Financial Analysis of Wastewater Treatment Plant in Famagusta – North Cyprus

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ABSTRACT

The aim of this study is to explore the unit cost of treated wastewater that farmers may be willing to pay per cubic meter for irrigation purposes in other to give up the use of underground water. For this, an appraisal for the wastewater treatment plant was undertaken using the cost-benefit analysis approach. The appraisal assesses solely the financial and sensitivity analysis to enable an efficient long term feasibility and sustainability of the wastewater treatment plant. The financial analysis conducted shows that the FNPV of the treated wastewater plant is positive and significantly large enough to generate high returns on investment for the municipality. Therefore, we can say that, the treatment plant project is feasible and it will be able to generate sufficient cash flows. Also, based on the sensitivity analysis results, it appears that the variables under observations are not sensitive enough to affect the FNPV of the project. At the end of this study, it was found that farmers in Gazimagusa – North Cyprus are paying higher for purifying wastewater (0.39 euros per cubic meter) when compared to what is obtainable by farmers in the South Cyprus (0.15 EUR per cubic meter) of treated wastewater.

Keywords: Investment Appraisal, Financial Analysis, Sensitivity analysis, Wastewater Treatment Plant, Gazimagusa - North Cyprus.

ÖZ

Bu çalışmanın amacı, çiftçilerin yeraltı su kullanımını vazgeçmek diğer sulama amaçlı metreküp başına ödemeye istekli olabilir arıtılan atıksu birim maliyetini araştırmaktır. Bununla birlikte, atık su arıtma tesisi bir değerlendirme maliyet-fayda analizi yaklaşımı kullanılarak yapılmıştır. değerlendirme sadece atıksu arıtma tesisinin etkin uzun vadeli fizibilite ve kalıcılığının sağlanması için mali ve duyarlılık analizi değerlendirir. gerçekleştirilen mali analiz arıtılmış atık su tesisinin FNPV pozitif ve belediye için yatırım yüksek getiri yeterli ölçüde büyük olduğunu göstermektedir. Bu nedenle, arıtma tesisi projesi uygulanabilir, diyebiliriz ve yeterli nakit akışlarını oluşturmak mümkün olacak. Ayrıca, duyarlılık analizi sonuçlarına göre, o gözlemler altında değişkenler projenin FNPV etkileyecek kadar duyarlı olmadığını fark ettik. Kuzey Kıbrıs metreküp başına 0.15 Euro Güney Kıbrıs'taki çiftçiler tarafından elde olanlarla karşılaştırıldığında oldukça pahalı Arıtılmış atıksuyun metreküp başına 0.39 Euro ücret uygulanır - Bu çalışmanın sonunda, Gazimağusa'da çiftçiler bulunmuştur bir atık muamele edilmiştir.

Anahtar Kelimeler: Yatırım Değerlendirme, Mali Analiz, Hassasiyet analizi, Atık Su Arıtma Tesisi, Gazimağusa - Kuzey Kıbrıs.

I dedicate this thesis to my parent, who taught me that there is dignity in learning.

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LISTS OF ABBREVIATION

A/R	Account Receivables
A/P	Account Payables
ADSCR	Annual Debt Service Capacity Ratio
BCR	Benefit Cost Ratio
CBA	Cost Benefit Analysis
CL_2	Chlorine
CMC	Centre for Mediterranean Cooperation
EAA	Environmental Engineer Association
EUR	Euros
$FeCL_3$	Ferric Chlorine
FNPV	Financial Net Present Value
GDP	Gross Domestic Product
IUCN	International Union for Conservation of Nature
NPV	Net Present Value
TRNC	Turkish Republic of North Cyprus
UNESCO	United Nations Educational, Scientific and Cultural Organization
UN	United Nations
VAT	Value Added Tax
WWTP	Wastewater Treatment Plant
WB	World Bank

Chapter 1

INTRODUCTION

1.1 Background to the Study

Water is a foundation of life and it is the key to sustainable development. Having access to potable water is becoming a pressing social, economic and geopolitical issue in the livelihood of people in the Mediterranean region, Middle East Region and North Africa. This is because, freshwater resources are very scarce and about 60% of freshwater comes from river basins (UN Water, 2017). The scarcity of freshwater resources is as a result of pollution and poor water management, that is, uncontrolled use of freshwater have led to a drop in the level of freshwater around the globe, whereby 1.8 billion people now use a source of drinking water contaminated by human waste; also around 80% of wastewater returns to the environment without adequate treatment, as well as 30% of global water abstraction is lost through leakages in pipelines due to poor sustainable development goal (UN, UNESCO, 2017).

Notwithstanding, global climatic conditions surges the problem of water scarcity around the globe as well as in the Mediterranean region, where over-pumping groundwater beyond natural recharge rates has resulted in lowering the water table and causing an increase in groundwater salinity, groundwater depletion and ecological degradation (World Bank, 2009). According to reports from the International Union for Conservation of Nature (IUCN) and Centre Mediterranean

Cooperation (CMC), they reported that, this region is exposed to constant and rapid climate change which forecast a sharp decrease in precipitation between -4% and -27% across all seasons, and an estimated increase in average surface temperature between 2.2 °C and 5.1 °C. Thus, making the rapid urbanized and agricultural based region that relies on rainfall to seek for alternatives source of freshwater resources due to water scarcity. This is especially the case of Island of Cyprus particularly the Northern Cyprus (The Turkish Republic of Northern Cyprus).

The Turkish Republic of Northern Cyprus popularly referred to as “TRNC” and also known as Kuzey Kibris Turk Cumhuriyeti is a partially recognized state that comprises the North Eastern portion of the Island of Cyprus. By being recognized only by the country of Turkey, Northern Cyprus is considered by the International Community to be part of the Republic of Cyprus (Wikipedia, 2018)

In 2016, the country is said to have had an estimated total population of 264,172 people and a surface area of about 3,355 km² (1,295 Square Milles) as well as a Gross Domestic Product (GDP) of over $4,032 billion in 2016. In addition, North Cyprus constitutes of six districts, Lefkosa (Capital), Gazimagusa, Girne, Guzelyurt, Iskele and Lefke. Three out of these six districts experienced rapid growth in population due to tourism, tertiary institutions (universities) and industrial development with Lefkosa of about 84,893, Gazimagusa -67,852 and Girne - 61,192 people respectively.

Despite its flourishing tourism sector, North Cyprus is located in a semi-arid area in the Mediterranean region, where these arid areas do experience continues rise in temperature. In the last century, the Island experienced 25% decrease in rainfall.

Year after years, North Cyprus faces not only water quantity problems but also water quality problems, which is due to erratic rainfall and water management problems.

Due to the constant decrease in rainfall rate, the demands for water, either for domestic, industrial and agricultural purposes is met mostly from groundwater resources, which covers about 92% from groundwater, 5% from surface waters and 3% from desalinization water respectively. The total annual fresh water resources supply were 90 million m^3 against 105 – 110 million m^3 annual water demands, while the bulk of the water say 60% - 80% was allocated for agricultural purposes (Michael and Rebecca, 2017). For this reason, there has been a decrease in the groundwater level, causing sea water intrusion in the shoreline aquifers. In addition, according to some reports from Michael et al (2017), the problem of water shortage stems from the uncontrolled use of water by certain farmers. This farmers was reported to have had direct access to the aquifers, couple with the absence of a strict policy from the local governing body that determine the most effective and efficient supply of agricultural water. This is done to encourage better techniques for irrigating crops and for tree planting. Furthermore, there is little or no policy or strategy to protect the natural resources used in the tourism sector. In a situation, where some large hotels were built in desalinization plants, this largely remains unregulated, thus have grievous effects on seawater or groundwater.

The continuous unregulated extraction of groundwater resources above sustainability level, led to a partial or almost complete depletion of all aquifers and seawater intrusion in the aquifers. This had pushed both the government and the local municipality to step up on drastic measures to improve and increase both the quantity and quality of water in North Cyprus. Such measures includes, bringing freshwater from Turkey, a project idea, which was dubbed as the project of the century, desalinization of plants, alongside wastewater treatment plants.

1.2 Wastewater Treatment Plant and its Importance

Wastewater treatment is a process used to convert wastewater (used water originating from domestic, industrial, agricultural, medical and transport activities) into an effluent (outflowing of water to a receiving body of water) that can be returned to the water cycle with minimal impact on the environment or directly reused. It is also known as water reclamation because the treated wastewater can be used for other purposes. However, wastewater does not include water released from ponds or reservoirs for fish farming, thus, the treatment of wastewater is of the field of sanitation, which involves the management of human waste (sewage water), solid and light waste (industrial wastewater) as well as storm water (drainage).

