KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY, KUMASI

DEPARTMENT OF MATERIALS ENGINEERING

FACULTY OF CHEMICAL AND MATERIALS ENGINEERING
COLLEGE OF ENGINEERING, KNUST-KUMASI

COST – BENEFIT ANALYSIS OF WATER SUPPLY: A CASE STUDY OF GHANA WATER COMPANY LIMITED ASHANTI-REGION

ANTWI-OPPONG, FREDERICK

JUNE, 2008

COST – BENEFIT ANALYSIS OF WATER SUPPLY: A CASE STUDY OF GHANA WATER COMPANY LIMITED ASHANTI-REGION

BY

ANTWI-OPPONG FREDERICK
B.Sc (Hons) MATHEMATICS

A THESIS PRESENTED TO THE DEPARTMENT OF MATERIALS ENGINEERING, KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE

OF

MASTER OF SCIENCE
(ENVIRONMENTAL RESOURCES MANAGEMENT)
FACULTY OF CHEMICAL AND MATERIALS ENGINEERING
COLLEGE ENGINEERING, KNUST-KUMASI.

JUNE, 2008

DECLARATION AND CERTIFICATION

I Frederick Antwi-Oppong, hereby declare that this submission is my own work towards the MSc and that, to the best of my knowledge, it contains no materials previously published by another person nor material which has been accepted for the award of any other degree of the university, except where due acknowledgement has been made in the text.

STUDENT	**SIGNATURE**	**DATE**
ANTWI-OPPONG FREDERICK	**………………..**	**…………….....**
SUPERVISOR	**SIGNATURE**	**DATE**
PROF I. K. DONTWI	**…………………..**	**……................**
HEAD OF DEPT.	**SIGNATURE**	**DATE**
DR. A.A. ADJAOTTOR	**…………………**	**…………….......**

DEDICATION

To Baaba, Papa and Genny,
without whom this would not have been possible

ABSTRACT

The effect of recent water crisis in and around the cities and regional capitals of Ghana is a great concern. It hindered proper economic growth and put much pressure and stress on workers, women and school children.

This research meant to look at the costs and benefits associated with improved water supply to the communities by the water company. Ghana Water Company Limited (GWCL)–Ashanti region was used as a case study.

Cost –Benefit Analysis (CBA) is performed on monthly costs and benefits (revenue) from January, 2006 to December, 2007 from GWCL- Ashanti. It used Government of Ghana 91-day Treasury bill rate of 11.27 % (Bank of Ghana) as the discount rate for the analysis.

The analysis indicated clearly that, the operation of GWCL is economically viable. The Benefit- Cost Ratio (BCR) gives the value of 1.3466 which is greater than one, the Net Present Value (NPV) is GH¢4,304,701.50 and that is greater than zero. The Internal Rate of Return (IRR) also gives the value of 27% which is also greater than the discount rate of 11.27%.

All these clearly show that, the benefits the communities derived from having water supply improved are by far more than the costs incurred. These benefits amount to time saving, less illness, increases productivities at the workplaces, increase in school attendance rates.

TABLE OF CONTENTS

PAGES

LISTS OF TABLES

LISTS OF FIGURES

ACKNOWLEDGEMENTS

I give thanks to the Lord Almighty, our creator who has sustained me and brought me this far. May His name be praised forever and ever.

I extend my sincere appreciation to my supervisor, Prof. I.K. Dontwi (Dean, Faculty of Physical Sciences) for readily accepting to supervise my work. For his guidance, patience, criticism, and useful suggestions, enabled me to complete this thesis.

I also offer my sincere thanks to the management and staff of Ghana Water company Limited (GWCL) –Ashanti region for the assistance they gave during my data collection.

Finally, I wish to express my profound gratitude to my dear wife Baaba, for her moral support and cooperation during the entire period of the work.

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND TO THE STUDY

Water is fundamental for life and essential for nearly every human endeavor. The earth is endowed with enormous water resources; approximately 1.4 billion cubic kilometers and of these only about 2.5 percent (i.e. 35,000,000km^3) are freshwater resources *Cunningham W. P. and Saigo B. W., (1990) and Ali'(2002).* The seriousness of is that, only about tiny fraction of the total freshwater are available for use by humankind.

We are used to thinking about water as an infinitely available renewable resource, because it is constantly purified and redistributed by the action of the sun, wind, and gravity. In many parts of the world including Ghana, water supply is increasingly limited. This is because of population growth, urbanization, industrial development and poverty place increasing demands on the resource.

