	+	0	0.4	1	3
O	24	Invest in increasing maintenance	-	100	+	-0.2	0.2	0	1	+	-0.1	0.1	0	1	+	-0	0.2	0	1	+	0	0	0	0
O	25	Invest in increasing water production capacity	-	1000	=					+	0	0.4	1	3	+	0	0.4	1	3	=				
O	26	Invest in office, computer hard- and software, technology)	-	300	+	0	0.2	0	1	+	0	0.2	0	1	+	0	0.2	0	1	=				
O	**#**	**Leakage reduction program**	**-**	**300**	**+**	**0**	**0.4**	**1**	**2**	**+**	**0**	**0.4**	**1**	**2**	**+**	**0**	**0.4**	**1**	**2**	**+**	**0**	**0**	**0**	**0**
O	28	Training program (HRD)	-	200	+	-0.1	0.2	0	1	+	-0.1	0.2	0	1	+	-0	0.2	0	1	+	0	0	0	0
		# of positive and negative effects			9					11					8					11				
		maximum effect (cumulative effect of positives only)				**-0**	**1.6**				**-0**	**1.9**				**-0**	**1.6**				**-0**	**1.2**		
		maximum investment		**6650**		0	100				0	100				0	100				0	100		
STARTING KPI (CHOKWE) in %							**57%**					**80%**					**###**					**24%**		

Appendix 17: Screenshot Water management game