The treatment process takes place in a Wastewater Treatment Plant (WWTP) as shown in Figure 1, which is often referred to as a Sewage Treatment Plant (STP) or a Water Resource Recovery Facility (WRRF). Here, all pollutants or contaminants in municipal wastewater, both household and small industries are broken down into by-products known as sewage sludge, via various processes and further treatments before being suitable for disposal or application to land.

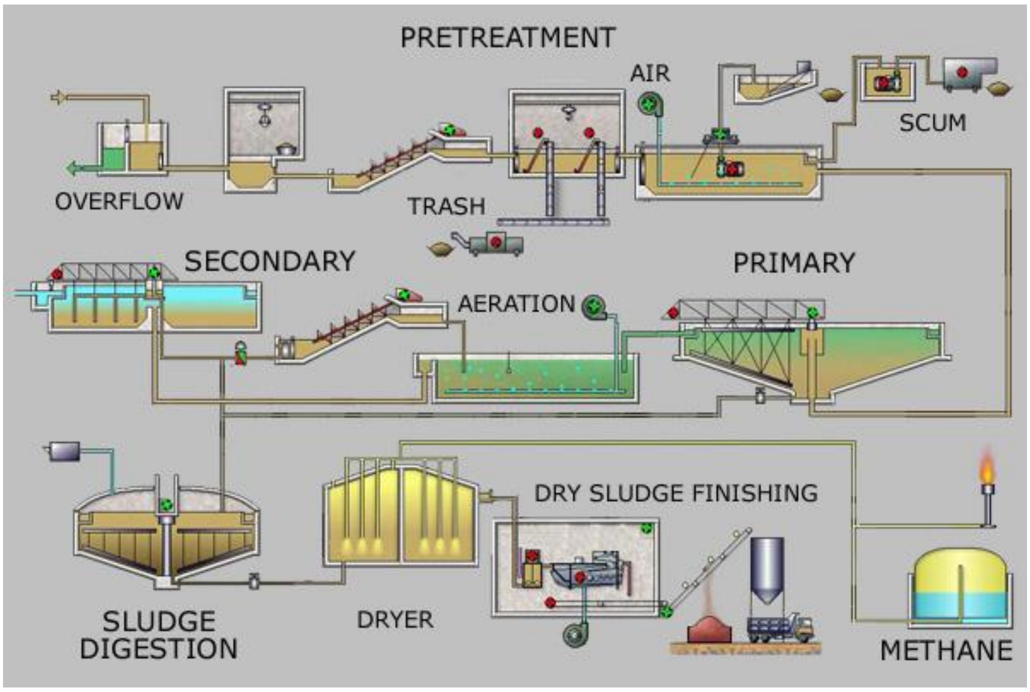

Figure 1: Wastewater Treatment Plant Process

Generally, the basic function of wastewater treatment plant is to speed up the natural processes by which water was purified and this involves three stages; the primary, secondary and tertiary treatment plant. First, before the wastewater enters the plant for primary treatment, it goes through a pretreatment for filtration, screening, water flow regulation and some fat and grease removal in the bar screen (removal of heavy and large objects such as rags, sticks, plastic packets, tree limbs, branches and other heavy objects), grit chamber (consists of sand, gravel, cinders and other heavy materials for the removal of leftover organic matters such as eggshells, bone chips, seeds, coffee grounds and others), clarifiers and equalization basin, after which it is transferred for primary treatment. Figure 2 show the Famagusta wastewater treatment plant.

Figure 2: Gazimagusa Wastewater Treatment Plant.

The primary treatment involves the separation of organic solid matter or human waste from wastewater. This can be done by putting the wastewater into expansive settlement tanks for the solids to sink to the foot of the tanks. Huge scrappers ceaselessly scrap the floor of the tank and thrust the slime towards the center where it is pumped for treatment. The rest of the water is then moved to the secondary or auxiliary treatment. Within the secondary or auxiliary treatment stage, the water is put into huge rectangular tanks. These tanks are called “aeration lanes”. During this phase, air is pumped into the water to encourage bacteria to breakdown the minor bits of sludge that escaped the sludge scrapping process.

In the tertiary treatment stage, the nearly treated wastewater is passed through a settlement tank. Here, more sludge is shaped at the foot of the tank from the settling of the bacterial activity. The sludge is scratched and collected for treatment. The water at this stage is almost free from harmful or destructive substances and chemicals. The water is permitted to flow over a wall where it is shifted through a bed of sand to evacuate any extra particles. Then, the filtered water is either discharged into the river or coordinated to the agriculturists for water system purposes.

Moreover, the wastewater treatment plant is highly important because its main objective is to produce an effluent that is, treated or untreated industrial and household wastewater that will do little or no harm to the aquatic ecosystem, animals or humans, when discharged to the stream. This serves as a prevention mechanism to pollution when compared to untreated wastewater into the environment.

Lastly, the treated wastewater is primarily important and useful for irrigation, given the increasing competition for water between agriculture and other sectors, (Sato et al. 2013 and Toze, 2006). Another importance of a wastewater treatment plant is that, since the crisis of water scarcity is looming on the horizon threatens the stability and security of the district, the crisis will continue and increase with time, if no suitable actions are taken as soon as possible. Therefore, the reuse of treated wastewater is well recognized for having a potentially significant role in alleviating the quantitative and qualitative stress of water resources in the region

1.3 Statement of the Problem

This study seek to investigate the activities of farmers in Northern Cyprus as it relate to wastewater treatment plant, since it has been observed that for a long time now, the underground aquifers where drying up and this was due to farmers activities in North Cyprus especially those of Gazimagusa. It was believed that, farmers in North Cyprus had access to fresh water in the aquifers for irrigation purpose, while the demand for drinking water kept on increasing; its supply was limited, in order to find a last lasting solution to this insufficient water supply. In this study, we intend to examine the causes of these problem and ways to reduce it. That is, we seek to find out, cost per cubic meter (m^3) of treated water, the farmers are paying in order to give up direct access to freshwater in the underground aquifers for irrigation purposes. Under the current analysis, we examined the financial analysis from the perspective of Private Public Partnership (PPP) and what is the unit cost of purifying water. The PPP agreement in this regards is a business relationship between the European Union and the municipality of Famagusta in Northern Cyprus.

1.4 Research Methodology

There are several instruments that have been adopted in analyzing the influence of a wastewater treatment plant on the economy; but hardly has any study employed, an integrated investment appraisal approach in wastewater treatment plant literature. This create a gap, this study is seek to fill, by estimating cost per cubic meter (m^3) of treated wastewater, that can be used as an alternative to lure farmers from using freshwater for irrigation purpose. This study seeks to conduct financial analysis, via the cost-benefit approach. Using this approach will helps us to understand the financial viability of a wastewater treatment plant in North Cyprus, while carrying out sensitivity analysis, will reveal those risky variables that might affect the treatment plant and the environment or the society involve.

1.5 Outline of the Study

Chapter one of this study, provides a brief history of water scarcity both in the world and in North Cyprus, the step by steps treatment of wastewater in a treatment plant, and the importance of a sewage treatment plant. Chapter two gives a brief overview of the wastewater treatment plant, its literature and the empirical reviews related to the study. Chapter three entails the methodology adopted to carry out this study, while chapter four deals with the financial appraisals of the study. The input parameters in this section will be used to construct the financial model of the sewage treatment plant. Financial analysis show how the input parameters are used to determine the depreciation periods, unit cost of wastewater, unit operating cost, the cost per cubic meter and the cash flows. In addition, the real net present value (R-NPV) is interpreted to guarantee that the plant is financially viable to the municipality. Lastly, chapter five concludes the study with suggested policy recommendations.

Chapter 2

AN OVERVIEW OF THE STUDY

2.1 Introduction

In recent time, it is believed that a significant amount of money is devoted to the treatment of water and sewer systems. The Environmental Engineers Association (EEA) voiced out that there have been a considerable increase in groundwater contamination which has led to the scarcity of freshwater and drying out of the underground aquifers over the years from wastewater and seawater intrusion as well as arid (or rigid) climatic conditions. The degree at which the wastewater affects the environment and groundwater cannot be underestimated. This implies that, water incorporates a valuable esteem and each drop must be accounted for, especially in water scarce regions. Wastewater has to be reclassified as a renewable water source rather than waste, as it helps increase water availability and prevents environmental pollution by treating and reusing it (Jhansi and Mishra, 2013). With agriculture being the main user of freshwater; the reuse of treated urban wastewater for agriculture could, at least, relieve the current freshwater stress, (Maite et al, 2012; Kimberly et al, 2015 and Arslan et al, 2015). Hence, there is a need for treatment plant(s) to be situated in every region of Northern Cyprus in order to avoid further groundwater contamination and drought in the aquifers.