Since the beginning of the industrialization and rapid rates of population growth worldwide, the demand for water has risen, putting much pressure on water supply resources and systems.

In 1999, the United Nation Environment Programme (UNEP) reported that water shortage is one of the most worrying problems of the new millennium.

This issue is no different in Ghana, where water supply in cities and regional capitals have been a major problem for years, but has worsening over the past two decades due to poor urban development, population growth, power outages and degradation of vegetations around the catchment area of rivers. Natural variation in rainfall, and wastefulness and extravagant uses and pollution make whatever water is available also unfit for many uses. As the need for water continue to increase people try as much as they could to hunt for water from one place to another.

It is therefore imperative to assess the operations of the water companies for efficient output and also outline possible policies to make them more vibrant and up to task to deal with the water problem facing the present and future generations.

1.2 STATEMENT OF THE PROBLEM

The water company has the duty to produce potable drinking water for distribution in and around a designated area.

The problem of water scarcity facing us today requires that we manage our water resources with great care. Rapid rates of population growth worldwide, rapidly growing income in many countries and consequent rapid urbanization had led to highly stressed water systems.

In Ghana, our cities are growing in size every day; therefore there is a need to put up comprehensive policies and guidelines to be able to meet the future supply of water.

This work seeks to look into the Cost –Benefit Analysis (CBA) of the operations of the water company. In order to ascertained, its worth to the societies, communities and nation as a whole.

1.3 OBJECTIVE OF THE STUDY

Over the past decades, the problem of shortage of water in parts of the metropolis and cities in Ghana are on the ascendancy. The water companies are the major stakeholder, responsibility for water supply to the people in cities. This research is aimed at performing a cost – benefit analysis of the operations of the water company to ascertain with the various factors contributing to these acute water shortages in the towns and cities. It is to determine whether the operations Ghana Water Company Limited are worthwhile or not.

This work is not to create resource, but to augment the available water resources in a manner which will ensure the greatest amount of utilization with high benefit-cost ratio (BCR). The main objective of the research is:

i. To perform Cost-Benefit Analysis (CBA) on costs and benefit (revenue) of the water company to determine whether it is worthwhile.

ii. Find out whether wastage through leakage, pipe burst and illegal connection still makes the water company operations viable.

iii. Find out the impact the operations of Water Company have on the societies, communities, region and nation.

1.4 JUSTIFICATION OF THE STUDY

In Ghana, most of urban water supply systems are by surface water treatment plants. The ever increasing population growth has resulted in putting much pressure on these fixed water resources. In 2008, UN Commission on Sustainable Development noted that, the amount of water available to each person decreases as the population grows, raising the possibility of water shortages.

Also, according to UN estimates, 1.65 billion people lived on Earth in 1900 and by 1999 the world's population had passed 6 billion people, and is expected to reach 9 billion people by 2050. The annual supply of renewable fresh water will remain constant. This means water crisis is likely if the proper considerations are not taking into account now. It major consequences will retard economic growth and lead to food shortages, and even death.

Most of the time, children, women and even men are seen loitering around and spend a large part of the day walking to and from one location to another in searching for water. Some times they have to queue for several hours in the village well and the water they bring home are often contaminated.

It is indicated that improving supply of safe drinking water and sanitation facilities will radically reduce population illness. *(WHO, 2004)*. In addition to the reduction of illness, increasing access to safe water supply and improved sanitation may confer many and diverse potential additional benefits. All these benefits would have economic impacts, both direct and future.

Evaluation of the costs and benefits of water and sanitation improvements at the global level, the WHO found that achieving the water and sanitation Millennium Development Goal (MDG) would bring substantial economic benefits; US$1 invested would yield an economic return of between US$3 and US$34, depending on the region.

The benefits would include an average global reduction of diarrhea episodes of around 10%. *(WHO Report, 2004)*

The health-related costs avoided due to less illness would reach US$7.3 billion per year world-wide if the MDG target is achieved.

The annual global value of adult days gained due to less illness, with respect to formal or informal employment, would rise to almost US$750 million if the target is met.

One of the major benefits of improving access to water and sanitation derives from the time saving associated with closer location of the facilities. Time savings occur due to, for example, the relocation of a well or borehole to a site closer to user communities, the installation of piped water supply in house and closer access to latrines. The annual value of these time savings, spread over the entire population would amount to US$64 billion if the MDG target is met. *(WHO, 2004)*

CHAPTER TWO

REVIEW MODELS IN COST-BENEFIT

2.1 DEFINITION OF WATER

Water is a substance composed of the chemical elements of Hydrogen and Oxygen in the ratio of 2:1 respectively and exiting in gaseous, liquid and solid states.