Wastewater treatment plant can be described as the process of removing contaminants from wastewater, primarily from household's sewage. The physical, chemical and biological processes are used to remove contaminants and produce treated wastewater that is safer for the environment.

2.2 The Use of Bacteria’s and Chemicals in the Wastewater Treatment Plant

2.2.1 The Secondary Process or Biological Treatment

The secondary stage in the wastewater treatment plant can also referred to as the biological stage. This stage involves the use of the micro-organisms or bacteria such as aerobic, anaerobic and facultative bacteria in the aeration basin, anaerobic chamber and the secondary clarifier tank to purify the water. Out of the microscopic organisms, the bacteria (singular: bacterium) are the most important in wastewater treatment plants and can be seen with the light microscope only under the highest magnification (Michael, 2006).

In the activated biological or sludge process, micro-organisms or bacteria are mixed with wastewater. The aerobic bacteria are also used in the aeration basin, where air is pump along the process. The purpose of this is to break down, oxygen accessible for the breath of the microbes. They utilize the free oxygen within the water to biodegradable materials within the approaching wastewater into energy (or as food), which they are utilized for development and propagation. The oxygen level in the wastewater is usually done mechanically through the utilized aerators within the circulated air basin (or bowl) of the treatment plant. With an ordinary influent stack of toxins, the broken up oxygen substance within the circulated air basin of the treatment plant can be maintained between 3 and 5 MG/L.

The anaerobic microbes are customarily utilized in an anaerobic digester to diminish the volume of slime to be arranged of and to deliver methane gas. This is completed in an anaerobic state, without any broken down oxygen within the water. The microscopic organisms regularly get the oxygen required for breath from food sources. This handle is additionally called aging. As previously said, amid the anaerobic absorption handle, the anaerobic microscopic organism produces methane gas as by-product. This gas, if legitimately cleaned and collected, it may be utilized as another vital energy source.

Another utilization of anaerobic microscopic organisms is within the organic disposal of phosphorus. Amid this prepare, portion of the high-impact area of the treatment plant may be made into an anaerobic zone to encourage the development of phosphorus amazing life forms, which in turn brings down the amount of phosphorus within the gushing.

Finally, facultative bacteria (or microscopic organisms) are capable to alter their method of breath from oxygen consumption to anaerobic and back once more. These microbes are capable of adjusting to any environment, they incline to high-impact (or aerobic) condition. These three categories of microbes are amassed as it were by their strategy of respiration. There are numerous species of microbes used in treatment of wastewater in a wastewater treatment plant. The composition and diversity of the microbial community had the greatest impact on stability and performance of the wastewater treatment plant according to Miura et al (2007). Once the biological treatment in the aerobic basin, anaerobic chamber and secondary clarifier tank is over, the biologically treated water is then transferred to the tertiary step for further (or chemical) treatment.

2.2.2 Tertiary Process or Chemical Treatment

The disinfection of wastewater is necessary and vital for secure portable water supplies and for sound rivers and streams. Micro-organisms are present in large numbers in the sewage treatment plant effluents and waterborne disease outbreaks have associated with sewage-contaminated water supplies and recreational waters. This is where the chemical treatment takes over before discharging the treated water into the river, streams or environment. The chemical treatment process involves the removal of micro-organisms such as bacteria, viruses, and other toxic pollutants such as cyanides, pesticides, industrial chemical wastes and other chemicals that remains after the secondary clarifier treatments which are known to be harmful to human. The chemicals that are majorly used in the wastewater treatment process include, Chlorine (CL_2), Polymers and Ferric Chlorine ($FeCL_3$) among others.

Chlorination plays a vital role in the wastewater treatment process and it is by far the commonly adopted method of wastewater disinfection. It is used worldwide for the removal of pathogens before discharged into receiving streams, rivers or oceans. Chlorine is known to be effective in destroying a variety of bacteria, viruses and protozoa including salmonella, shigella, vibrio cholera, typhoid, dysentery, ammonia and many others.

The process of chlorination is usually applied physically or mechanically with strict steps for safe handling purpose. It is either applicable in gaseous form (elemental chlorine) or in liquid form (sodium hypochlorite solution or chlorinated compound) or in a solid form (calcium hypochlorite). Generally, elemental chlorine is the most commonly used with a cost effective option. This is because, its concentration and pH-level in the treatment process is easy to control.

In addition, wastewater treatment polymers are synthetics with the natural flocculants applications that are used for clarification, thickening or dewatering. It is of three form (or shapes): nonionic polymers (it shows impartial behavior in solution), anionic polymers (attracts positively charged ions in solutions) and cationic polymers (attracts negatively charged ions in solution). When applicable, polymer chains acts to attract the fine particles suspended in a liquid, forming (or shaping) larger groups, called FLOCS (these are masses of bacteria (or microorganisms) held together by slime (or ooze) and fungal filaments (or contagious fibers) to create mesh-like structures). If these FLOCS develop sufficient density, then they we precipitate during settling, leaving behind a clear liquid. On the other hand, low density FLOCS may be used to isolate undesirable particles from the surface of the treated water, leaving behind clear water.

Another chemical use is ferric chloric ($FeCL_3$). It is aim at making the water clean, clear (colorless) and odorless. This is due to its high efficiency and effectiveness in clarification and utility as a sludge dewatering agent. The chemical offers very good turbidity removal.

2.3 The Effect of Wastewater to the Environment and Groundwater

Wastewater is simply water that has been used. It contains various forms of pollutants from households, industries and others. When sewage is not properly treated, the first danger is usually on the aquatic life in nearby rivers, lakes or streams. Obviously, chemical contaminants and toxic metals will kill fishes and aquatic plants, even regular sewage will harm aquatic life. Regular organic waste contains large amounts of phosphorus and other fertilizing compounds. This can stimulate overgrown algae and other aquatic plants.

However, this is not beneficial to the aquatic organisms, because these plants also die and decomposed. Normally, bacteria are responsible for this decomposition because the bacteria consume oxygen. When the amount of decomposition is manageable, then the bacteria will do their job and make available enough oxygen for fishes and aquatic animals. When the environment is unbalanced, the bacteria multiply to large amounts and consume all of the oxygen in the water. Fish populations usually experience mass death during this period.

On the other hand, when the environment is depleted of oxygen, the bacteria will continue to decompose the waste but will switch to anaerobic metabolism instead. This produces more noticeable waste compounds and smelly gases. Hence, the environment produces many of the smells of rot decomposition.

In addition, the dangers posed by wastewater to humans include infections such as typhoid, cholera and dysentery. This is due to the scarcity of freshwater available for drinking and wastewater infiltration into the ground. This is usually difficult to restore and could cause large amounts of water to become unusable and expensive to purify.

More so, untreated wastewater especially from industrial sources is often contaminated with various metals. These metals are not usually harmful in small amounts, but they are usually heavily concentrated in wastewater. If the water is not properly treated then the disposed metal in the soil and consumed by plants. Since, many farms and croplands around the world are irrigated primarily by treated wastewater. Then as time passes by, these crops will take up larger concentrations of metals, which ultimately contaminate the food supply. Unfortunately, these contaminants are difficult to detect and may result to food poisoning. Lastly, when the water is managed and treated properly, it does not cause harm and can be recycled for a variety of benefits.

2.4 Benefits of Reused Treated Wastewater

The reuse of treated wastewater in irrigation will increase the water supply for agriculture and the availability of freshwater resources for domestic and industrial uses again (Nassar et al., 2009). Nassar et al. (2010) argued that, the treated effluent from wastewater treatment plant that will be used for irrigation, must meet with appropriate quality standards to ensure adequate protection of human health, agricultural and the environment. The reuse of treated wastewater is not only environmentally and financially sound; it is becoming indispensable for meeting the staggering water demand in certain regions, especially under conditions of alarming water scarcity (Esra et al. 2017).

Wastewater recovery and reuse is well recognized for its capacity to relieve water deficiency which is a major threat to sustainable development and political stability. The reuse of wastewater has been practiced in many areas worldwide for thousands of years, the economic incentives to reuse reclaimed wastewater is the scarcity of water resources and the environment (Abu-Mad and Al-Sa'ed, 2009).

In addition, treated wastewater makes a significant contribution to the limited irrigation water supply and ensures the contamination of agriculture in parts of the country (Carr et al, 2011). Reclaimed water contain substantial amount of plants nutrients; thus, reducing the amount of chemical fertilizers needed to profitable crop yields (Carr et al, 2011 and Hanjra et al, 2012).

Chapter 3

METHODOLOGY

3.1 An Overview of Cost-Benefit Analysis

In this section, we analyze the method used in measuring the impact of treatment plant to region in question. There are several instruments used by municipalities to boost economic growth and development of its region, but the most important instrument is the efficient use of funds. A viable project is needed to meet up with the current policies that will enhance the societal growth as a whole including the limited economic resources. Therefore, a suitable analysis is required to identify the type of project in question that will be productive and according to the society's standard.

In this segment of the study we however present the approach utilized to deliver feedbacks to the aims and objectives of the study. The cost – benefit analysis (CBA) techniques has been extensively utilized in several ways and is been reported to be highly effective and efficient. The cost – benefit appraisal techniques is one of the unique integrated appraisal method developed by Jenkins and Harberger in 2002 (Jenkins, Harberger and Kuo, 2013). This approach was developed to take into consideration several integrated appraisal steps, such as the financial, economic and stakeholder's analysis over project operation period. The integrated investment appraisal will help us carryout evaluations which will help to established viability and sustainability of the project that is been considered as well as the risk associated with the project. However, in this thesis, we only embarking on financial and sensitivity analysis of the wastewater treatment plant project.

3.2 Components of Analyzing a Project

Different projects have varying components that must be taken into considerations before embarking on financial analysis. These components are known as the building blocks or modules. These modules includes: demand, technical, environmental, human resources, institutional, financial and economic modules as well as social appraisal or distributive analysis. The building blocks helps in the efficient and effective analysis of the plant during appraisal, as stated by Jenkins, Harberger and Kuo (2013). These modules are discussed below:

The demand modules emphasis the use of primary data; in other words, it study the sources of demand and the nature of market, by determining if the product is either used domestically or sold for other consumption internationally . In addition demand module also put into consideration the market prices both real and nominal over the project's life.

The technical modules, on the other hand layout the various investments and operational cost phases of the project as well as secondary information that can be used in appraising a project. All input forms, quantity as well as the required skills and wages should be known in other to determine the construction and operational cost including the uncertainties surrounding the project.

The financial module shows how the sources of debt and equity financing arise. Since, the projects viability is determine by its financial stability. Supposed, the project is financed by borrowings then the reimbursement (repayment) schedules should be stated and the number of years to be refunded should be accounted for.

In other to construct viable financial model, the following should be taken into consideration: The table of parameter should be built, to show all the required variables that will be available in carrying out financial analysis in evaluating the project and it would also be very advantageous in building its economic, sensitivity and/or stakeholder analysis.

Integrated investment appraisal and project finance is meant to calculate the cost and benefits surrounding the domestic prices for both financial and economic appraisal. It is also used to fish out the impact on the stakeholder among other parties. Despites the fact that, projected costs and revenues are being spread throughout the projects life, the occurrence of any force majeure due to uncertainty are dealt with before the financial analysis is carried out and the impacts which are then assessed in the economic analysis, hence, an overview on how a project is evaluated through an integrated financial, economic, risk and stakeholder analysis.

3.3 Financial Appraisal

According to Harberger and Jenkins (2003) the input variables helps in determining the feasibility of the project. In order to be able to carry out an evaluation financially, it is necessary to get the respective primary or secondary data, which provides the fundamental information on the volume of wastewater intake and the capacity of the plant.

However, most financial models are built with specific base case assumptions carried out as regards to the prices and quantities of the project inputs, outputs and other parameters which are stated in the table of parameter as well as the depreciation of each equipment life span. The built-in model generates the cash inflow and cash outflow of the domestic currency in nominal terms which are later converted into real terms over life of the whole project.

More so, due to fluctuations in foreign exchange rate the price per cubic meter is set in foreign currency. In addition, the projected nominal cash flows are then converted into real cash flows but a required rate of return is needed to make sure the project is viable. In evaluating the viability of a project, several criteria are taken into consideration such as the net present value (NPV), benefit – cost ratio (BCR), pay-out or payback period, internal rate of return (IRR) and debt service coverage ratio (DSCR) as well as the average debt service coverage ratio (ADSCR) and loan life coverage ratio (LLCR). The most useful and preferred criterion is the NPV. It is used to evaluate whether a project is financially feasible enough to be undertaken or not. Project with negative cash flows are usually rejected, while ones with positive cash flows are undertaken. Investor(s) must invest in a project with NPV greater than zero (NPV > 0) and such project must be the one that its IRR is larger than the cost of funds. Therefore, projects with negative NPV are not financially viable but should be revised before considering worth investing.

3.4 Sensitivity Analysis

The financial analysis is usually based on deterministic values estimated from the projects variables. However, the likelihood of adverse event occurring cannot be ignored, such as changes in the rate of inflation, market exchange rate, price and quantities of inputs and the projection of outputs throughout the project's life. Since, these variables are complex and prone to uncertainty; risk analysis therefore plays a major role in identifying the threats, estimating the risk, measuring the probability of a project to succeed or fail, analyzing the possible future economic states, forecasting and minimizing future negative unforeseen risk, sharing and controlling the risk as well as preparing for unintended consequences.

In addition, the variables used should not only consider a greater portion of the costs and benefits of the project but it should also take into consideration a significant amount of past results that would vary in terms of the final outcomes. It is highly important to solely focus on the key risky variables that contribute to the projects wellbeing in a significant way. In addition, it identifies the probability distribution and the range of these values for each risky variable as well as the previous variables.

A Monte Carlo simulation analysis is vital, in order to bring about a projects probability distribution outcome. This is because; every project is connected to various types of instability and uncertainties. Project owners do perceive uncertainty and various hazards differently when confronted with future uncertainties. These uncertainties can be perceived with suppliers, customers and some venture financing. There is a need for some security arrangements to reallocate these risks more effectively in order to ensure project completion. While, upon completion it should ensures that such a project generates sufficient cash flows to cover operating expenses and meet debt service requirements as well as to ensure that the projects can service their debts in the event of disruption in operation (including force majeure).

Moreover, most projects usually necessitate security contracts such as the mortgage on project assets, turnkey contracts, sales and purchase contractual agreements, sponsors' commitment/support, financial covenants, guarantees, insurance, escrow funds and others etc. to further mitigate more risk. Thus, after all the necessary security packages are done, the project owners can then move on to term sheets which can then enable the project to commence.

More so, projects in the form of grants, such as the one we are evaluating in this thesis, do not have to undergo all the necessary steps, since they are given as grant to the region under observation. For example, the Gazimagusa wastewater treatment plant (WWTP) which was designed, built and handed to the Gazimagusa municipality as a grant by the European Union. This necessitates us to carry out financial viability as well as sensitivity analysis of wastewater treatment plant, using the NPV criteria to evaluate investment opportunities.

Chapter 4

PROJECT DESCRIPTION

4.1 Project Parameter and Assumption

The financial model for the wastewater treatment plant is built on the parameter value of the wastewater treatment in Famagusta North Cyprus. The construction of this project was completed in 2016. This plant is owned by the Famagusta municipality and operation of the plant has also been overseen by them. In order to achieve our study objective, the calculation of the financial net present values is based on the key variables which were stated in the table of parameters.

4.2 Projects Life

The wastewater treatment plant has a life span of 25 years evaluation period with development duration of one year. The project operations are set to start and end in 2016 and 2041.

4.3 Investment Cost

The actual investment cost in 2016 for the wastewater treatment plant was 6,198,221 euros, in which all the budgeted or allocated fund was used during the construction period. The sum of 100,000 euros was allocated for land, while 5,701,563 euros was allocated for capital (this is due to the cost and sophisticated nature of the machinery as well as their unique characteristics that accelerates the treatment process of wastewater to be free from impurities) and lastly 396,658 euros was allocated for human resource expenses. There was no investment cost over-run as reported in Table 1.

Table 1: Investment Cost Variables

	Currency	Amount
Land	EUR	100,000
Capital Cost	EUR	5,701,563
Human Resource Cost	EUR	396,658
Total Investment Cost	EUR	6,198,221
Investment Cost Overrun		0%

4.4 Project Financing

The wastewater treatment plant project was financed through a grant from the European Union. The project has neither debt nor grace period, since it was handed to the municipality as a gift and subsequently started receiving its cash flows from year one of the operating period. However, the total investment cost was fully financed by the grant. A real rate of discount of 10% was used as the opportunity cost of funds for the municipalities.