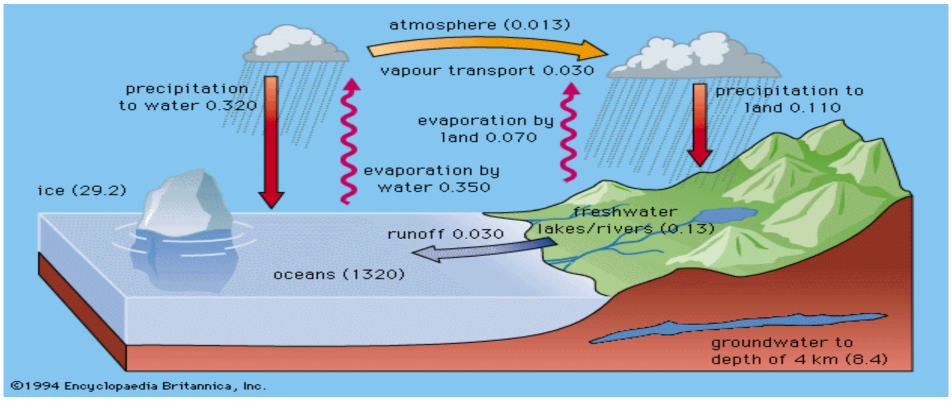
It is vital to life, participating in virtually every living process that occurs in plants and animals. Water is colourless, tasteless, and odourless liquid at room temperature. One of the most important properties of water is that it has the ability to dissolve many other substances.

2. 2 SOURCES OF WATER

There are three sources of water namely; the atmospheric water (mainly precipitation), surface water (including Rivers, Seas, Lakes, Lagoons, and Oceans) and groundwater (including soil moisture).

2.3 WATER CYCLE (HYDROLOGIC CYCLE)

Hydrologic cycle is the circulation of water as it evaporates from land, water bodies and organisms, enters the atmosphere, condenses and it precipitated to the Earth's surfaces, and moves underground by infiltration or overland by runoff into rivers lakes and seas. *(Britannica Encyclopedia Reference Library Premium, 2006)*

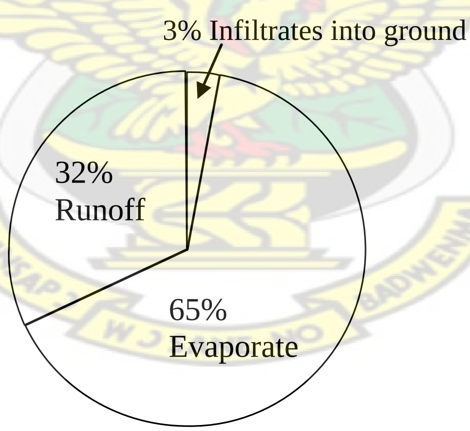


The present-day surface hydrologic cycle.
The numbers in parentheses refer to volumes of water in millions of cubic kilometres, and the fluxes adjacent to the arrows are in millions of cubic kilometres of water per year

(Source: Britannica Encyclopaedia Reference Premium, 2006)

Figure2.1: Hydrologic Cycle

Although the total amount of water on the earth remains constant, its distribution varies from one place to another. During precipitation, 65% of the water is evaporated back to the atmosphere, 32% in the form runs off into rivers lakes, oceans and 3% infiltrates into ground.



(Source: Cunningham W. P. and Saigo B. W., 1990)

Figure 2.2: Fate of daily precipitation

2.4 DEFINITION OF TERM

2.4.1 EVAPORATION

Evaporation is the process in which a liquid is changed to vapour (gas phase) at temperature well below its boiling point. (*Cunningham W. P. and Saigo B. W., 1990)*

2.4.2 TRANSPIRATION

Transpiration is the evaporation of water through minute pores, or stomata, in the leaves of plants. (*Cunningham W. P. and Saigo B. W., 1990).* The lumping together of transpiration and evaporation from all water, ice, soils, snow, vegetation and other surfaces is called evapo-transpiration.