4.5 Treatment of Wastewater

The treatment of wastewater commenced in the first year of operation immediately after the construction period. The maximum capacity or wastewater intake of the treatment plant is 4,100,000m^3/year while the estimated amount of treated wastewater discharged in the first year, 2017 was 1,929,187 m^3 and it is expected to increase until it gets to full capacity of the plant as shown in Table 2. Lastly, the treated wastewater is usually discharged into the reservoirs.

Table 2: Total Wastewater Treated/Discharge

	Constants	Units	Year 0	Year 1	Year 2	Year 3	Year 10	Year 15	Year 20	Year 25	Year 26
Total Water Discharge											
Total Population of Gazimagusa		#	67,852	68,497	69,148	69,804	74,581	78,191	81,977	85,945	
Annual Water Discharged in Gazimagusa		Tons/Yea	2,211,687	2,256,312	2,301,849	2,348,316	2,701,309	2,985,959	3,301,075	3,650,009	
Water Consumption Growth Rate	3%	%	1	1.03	1.06	1.09	1.34	1.56	1.81	2.09	
Infiltration Ground-Water		m^3/Year	182,500	182,500	182,500	182,500	182,500	182,500	182,500	182,500	
Rainwater Intrusion		m^3/Year	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	
Total Water Discharged		m^3/Year	1,929,187	2,041,502	2,159,532	2,283,569	3,347,834	4,369,527	5,679,608	7,359,808	
Maximum Capacity of TREATMENT plant	4,100,000										
Wastewater treated		m^3/Year	1,929,187	2,041,502	2,159,532	2,283,569	3,347,834	4,100,000	4,100,000	4,100,000	

4.6 Inflation and Foreign Exchange Rate

In Table 3, we reported a domestic inflation rate as 14.68% and it is assumed or set to be steady each year for the entire project life. This is reported in Table 3 row. The projected foreign inflation rate is 1.10% and it is set to be consistent throughout the project life. This is reported in Table 3 row 5. The real exchange rate in year zero of 3.69 TL/EUR, while it remain constant at 3.25 TL/EUR for the consecutive years. This is assumed to hold for the entire period as is reported in Table 3 row 10 and 11. In addition, we reported the relative price index in Table 3 row 12. This ratio is calculated by dividing the projected domestic price index for North Cyprus reported in Table 3 row 3 by the projected foreign price index for the EU in Table 3 row 6. It reflects the prices of commodity, good and/or service as it compares to another. Lastly in Table 3 row 13, we reported the nominal exchange rate (TL/EUR) for the wastewater treatment plant over the project lifetime. Nominal exchange rate is expected to show, the units of domestic currency (TL) that is needed to purchase a unit of a given foreign currency (EURO). This is calculated by dividing the real exchange rate by the relative price index as reported in Table 3, row 11 and 12 respectively. This is expected to change according to the inflationary level.

Table 3: Inflation Rates, Interest Rates and Foreign Exchange Rates

	Constants	Units	Year 0	Year 1	Year 2	Year 3	Year 10	Year 15	Year 20	Year 25	Year 26
Inflation Rates, Relative Price Indexes and Exchange Rates											
Inflation Rates											
Domestic - North Cyprus											
Counter		Flag	0	1	2	3	10	15	20	25	26
% Change in Domestic Inflation - North Cyprus	14.68%	%									
Projected Domestic Inflation - North Cyprus		%	14.68%	14.68%	14.68%	14.68%	14.68%	14.68%	14.68%	14.68%	14.68%
Projected Domestic Price Index - North Cyprus		Index	1	1.15	1.32	1.51	3.93	7.80	15.48	30.70	35.21
Foreign - European Union											
% Change in Foreign Inflation - European Union	1.10%	%									
Projected Foreign Inflation - European Union		%	1.10%	1.10%	1.10%	1.10%	1.10%	1.10%	1.10%	1.10%	1.10%
Projected Foreign Price Index - European Union		Index	1	1.01	1.02	1.03	1.12	1.18	1.24	1.31	1.33
Relative Price Index											
Projected Relative Price Index (Domestic/Foreign)		Index	1.00	1.13	1.29	1.46	3.53	6.62	12.44	23.36	26.49
Interest Rates											
Projected Foreign Inflation Rate - EUR		%	1.10%	1.10%	1.10%	1.10%	1.10%	1.10%	1.10%	1.10%	1.10%
Norminal Interest Rate on Foreign Funds		%	0.011	0.012	0.014	0.016	0.039	0.073	0.137	0.257	0.291
Exchange Rates											
Turkish Lira per Euro	3.69	TL/EUR									
Real Exchange Rate (TL/EUR)		TL/EUR	3.69	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25
Relative Price Index (Domestic/Foreign)		Index	1.00	1.13	1.29	1.46	3.53	6.62	12.44	23.36	26.49
Nominal Exchange Rate (TL/EUR)		TL/EUR	3.69	3.69	4.19	4.75	11.47	21.54	40.46	75.98	86.19

4.7 Depreciation and Residual Values

Here the structure and machinery of the treatment plant is set to depreciate in value base on their useful life, this is calculated using straight line depreciation method (Useful life of Assets – {Useful life of Assets / Cost of Assets}) as shown on Table 4. Depreciation is an expense that relates to a company's fixed assets. It is crucial to estimate depreciation of an asset, because depreciation expense represents the use of assets each accounting year. There are many different types of assets that can incur depreciation, such as vehicles, equipment; facilities are among the most common assets that depreciate.

We anticipate that there will be a need for reinvestment during the project life. This replacement is peculiar to the structure and machinery used in the wastewater treatment plant. We obtained the residual value of both the structure and machinery of the wastewater treatment plant by subtracting the initial values from salvage value. The residual values for both the structure and machinery are reported in Table 5, row 4 and row 10 respectively. The structure of the treatment plant is set to have a useful life of 50 years, while that of machinery varies between 10 and 15 years.

Table 4: Depreciation Values

Depreciation Schedule & Residual Values

Years			Year 0	Year 1	Year 2	Year 3	Year 10	Year 15	Year 20	Year 25	Year 26
Depreciation Period		Flag	0	1	1	1	0	0	0	1	
Useful Life of Structure	50	Years									
Treatment Facility - Construction (or WWTP Civil Structure)		EUR	1,944,170	1,905,287	1,867,181	1,829,075	1,562,335	1,371,806	1,181,278	990,749	952,643
Machinery											
	Useful Life										
1 Home Connection Cleaning Tool (Blockage Removal Vehicle) - Cost	10	EUR	30,000	27,000	24,000	21,000	-	15,000	-	15,000	
Wastewater Pump	10	EUR	85,000	76,500	68,000	59,500	-	42,500	-	42,500	
Generators	10	EUR	70,000	63,000	56,000	49,000	-	35,000	-	35,000	
Treatment Facility (Mechinical, Electrical, Electronic and SCADA Structure) - Cost	15	EUR	3,757,393	3,506,900	3,256,407	3,005,914	1,252,464	(0)	2,504,929	1,252,464	

Table 5: Residual Values

Residual Values				Initial Values	Residual Value	Acc. Dep.
Structure						
Nominal Exchange Rate	86.19	TL/EUR		Initial Values	Residual Value	Acc. Dep.
Treatment Facility - Construction (or WWTP Civil Structure)		EUR		1,944,170	952643.3	991,527
Total Residual Value for Structure		TL			82,105,056	
Machinery						
1 Home Connection Cleaning Tool (Blockage Removal Vehicle) - Cost		EUR		27,000	3,000	24,000
Wastewater Pump		EUR		76,500	8,500	68,000
Generators		EUR		63,000	7,000	56,000
Treatment Facility (Mechinical, Electrical, Electronic and SCADA Structure) - Cost		EUR		3,506,900	250,493	3,256,407
Total Residual Value for Machinery		TL			23,183,572	
Land						
Total Land Value	100,000	EUR				
Land Residual Value					8,618,657	

4.8 Taxes

It was reported that, 15% tax are levied on personal income, 10% on corporate tax and 3% Value Added Tax (VAT) on electricity consumed respectively.

4.9 Workers

Workers in this study are divided into skilled, semi-skilled and unskilled. The workers and the unit employed include; for the skilled worker, the study make use of one civil Engineer, one environmental Engineer, one lab Assistant and one plant Manager. While for the semi-skilled workers, the study employed services of five operators, and lastly, four channels cleaner and one sewage truck driver as unskilled workers. This makes a total number of 14 workers that will be employed to operate the treatment plant and the total labor cost annually was 396,658 euros as shown in Table 6 below.

4.10 Debt Financing

It is important to state here that, the wastewater treatment plant project in Northern Cyprus for the municipality is solely financed through grant given by the European Union and not by debt. Thus, there is no debt obligation or repayment required for financing this project.