2.4.3 PRECIPITATION

Precipitation is all liquid and soil water particles that fall from the clouds and reach the ground. The particles include drizzle, rain, snow, snow pellets, ice crystals, and hails. *(Cunningham W. P. and Saigo B. W., 1990).*

2.4.4 CONDENSATION

Condensation is the process where by molecules at the liquid states gain enough energy to move into gaseous state. (*Cunningham W. P. and Saigo B. W., 1990).*

2.4.5 RUNOFF

Runoff is the downward movement of surface water by gravity in channels ranging from small rills to large rivers. These channels of flows can be perennial, flowing over all the time, or they can be ephemeral, flowing intermittently after periods of rainfall or snowmelt. Runoff provides the majority of the water utilized by human. *(Cunningham W. P. and Saigo B. W., 1990).*

2.4.6 INFILTRATION

Infiltration is the precipitation that does not evaporate back into the air or runoff over the surface percolates through the soil and into pores and hollows of permeable rocks beneath the earth. *(Cunningham W. P. and Saigo B. W., 1990).*

2.4.7 WITHDRAWAL

Withdrawal is the total amount of water taken from a river, lake, or aquifers for any purpose. *(Cunningham W. P. and Saigo B. W., 1990).*

2.4.8 CONSUMPTION

Consumption is the fraction of withdrawal water that is lost in transmission, evaporation, absorption, chemical transformation or otherwise made unavailable for other purposes as a result of human use. *(Cunningham W. P. and Saigo B. W., 1990).*

2.4.9 DEGRADATION

Degradation is a change in water quality due to contamination or pollution so that it is unsuitable for other desirable services. *(Cunningham W. P. and Saigo B. W., 1990).*

2.4.10 CONTAMINATION

Contamination is the process where by there is external intervention commonly caused by man and sometimes can be used for it intended purpose. That is the contaminants are below the threshold level. *(Ali, 2007).*

2.4.11 POLLUTION

Pollution is the process where by a substance becomes contaminated to the extent that it threshold exceeds the purpose for which it intended *(Ali, 2007).*

2.5 AVAILABILITY OF WATER

There are various estimate of the quantity of water available on the earth, but generally about 1,400,000,000 km^3 in all forms. Of these, seawater represents about 97.5% and freshwater account for the remaining 2.5% *(Ali, 2007).*

Of the freshwater, 0.3% are lakes and river storage, 30.8% are groundwater, including soil moisture, swamp water and permafrost (permanently frozen ground) and 68.9% glacier and permanent snow cover *(Ali, 2007).*

The availability of water determines the location and activities of human on earth. The average annual runoff by continents is shown in the table below.

TABLE 2.1: DISTRIBUTION OF RENEWABLE FRESHWATER SUPPLIES BY CONTINENTS.

(*Source: Cunningham W. P. and Saigo B. W., 1990)*

Continent	Average annual runoff (km^3)	Share of Global runoff (%)	share of Global population (%)	Share of Runoff that is stable (%)
Africa	4,225	11	11	45
Asia	9,865	26	58	30
Europe	2,129	5	10	43
North/Central America	5,690	15	8	40
South America	10,380	27	6	38
Oceania	1,965	5	1	25
Soviet Union	4,350	11	6	30

The richest continents in terms of total freshwater supply are South America and Asia, both receives about one-fourth of the total global runoff (Table 2.1). In terms of water available per person, South America has the most abundant supply. It 27 percent of total runoff is shared by only 6% of the world population. The low population is as a result of most of the rainfall and runoff in South America occurs in the jungles of the Amazon basin, where infertile soil and inhospitable conditions limit human habitation.

Much of the runoff in Asia occurs in areas suitable for agriculture, which is one of the reason that Asia has nearly 60% of all humans' population on earth.

In most part of the world, majority of the precipitation falls during a limited season. At these periods, water is in abundance and much of it quickly drains away to the oceans and it is not available during the succeeding dry season. In India, 90% of the precipitation falls between June and September (*Cunningham W. P. and Saigo B. W., 1990)*

Another consideration is the inter-annual variability of rainfall. In Africa especially Sahel region, abundant rainfall occurs some years, but not other years.

Unless steps are taken to even out water flows, by storing water in reservoirs, or divert it from streams so that some amount of water would be available during the dry season or dry years.

2.6 USES OF WATER

Uses of water are characterized by several types of demand, including domestic, public, commercial, and industrial.

Domestic demand includes water for drinking, cooking, laundering, and other household functions. Public demand includes water for fire protection, street cleaning and uses in schools, and other public buildings. Commercial and industrial demands include water for stores, offices, hotels, laundries, restaurants, and most manufacturing plants.

There is usually a wide variation in total water demand among different communities. This variation depends on population, geographical location, climate, the extent of local community industry activity, the cost of water, habits of people, and efficiency of the water supply system.