4.11 Discount Rate

This is the minimum interest rate used in discounted cash flow analysis to determine the present value of future cash flows. The required discount rate for the wastewater treatment plant project is fixed at 10% over the project life.

Table 6: Human Resources (Workers)

Human Resource			
Year		Year	
Engineers			
Civil Engineers			
Number of Civil Engineers employed		#	1
Monthly Payment		EUR/Month	2,166.7
Annual Payment	26,000	EUR/Year	
Environmental Engineers			
Number of Environmental Engineer		#	1
Monthly Payment		EUR/Month	2,000
Annual Payment	24,000	EUR/Year	
Total Annual Payment for Engineers	**50,000**	EUR/Year	
Workers - Channel Cleaning			
Number of Workers		#	4
Monthly payment for workers		EUR/Month	1,777.77
Total Annual Payment	85,333	EUR/Year	
Municipal Staff Contribution and Overhead	118,000	EUR/Year	
Total Personnel Cost during Construction Period	**253,333**	EUR	

Personnel Cost - After Construction Period			
Plant Manager			
Number of Plant Manager		#	1
Month Payment		EUR/Month	2,708
Annual Payment	32,500	EUR/Year	
Lab Assistant			
Number of Lab Assistant		#	1
Monthly Payment		EUR/Month	2,167
Annual Payment	26,000	EUR/Year	
Operators			
Number of Operators		#	5
Monthly Payment		EUR/Month	1,300
Annual payment	78,000	EUR/Year	
Overhead Cost (%5 of the Total)	6,825	EUR/Year	0.05
Total Personnel Cost - After Construction Period	143,325	EUR/Year	
Total Human Resource Cost	396,658	EUR/Year	

4.12 Cash Flows

The followings components are explained under cash flow statement for wastewater treatment plant.

4.12.1 Total Revenue from Reclaimed Water Sales

One of the cash inflows components of the wastewater treatment plant is the reclaimed water. In order to calculate the reclaimed water price in Turkish Lira, we used the available reclaimed water price data as of 1999 at 0.88 euros per m^3, multiplied by the nominal exchange rate for 2016. This gives us 3.25TL per m^3 in year zero. Then, we multiplied the price by the domestic price index to calculate price of reclaimed water for the consecutive years as shown in Table 7 row 2. The total revenue from reclaimed water is then obtained by multiplying the price of reclaimed water per m^3 in TL with the amount of reclaimed water available for sales. Consequently, we observed a persistent increase in reclaimed water total revenue as the amount of treated wastewater prices and sales increases overtime. However, larger part of the reclaimed water sales are recorded under account receivables, as it appears that there are more credit sales than cash sales of the treated wastewater in Famagusta.

4.12.2 Total Revenue from Sludge Discharge

Total revenue from sludge discharge is the third components of cash inflows used in this study. In order to calculate the price of sludge per m^3 in Turkish Lira, we used the available data as of 1999 at 198 euros per m^3, multiplied by the nominal exchange rate for 2016, this amount to 731 TL per m^3 in year zero. Then, this price was multiplied by the domestic price index to calculate sludge discharge for the consecutive years as shown in Table 7 row 19. The total revenue from sludge discharge is the multiplication of sludge price per m^3 with the average sludge discharged per m^3 per year. The average sludge discharged per m^3 per year is obtained by dividing wastewater inflow with the annual sewage sludge production (1,490) per m^3 per year. From the results reported in Table 7 row 23, we observed that, total revenue on sludge discharge increases as the amount of wastewater inflow and the average sludge discharge increases over the years.

Table 7: Cashflow Components

			Year 0	Year 1	Year 2	Year 3	Year 10	Year 15	Year 20	Year 25
Total Revenue from Reclaimed Water										
Price of Reclaimed Water	0.88	EUR/m³								
Price of Reclaimed Water per M3		TL/m³	3.25	3.72	4.27	4.90	12.78	25.34	50.26	99.70
Wastewater Treated		m³/Year	1929186.55	2041501.74	2159531.924	2283568.7	3347833.97	4100000	4100000	4100000
% Loss in Treatment Process	15%	%								
Reclaimed Water for Sale		m³/Year	1,639,809	1,735,276	1,835,602	1,941,033	2,845,659	3,485,000	3,485,000	3,485,000
Total Revenue from Reclaimed Water - Nominal TL		TL	5,324,786	6,461,977	7,839,041	9,506,159	36,355,382	88,313,498	175,172,330	347,459,290
Revenue from Discharge Sludge										
Price of Sludge Per M3 - EUR	198	EUR/m³								
Price of Sludge Per M3 - TL		EUR/m³	730.62	837.88	960.88	1101.93	2874.54	5701.73	11309.55	22432.81
Wastewater Inflow		m³/Year	1929187	2041502	2159532	2283569	3347834	4100000	4100000	4100000
Annual Sludge Production	1,490	m³/Year								
Average Sludge Discharge		m³/Year	1,295	1,370	1,449	1,533	2,247	2,752	2,752	2,752
Total Revenue from Discharged Sludge		TL	945,975	1,148,002	1,392,645	1,688,816	6,458,714	15,689,330	31,120,232	61,727,864

4.12.3 Capital Expenditures

The capital expenditure is a component of cash outflows. It comprises the land price, treatment facility on constructions, the home connection cleaning tools, the wastewater pumps, generators, other treatment facilities such as mechanical, electrical and electronic tools and the human resource cost during construction.

4.12.4 Reinvestment – Future Capital Expenditures

Reinvestment is usually advocated for as an asset depreciates and required replacement. This usually occurs within the operation period, most especially at the end of the useful life of the machinery. As observed in Table 8 & 9 row 12, the reinvestment of capital expenditure is scheduled to take place in year 10, 15 and 20 year respectively.

4.12.5 Operating and Maintenance Costs

Operating and maintenance costs are made up of electricity expenses, insurance costs, fuel costs, chemical costs and personnel expenditures. As observed in Table 9 row 13, the operating and maintenance costs, appears to increase consistently over the years, particularly as the amount of treated water increases over the projects life.

4.12.6 Working Capital

The working capital in the wastewater treatment plant is associated with account receivables, account payable and cash balance. We found that, both the percentage change in account payables and account receivables are not significant enough to affect the FNPV of the project.

The cash balance on the other hand has no distortion. It is the cash held by the project to facilitate the daily sales/transactions of the treatment plant. The cash balance is associated with the percentage of repairs and maintenance costs (in operating and management expenses) and the percentage of procurements (including the WWTP, pump station operating and management contracts).

4.13 Sensitivity Analysis

The following critical variables are discussed under sensitivity analysis;

4.13.1 Percentage Change in Account Receivables

The account receivables of the project are associated with reclaimed water sales, sewage surcharges and sewage sludge sales. Consequently, as the percentage of account receivables increases from 15% to 45% the projects NPV decreases from 20,627,954 euros to 19,392,299 euros (as shown in Table 10 below), contrarily as the percentage of account receivables decreases 15% to 5% the project's NPV increases to 20,627,954 euros 21,039,839 euros. Therefore, the percentage change in account receivables is not significant enough to affect the FNPV of the project.

4.13.2 Percentage Change in Account Payable

As observed in the cash flow statement, as account payable gradually increases from 8% to 32%, the projects NPV increases from 20,627,954 euros to 20,737,235 euros as shown in Table 10. Similarly, as the percentage of account payables decreases from 8% to 4% the project's NPV decreases from 20,627,954 to 20,609,741 euros. Based on these results, it appears that the changes in account payables are not significant enough to affect the FNPV of the project.

4.13.3 Percentage Loss in Treatment Process

Similarly, the percentage loss in treated water process appears to have a huge impact on the projects outcome. This can also controlled for. Projects manager should put this into consideration in order to achieve the desired outcomes. It was observed that, as the percentage wastewater loss during the treatment process increases from 15% to 23%, the NPV gradually drop from 20,627,954 to 18,500,080 euros. When the percentage loss in treatment process decreases from 15% to 14% the project's NPV increases from 20,627,954 to 20,893,938 euros, as reported in Table 10.

4.13.4 Investment Cost Over-run Factor

The investment cost over-run factor takes into account the cost and time over-run that may arise during the implementation phase of the project. It is assumed that the investment cost over-run in the deterministic case is assumed to be 0%. Under the sensitivity analysis in Table 10, we test between a minimum of -20% and maximum of 20%. A maximum of 20% is used because we assume an increase in investment cost, which might have significant on project outcomes. Significantly changes in sensitivity results is expected to help the project manager to be aware of the magnitude impacts changes in investment cost can have on the project outcomes. This will enable project to put in place plan for any unforeseen contingency. According to the sensitivity test, it appears investment cost over-run does not have any serious significant impact on the project outcomes.