Water demand is expressed numerically by average daily consumption per capita (per person). In the United State, the average is approximately 100 gallons (380 litres) per capita per day for domestic and public needs. Overall average total demand is about 180 gallons (68 1litres) per capita per day, when commercial and industrial water uses are included. The total quantity available may remain constant after some uses, but the quality is degraded so that water is no longer as valuable as it was. The combined total of assumption and degradation accounts for about half of the withdrawal in most industrial countries. The other half of the water we withdraw would still be valuable for further uses if we could protect it from contamination and make it available to potential consumers.

Water is a renewable resource, but renewal takes time. Because of that may people treat water as inexhaustible supply, and therefore can dump all water available to them and get a new supply rather than to determine what is contaminated and what is not.

The rate at which we are using water now may make it necessary to conscientiously protect, conserve, and replenish our water supply. Agriculture sector alone claims about 70 percent of the total water withdrawal worldwide. *(Cunningham W. P. and Saigo B. W., 1990).*

It is interesting to note that, closed to 70 to 90 percent of the water withdrawn for agriculture never reaches the crops for which it is intended.

The peak demands in residential areas usually occur in the morning and early evening (just before and after the workday) and weekends. Water demands in commercial and industrial districts are usually uniform during the working day. The minimum water demands typically occur in the very early or predawn morning hours.

2.7 WATER COMPANY

Water Company is an organization which is mandated to build dams to impound water, treat water and distribute to homes. The water company is much concern for transporting water from areas of abundance to areas of shortage. The work of the company includes collection, transmission, treatment, storage, and distribution of water for homes, commercial establishments, industry, irrigation, as well as for such public needs as fire fighting and street flushing.

Reservoirs are formed by constructing dams across rivers. Dams provide a way of regulating water collection and flow so that the supply remains constant. The main problem with dams is inefficiency, dam loses so much water through evaporation and seepage into porous rock beds that they waste more than they make available.

The evaporative loss from Lake Mead and Lake Powell on the Colorada River is about

one km^3 per year. That is about 10% of the annual river flow. This amounts to nearly 4,500litres (1,200 gallon) for each person in the United State per year. *(Cunningham W. P. and Saigo B. W., 1990)*

Water-treatment works employ a variety of other treatment processes, which include long period storage, aeration, coagulation, sedimentation, softening, and filtration.

These processes are used in varying combinations, depending mostly on the characteristics of the water and its intended purposes.

Long-period storage, usually in the reservoir gives particulates a chance to settle out, filtration through beds of fine sand or through crushed anthracite coal trap the suspended matter. Different chemical additives causes particles to coagulate and thus to settle.

Aeration mixed air with water either by spraying the water into the air by allowing the water to cascade, or by forcing small air bubbles through the water and it is primarily to reduce unpleasant odours and tastes.

Softening is the process of removing calcium and magnesium from the water either by chemical precipitation or by ion exchange.

After treatment, water is pumped either directly into the distribution system or to an elevated storage location, such as overhead reservoir.

For adequate distribution, water systems must operate under pressure. In some cases, the gravity drop of water from its elevated storage provides enough pressure to aid distribution; otherwise; it is supplied by sufficient pressure at a pumping station.

Adequate pressures range between 30 and 100 pounds per square inch (2 and 7 kilograms per square centimeter).

Materials used in transporting water to homes and industry include pipes of cast iron, steel, concrete, PVC and asbestos cement. Meters record water usage at the site of consumption, and charges are levied to help pay for operation and maintenance of the system.

As the world's population continues to grow, dams, aqueducts, and reservoirs will still have to be built, particularly in the developing countries where basic human needs have not been met. But such projects must be built to higher standards and with more accountability to the local people and their environment.

Even in regions where the projects seem warranted, we must find ways to meet demands with fewer resources, minimum ecological disruption and less loses.

In many countries, 30 percent more of the domestic water supply never reaches its intended destinations, disappearing from leaky pipes, faulty equipment or poorly maintained distribution systems. In Mexico City, the quantity of water supply system losses is enough to meet the needs of a city the size of Rome. Even in more modern systems, losses of 5% to 7% are common. *(Kamala A. and Kanthrao D. L., 2002).*

2.8 LEAKAGE

Leakage is lost of water during distribution and treatment processes as a result of pipe burst, and loose joint. *(Kamala A. and Kanthrao D. L., 2002).*

2.8.1 CAUSES OF LEAKAGE

Water wastage may be caused due to leakage in;

- Service reservoirs
- Treatment units of waterworks
- Water-mains due to corrosion, fracture
- Faulty joints
- Ferrule connection
- Service pipes and fittings inside the consumers' premises due to joints, corrosion, faulty washers in the valve, taps, etc
- .Failure to turn off taps in premises of consumers
- The intermittent system (the householder generally leaves the taps open throughout and also empties water to store fresh one)

In continuous system of water supply, where water is supplies all the 24hours in the day, wastage is assessed by the daily average consumption and is about 10-20% average. Above this, it is alarming. *(Kamala A. and Kanthrao D. L., 2002)*

But in intermittent system, the wastage in the mains is assessed in a zone by closing all taps in the house service connection. Wastage of 5-7% in normal and more than 20% is too alarming. *(Kamala A. and Kanthrao D. L., 2002).*

2.8.2 LEAKAGE DETECTION

Leakage Detection is done by a waste water survey. This consists of:

- Finding leaks in pipe by visual examination of surface. It involving noticing dampness and stagnant water.
- Traversing the particular zone in the night with an electronic leak detector or by a sounding rod. The Electronic leak detector consists of a pick-up amplifier and

headphone. The sound vibration created by water escaping through leaks in pipes are magnified and pick-up. The electronic leak detector is used especially when records for locating the alignment of pipes are not adequate.

- Sounding rod. It is a hollow mild-steel rod, flat or pointed at one end with a cup-shaped brass cap. The rod is traversed over the surface along the central line of pipe and noises due to water leaking are picked up by the human ear.
- Mobile waste –water flow-meter. A meter is mounted in a trailer and waste flow a sub - zone in measured. The rate of flow is recorded on a drum chart.

2.8.3 CORRECTIVE ACTION

After location of the leaks, prompt repairs to pipes and valves have to be undertaken. After repairs of flow test of the sub-zones is conducted to determine the efficiency of the corrective measures *(Kamala D. and Kanthrao D. L., 2002).*

CHAPTER THREE

METHODOLOGY

3.1 COST BENEFIT ANALYSIS

Cost – Benefit Analysis is a quantitative technique to help guide investment decision in a systematic approach. *(Mensah –Bonsu I. F., 2000)*

The costs and benefits of the investment are compared in order to determine whether on a balance, the investment is worthwhile; or whether its worth could be increased by altering design parameters such as the location, timing, scale composition, technology, or method of implementation; and whether the policy environment bearing on the project is or could be made conducive to its successful implementation and operation.

3.2 COST ANALYSIS

Cost analysis involves trying to identify and value all the costs associated with a project. The costs associated with a particular project depend on whether they are viewed from the stand point of the individuals concerned or of the society as a whole. Thus, in project analysis, there is a distinction between economic analysis and financial analysis.

Economic analysis deals with costs and benefits from the view point of the country as a whole. This is called Economic Cost – Benefits Analysis. Financial analysis deals with costs and benefits from the view point of the individual (or an agency or enterprise). The distinction between economic and financial analysis can be summarized as;

i. In economic analysis, market prices are adjusted to reflect economic values (eg ‘shadow’ or ‘accounting’ prices), but in financial analysis, market prices, which might include taxes and subsidies are always used.

ii. In economic analysis, taxes and subsidies are treated as transfer payments. Taxes are considered as part of the total project benefits, which is transferred to society as a whole, and not treated as a cost. On the other hand, a subsidy is considered as a cost to the society because it represents an expenditure of resources incurred by the economy for the purpose of operating the project, but in financial analysis such adjustments are not required. Taxes are treated as cost and subsidies as return (benefit).

iii. In economic analysis, interest on capital is not separated out and deducted from our gross returns, since it is a part of the total return to capital available to the society as a whole and it is that total return including interest which our economic analysis is designed to estimate for us. In financial analysis, interest paid to outside suppliers of money is treated as cost and repayment of money borrowed from outside suppliers is deducted before arriving at the benefit stream.

3.3 STEPS TO CONSIDER FOR COST ANALYSIS (ECONOMIC ANALYSIS)

In cost analysis, first; identify all costs, calculate incremental project costs, exclude non-economic items, value economic items, estimate externalities and add cost by year.