Table 8: Financial Cash Flow Statement (Nominal)

CASH FLOW STATEMENT FROM EQUITY POINT OF VIEW - NORMINAL										
CASH INFLOWS		Year 0	Year 1	Year 2	Year 3	Year 10	Year 15	Year 20	Year 25	Year 26
	Flag	0	0	0	0	0	0	0	0	0
Reclaimed Water	TL		6,461,977	7,839,041	9,506,159	36,355,382	88,313,498	175,172,330	347,459,290	
Sludge	TL		1,148,002	1,392,645	1,688,816	6,458,714	15,689,330	31,120,232	61,727,864	
Account Receivables (A/R)										
Change in Account Receivables	TL		(200,883)	(243,256)	(294,493)	(1,115,818)	(1,996,985)	(3,961,076)	(7,856,907)	61,378,073
Grant	TL	22,871,435								
Residual Values										
Structure										82,105,056
Machinery										23,183,572
Land										8,618,657
Total Cash Inflow	TL	22,871,435	7,409,096	8,988,430	10,900,482	41,698,278	102,005,843	202,331,486	401,330,247	93,180,302

CASH OUTFLOW

Depreciation Period - Every 10 Years for Reinvestment	Flag	1	0	0	0	1	0	1	0	0
Depreciation Period - Every 15 Years for Reinvestment	Flag	0	0	0	0	0	1	0	0	0
Capital Expenditure										
Land Price	TL	369,000								
Treatment Facility - Construction (or WWTP Civil Structure)	TL	7,030,508								
1 Home Connection Cleaning Tool (Blockage Removal Vehicle) - Cost	TL	99,630								
Wastewater Pump	TL	282,285								
Generators	TL	232,470								
Treatment Facility (Mechinical, Electrical, Electronic and SCADA Structure) - Cost	TL	12,940,461								
Human Resource Cost during Construction	TL	934,800								
Reinvestment - Future Capital Expenditure										
1 Home Connection Cleaning Tool (Blockage Removal Vehicle) - Cost	TL		-	-	-	121,823	-	479,297	-	
Wastewater Pump	TL		-	-	-	345,164	-	1,358,009	-	
Generators	TL		-	-	-	284,253	-	1,118,361	-	
Treatment Facility (Mechinical, Electrical, Electronic and SCADA Structure) - Cost	TL		-	-	-	-	31,385,305	-	-	
Operating and Maintenance Costs										
Electricity Expenses	TL		666,966	764,876	877,160	2,288,193	4,538,696	9,002,632	17,856,976	
Insurance Costs	TL		25,390	29,117	33,392	87,107	172,780	342,714	679,782	
Fuel Costs	TL		16,927	19,412	22,261	58,072	115,187	228,476	453,188	
Personnel Expenditures	TL		606,506	695,541	797,646	2,080,770	4,127,266	8,186,549	16,238,252	
Chemical Costs	TL		244,382	280,257	321,399	838,414	1,663,017	3,298,642	6,542,951	
Operating and Maintenance Costs	TL		873,874	1,002,159	1,149,276	2,998,045	5,946,707	11,795,463	23,396,636	
Total Oprating and Maintenance Cost	TL	**0**	**2,434,045**	**2,791,362**	**3,201,134**	**8,350,600**	**16,563,653**	**32,854,475**	**65,167,785**	

Working Capital											
Change in Account Payable		TL		(15,977)	(18,323)	(21,012)	(54,814)	(108,725)	(215,658)	(427,765)	3,341,692
Change in Cash Balance		TL		22,017	25,249	28,956	75,535	149,826	297,185	589,474	(4,604,965)
Total Change in Working Capital		TL	0	6,040	6,927	7,943	20,721	41,102	81,526	161,709	(1,263,273)
Total Cash Outflow		TL	21,889,154	2,440,085	2,798,289	3,209,078	9,122,562	47,990,059	35,891,669	65,329,494	(1,263,273)
Change in Cash Flow - TL		TL	982,281	4,969,012	6,190,141	7,691,404	32,575,717	54,015,784	166,439,817	336,000,753	94,443,574
Net Cash Flow - EUR		EUR	266,201	1,346,616	1,478,896	1,619,967	2,839,480	2,507,165	4,113,740	4,422,188	1,095,804

Table 9: Financial Cash Flow Statement (Real)

CASH FLOW STATEMENT FROM EQUITY POINT OF VIEW - REAL		Year 0	Year 1	Year 2	Year 3	Year 10	Year 15	Year 20	Year 25	Year 26
	Flag	0	0	0	0	0	0	0	0	0
Projected Domestic Price Index - North Cyprus	Index	1	1.15	1.32	1.51	3.93	7.80	15.48	30.70	35.21
CASH INFLOW										
Reclaimed Water	TL		5,634,790	5,960,567	6,302,924	9,240,423	11,316,492	11,316,492	11,316,492	
Sludge	TL		1,001,048	1,058,924	1,119,746	1,641,607	2,010,431	2,010,431	2,010,431	
Account Receivables (A/R)										
Change in Account Receivables	TL		(175,168)	(184,964)	(195,260)	(283,607)	(255,894)	(255,894)	(255,894)	1,743,145
Grant	TL	22,871,435								
Residual Values										
Structure	TL									2,331,794
Machinery	TL									658,416
Land	TL									244,771
Total Cash Inflow	TL	22,871,435	6,460,670	6,834,527	7,227,409	10,598,424	13,071,029	13,071,029	13,071,029	1,743,145

CASH OUTFLOW										
Depreciation Period - Every 10 Years for Reinvestment	Flag	1	0	0	0	1	0	1	0	0
Depreciation Period - Every 15 Years for Reinvestment	Flag	0	0	0	0	0	1	0	0	0
Capital Expenditure										
Land Price	TL	369,000								
Treatment Facility - Construction (or WWTP Civil Structure)	TL	7,030,508								
1 Home Connection Cleaning Tool (Blockage Removal Vehicle) - Cost	TL	99,630								
Wastewater Pump	TL	282,285								
Generators	TL	232,470								
Treatment Facility (Mechinical, Electrical, Electronic and SCADA Structure) - Cost	TL	12,940,461								
Human Resource Cost during Construction	TL	934,800								
Reinvestment - Future Capital Expenditure										
1 Home Connection Cleaning Tool (Blockage Removal Vehicle) - Cost	TL		-	-	-	30,964	-	30,964	-	
Wastewater Pump	TL		-	-	-	87,730	-	87,730	-	
Generators	TL		-	-	-	72,248	-	72,248	-	
Treatment Facility (Mechinical, Electrical, Electronic and SCADA Structure) - Cost	TL		-	-	-	-	4,021,713	-	-	
Operating and Maintenance Costs										
Electricity Expenses	TL		581,589	581,589	581,589	581,589	581,589	581,589	581,589	
Insurance Costs	TL		22,140	22,140	22,140	22,140	22,140	22,140	22,140	
Fuel Costs	TL		14,760	14,760	14,760	14,760	14,760	14,760	14,760	
Personnel Expenditures	TL		528,868	528,868	528,868	528,868	528,868	528,868	528,868	
Chemical Costs	TL		213,099	213,099	213,099	213,099	213,099	213,099	213,099	
Operating and Maintenance Costs	TL		762,011	762,011	762,011	762,011	762,011	762,011	762,011	
Total Oprating and Maintenance Cost	TL	**0**	**2,122,467**	**2,122,467**	**2,122,467**	**2,122,467**	**2,122,467**	**2,122,467**	**2,122,467**	

Working Capital											
Change in Account Payable		TL		(13,932)	(13,932)	(13,932)	(13,932)	(13,932)	(13,932)	(13,932)	94,904
Change in Cash Balance		TL		19,199	19,199	19,199	19,199	19,199	19,199	19,199	(130,782)
Total Change in Working Capital		TL	0	5,267	5,267	5,267	5,267	5,267	5,267	5,267	(35,877)
Total Cash Outflow		TL	21,889,154	2,127,733	2,127,733	2,127,733	2,318,676	6,149,446	2,318,676	2,127,733	(35,877)
Net Cash Flow - TL		TL	982,281	4,332,937	4,706,794	5,099,676	8,279,748	6,921,583	10,752,354	10,943,296	1,779,022
Net Cash Flow - EUR		EUR	266,201	1,331,964	1,446,889	1,567,663	2,545,232	2,127,725	3,305,321	3,364,018	546,879
Discount Rate	10%	%									
NPV EQUITY POINT OF VIEW - REAL	20,627,954	EUR									