3.2.1 IDENTIFYING PROJECT COSTS

All the costs associated with the project are identified as the first step in cost analysis. Costs comprise all of the expenses related to the construction and operation of the project facilities or system. Costs related to construction are often referred to as investment costs. These include the cost of land, buildings (and other civil works), and equipment. Costs related to the operation of the project are also referred to as operation and maintenance costs. These include;

1. direct materials: - raw materials, auxiliary materials, utilities, spare parts, tools to mention few,
2. direct man-power:- salaries and wages, benefits and social security contributions
3. overheads man-power:- management, functional staff, and indirect labour
4. Factory and administrative overheads: - utilities, communication, repairs and maintenance, rents, etc.
5. Depreciation

3.2.2 INCREMENTAL PROJECT COSTS

The second step is to calculate the project incremental costs. Incremental costs can be calculated by subtracting "*without*" project costs from "*with*" project costs. It should be noted that "*with*" and "*without*" project costs are not necessarily the same as costs "*after*" and "*before*" the project. It is advisable to use the "*with*" and "*without*" project approach because incremental costs represent the net effect a project's use of scarce resources, and therefore it relevant in economic analysis.

3.2.3 EXCLUDE NON-ECONOMIC ITEMS

The third step in cost analysis is to decide which project costs are non-economic and are excluded from the analysis.

Economic items are those that meet these three criteria: 1. they represent the real use of resources such as land, labour, or capital; 2. they have an alternative use in the economy and 3. they could produce benefits to society in an alternative use.

Non-economic items do not use up resources, they do not have alternative uses in the economy, or they would not produce benefits to society in alternative uses. Typical example of non-economic items to be excluded in economic analysis (cost analysis) is direct transfer payments such as taxes, duties, subsidies and interest. Depreciation, which is an internal book-keeping transaction, is also a non-economic item since the investment to which it refers would already have been included under investment costs. But in financial analysis, these items are included as costs.

3.2.4 VALUE ECONOMIC ITEMS

The 4^{th} step in cost analysis is to value each cost from an economic point of view. That is, the value of the resources to society in an alternative use is calculated in economic analysis. That is not true with financial analysis.

Financial costs may be adjusted if they are based on market prices that often do not reflect the true value of the item to society. Financial prices are also adjusted if they are administered or kept at a level that is higher or lower than the true value of the item in its alternative use.

Calculated economic value (for use in economic analysis) begins with identifying a correction factor.

$$\text{Correction Factor} = \frac{\text{Sales Revenues} + \text{Consumer's Surplus}}{\text{Sales Revenue}} \qquad (3.1)$$

The correction factor reflects the amount by which to adjust a cost expressed in financial prices. The financial cost is multiplied by the correction factor to give the economic cost.

For example, if the consumers' surplus is estimated to be equal to 33% of the sales revenue of 10 million, that is generated through the tariffs that consumers pay,

Then, correction factor = $\frac{10 + 3.3}{10} = \frac{13.3}{10} = 1.33$

$$\text{Economic Price} = \text{Financial Price} \times \text{Correction factor} \qquad (3.2)$$

3.2.5 ESTIMATE EXTERNALITIES

The fifth step in cost analysis is to identify the externalities, or external costs, associated with project. Externalities are costs that are borne by someone other than a direct project beneficiary

Externalities are measured and valued like any other project costs. That is, they are separated into "with" and "without" external costs so that the incremental external costs can be calculated.

3.2.6 ADD COSTS BY YEAR

The sixth step is to obtain totals for the costs in each project year. Annual totals are convenient summaries of expected project costs. They facilitate the comparison of the total cost in each project year.

3.3 TAXES

In economic analysis, taxes are considered as a transfer payment, a part of the net return from the project which is turned over to the government to spend on behalf of the society as a whole rather than by the individuals or project management. Therefore, taxes in economic analysis are not deducted from the income stream as cost.

3.4 SUBSIDIES

A subsidy, in effect, is a transfer payment to the project from the society. For example, a subsidy on fertilizer reduces its cost to the farmer and thereby increases his income.

Thus, subsidy reduces cost and the money transfer goes to those who participate in the project.

In economic analysis, one must adjust market prices to reflect the amount of any subsidy. If subsidies operate to reduce input costs, they must be added to the market price of the commodity. For example, if a fertilizer is subsidized so that it sells at only 80% of its true cost to the society, then if we are to compare our agricultural project with alternative investment in the society, we must add 20 percent to the cost of the fertilizer used in the project.

3.5 INFLATION

There are two alternative ways of coping with inflations in project analysis. To inflate all costs and returns by what you expect will be an average rate of inflation. This alternative seems, however cumbersome. Another alternative is to assume that all prices on both the cost side and the benefit side will rise uniformly by the same proportion and that they will not change their relative values. This is considered equivalent to deflating all costs and benefits by some kind of price index.