Table 10: Sensitivity Analysis

PROJECTS SENSITIVITY ANALYSIS

				NPV
% Change in Domestic Inflation - North Cyprus	14.68%	%		20,627,954
			11%	20,099,274
			12%	20,243,004
			13%	20,386,684
			14.68%	20,627,954
			15%	20,673,894
			16%	20,817,425
			17%	20,960,906
			18%	21,104,337

				NPV
% Change in Foreign Inflation Rate - European Union	1.10%			20,627,954
			0.05%	20,841,646
			1.00%	20,648,114
			1.05%	20,638,029
			1.10%	20,627,954
			1.15%	20,617,889
			1.20%	20,607,834

PROJECTS SENSITIVITY ANALYSIS

				NPV
Investment Cost Over-run Factor	0%			20,627,954
			20%	21,867,598
			15%	21,557,687
			10%	21,247,776
			5%	20,937,865
			0%	20,627,954
			-5%	20,318,043
			-10%	20,008,132
			-15%	19,698,221
			-20%	19,388,310
				NPV
Account Receivables	15%			20,627,954
			5%	21,039,839
			10%	20,833,897
			15%	20,627,954
			20%	20,422,011
			25%	20,216,069
			30%	20,010,126
			35%	19,804,184
			40%	19,598,241

PROJECTS SENSITIVITY ANALYSIS

					NPV
Account Payables	8%				20,627,954
				4%	20,609,741
				8%	20,627,954
				12%	20,646,167
				16%	20,664,381
				20%	20,682,594
				24%	20,700,808
				28%	20,719,021
				32%	20,737,235
					NPV
% Loss in Treatment Process	15%				20,627,954
				14%	20,893,938
				15%	20,627,954
				16%	20,361,970
				17%	20,095,985
				18%	19,830,001
				19%	19,564,017
				20%	19,298,033
				21%	19,032,048
				22%	18,766,064

4.14 Municipality's Point of View

The cash flow statement for the wastewater treatment project is derived from municipal's point of view. The net cash flows are measured in real terms, and it is the difference between cash inflow and cash outflow. The cash inflow includes revenue from reclaimed water, surcharge and sludge, account receivables and residual values. Cash outflow on the other hand, includes capital expenditures, reinvestment – future capital expenditure and working capital.

In Table 9 row 41[1], we reported estimated net present value (NPV) of 20,627,954 euros. The estimated NPV value is positive (i.e. greater than 0) and this value show overall performance of the project. A positive net present value indicates that the projected earnings generated by a project or investment (in present euro) exceed the anticipated costs (also in present euro). From the positive NPV derived, it appears the wastewater treatment plant project is financially viable over the project life. Thus, from the municipality's point of view, the wastewater treatment plant project will bring about wealth creation therefore the project should be undertaken.

Having ascertained that the wastewater treatment plant project is financially viable and should be undertaken, we proceeded to sensitivity analysis. As discussed earlier, Sensitivity analysis is also referred to as "what-if" or simulation analysis and is a way to predict the outcome of a decision given a certain range of variables. By creating a given set of variables, an analyst can determine how changes in one variable affect the outcome. From the sensitivity analysis results reported in Table 9 for different set of variables, it appears that, the observed variables such as, change in domestic inflation rate, change in foreign inflation rate, investment cost overrun factor,

[1] Table 8 is in Nominal values. We report financial values in real terms.

account receivables, account payables, leakage in sewage pipelines and change in treatment process are not sensitive enough to have a negative influence on the financial net present value or bring about changes in overall performance of the project. Consequently, changes in key project variables as discussed above will not influence the overall project performance and the wastewater treatment plant project should be undertaken.

4.15 Wastewater Unit Cost

In Table 11, we report the wastewater unit cost for the treated wastewater plant project. In order to achieve our research objective, we calculated the unit cost of treated wastewater and found it to be 0.39 EUR/m³ or 1.45 TL/m while the unit is operating cost are 0.18 EUR/m³ or 0.66 TL/m ³. This is the unit cost per m³ the treated water will be sold to the farmers in Gazimagusa district for irrigation purposes.

Table 11: Wastewater Unit Cost

Wastewater Unit Cost - REAL			Year 0	Year 1	Year 2	Year 3	Year 10	Year 15	Year 20	Year 25	Year 26
Total Cash Outflow		TL	21,889,154	2,127,733	2,127,733	2,127,733	2,318,676	6,149,446	2,318,676	2,127,733	(35,877)
Wastewater treated		m³/Year	1,929,187	2,041,502	2,159,532	2,283,569	3,347,834	4,100,000	4,100,000	4,100,000	-
Discount Rate	10%	%									
PV of Total Cash Outflow	42,264,429										
PV of Wastewater Treated	29,193,793										
Wastewater Unit Cost	1.45	TL/m³									
	0.39	EUR/m³									

Operating Expenditures											
Electricity Expenses		TL	-	581,589	581,589	581,589	581,589	581,589	581,589	581,589
Insurance Costs		TL	-	22,140	22,140	22,140	22,140	22,140	22,140	22,140
Fuel Costs		TL	-	14,760	14,760	14,760	14,760	14,760	14,760	14,760
Chemical Costs		TL	0	213,099	213,099	213,099	213,099	213,099	213,099	213,099
Operating and Maintenance Costs		TL	0	762,011	762,011	762,011	762,011	762,011	762,011	762,011
Personnel Expenditures		TL	0	528,868	528,868	528,868	528,868	528,868	528,868	528,868
Total Operating Expenditures		TL	-	2,122,467	2,122,467	2,122,467	2,122,467	2,122,467	2,122,467	2,122,467
Wastewater treated		m³/Year	1,929,187	2,041,502	2,159,532	2,283,569	3,347,834	4,100,000	4,100,000	4,100,000
Discount rate	10%									
PV of Total Operating Expenditure	19,265,714									
PV of Wastewater Treated	29,193,793									
Unit Operating Cost	0.66	TL/m³	0	1.04	0.98	0.93	0.63	0.52	0.52	0.52
	0.18	EUR/m³	0	0.28	0.23	0.20	0.06	0.02	0.01	0.01

Chapter 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

In this study, we carry out financial appraisal of Wastewater Treatment Plant (WWTP). Under the current analysis, we examined the financial analysis from the perspective of Private Public Partnership (PPP) and what is the unit cost of purifying water. The PPP agreement in this regard, is a business relationship between the European Union and the municipality of Famagusta in Northern Cyprus.

The objective of this study is to examine, whether investing in wastewater treatment plant project in sampled region is financially viable or not. In addition, we seek to find out, cost per cubic meter (m^3) of treated wastewater the farmers are paying in order to give up direct access to freshwater in the underground aquifers for irrigation purposes. We carried out this study using the cost – benefit analysis approach. In this study, we solely examine the financial and sensitivity analysis. This is done in order to ascertain the project financial viability and also to examine the critical variables that might affect the overall performance of the project. The proposed project was built to help refilled the underground aquifers with clean treated water in the Gazimagusa district, which will prevent it from drying out and environmental pollution as well as help farmers for agricultural purposes.

The reason for conducting a financial analysis is to estimate the unit cost of treated wastewater and by so doing assess the sustainability of the WWT plant solely from municipality point of view. This is done to examine whether the cash flows obtained from the treatment plant will generate immense returns (or profits) for the municipality or not.

The financial analysis conducted shows that the F-NPV of the treated wastewater plant is positive and significantly large enough to generate high return on investment for the municipality. Thus, we conclude that, the wastewater treatment plant project is feasible and will be able to generate sufficient cash flows. Based on the sensitivity analysis results, it appears that, the critical variables under observations are not sensitive enough to affect the overall performance of the project.

5.2 Recommendations

Based on the results obtained from the financial cash flow statement, the following recommendations are suggested. First, we found that, the wastewater treatment plant project produces positive NPV; this is an indication that, the project under consideration will create additional wealth for the sampled region. Thus, we are of the opinion that, instead of discharging the treated water back to the ground to refill the aquifers, the municipality in Gazimaguza should encourage the local farmers in the district to buy more of the treated water for agricultural (irrigation) purposes. The farmers should be encouraged to acquire advanced equipment to put in adequate irrigation network for agricultural purposes.

Second, there is a need to convince the local farmers that using the treated wastewater for irrigation purposes is affordable and profitable both in the short- and long-run. The farmers should also be educated about the dangers surrounding the use of water from the underground aquifers for irrigation purposes. However, from our financial analysis, it appears that, unit cost of purifying wastewater (0.39 euros per m^3) in North Cyprus is on a higher side when compared to the unit cost of purifying water in the South Cyprus (0.15 euros per m^3) for irrigation purposes.

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