3.6 SUNK COSTS

Sunk costs are costs incurred before the start of the appraisal period and for which there is no value to the resources in some alternative use. Common examples include the costs of policy development or feasibility studies undertaken at an earlier date. Sunk costs are not included in an economic CBA because there is no opportunity cost involved and their inclusion may distort the analysis at hand by requiring a very high return on the investment. In another way, sunk costs are irrelevant because they are the outcome of past decisions and should therefore be excluded from future decisions

3.7 SHADOW PRICES

A shadow price may be defined as that price which would prevail in the economy if it were in prefect equilibrium under conditions of perfect completion.

Market prices of goods or services do not always reflect the true cost or value of those goods or services. For example, a subsidy on a particular good is likely to make the price of the good lower than the true cost of the resources that went into making it. The true cost would instead be the price of the good, plus the per unit value of the subsidy.

3.8 REVEALED PREFERENCE TESTING

Revealed Preference Testing compares situations where people have historically made trade-offs between a cost and some form of benefit. For example farmers who have contributed towards some form of flood protection works to reduce the risk of their farm being flooded. This information can give an indication of the extent to which people are prepared to pay for a given benefit. Examples of this method include:

i. Hedonic pricing use the different characteristics of a traded good to estimate the value of a non-traded good. For example, the value of a piece of lakefront could be calculated by comparing the price of a house on the lakefront with the price of a similar house located elsewhere.

ii. Travel Cost Analysis uses the value of traded goods and services to estimate the value of non-traded goods. For example, the value of a recreational park to people might be calculated as the sum of the costs incurred by people traveling to the park (including travel time). This may result in a minimum value for the park, as it ignores what is likely to be a significant value to the consumer above what is paid (consumer surplus).

3.9 STATED PREFERENCE TESTING

Stated Preference Testing uses survey to identify their preference for trading off costs and benefits under certain hypothetical scenarios. The approach simulates a market by estimating a consumer's: i. Willingness to pay: for good or service, ii. Willingness to accept: compensation to tolerate a negative or bad economic outcome.

3.10 CONTINGENCIES

To improve upon the accuracy of cost estimates, it is important to include contingency. Thus, cost estimates usually have a base estimate and contingency added to it.

The base estimate represents the best judgment as of the date specified of what the project will cost. It assumes that the project will be implemented as planned and that the quantities of works, goods and services and their prices are known with reasonable accuracy and will not change during implementation.

Contingencies normally consist of physical contingency and price contingency. Physical contingencies reflect how much costs are expected to rise above the base estimates as the project progresses, owing to changes in the quantity of work performed; in the amount or type of equipment purchased, or the method of implementation.

Prices contingencies allow for expected increases in project costs due to changes in unit prices for the various components after the date of the base estimate.

In determining the appropriate level of price contingencies, two of the factors to be considered are the extent of expenses local and international inflation during project execution, and the extent to which local or foreign prices for particular types of works, goods, or services are expected to diverse from general inflation trends.

3.11 DEADWEIGHT LOSSES

A deadweight loss is the net cost to society attributable to a move away from an economy's competitive equilibrium, usually through the imposition of a tax or regulation. For example, imposing a tax on a particular good or service causes some consumers to purchase less of that good or service than they would in the absence of the tax. The deadweight loss (sometimes termed excess burden) is the loss of welfare resulting from the tax-induced behavioural change.

The recommended approach is to consider whether or not to include deadweight losses on a case-by-case basis. As a general rule, deadweight losses should be included if they are of sufficient size relative to the overall costs and benefits of the proposal that they are capable of altering the decision as to whether or not to proceed with the proposal. Having said this, deadweight losses are notoriously difficult to quantify.

3.13 BENEFIT ANALYSIS

Benefit Analysis involves trying to identify and value all the benefits associated with a project. The main steps in benefit analysis are: 1. identify all benefits, 2. calculate incremental project benefits, 3. exclude non-economic items, 4. value economic items, 5. estimate externalities and 6. Add benefits by year.

3.13.1 IDENTIFY ALL PROJECT BENEFITS

A benefit is any good or service that is produced by a project. Benefit can also represent cost savings or reductions. Good initial sources of information on benefits are historical and projected financial statements.

Benefits associated with water supply projects often include sales revenue, investment income, increased production capacity and delivery capacity.

3.13.2 CALCULATE INCREMENTAL PROJECT BENEFITS

Incremental project benefits are calculated by subtracting "without" project benefits from "with" project benefits. Incremental benefits represent the net results of a project use of scarce resources. It should be noted that "with" and "without" benefits are not necessarily the same as benefits that are received "after" and "before" the project.

Comparing the situation with and without the project constitutes the basic method of measuring the additional benefits that can be attributed to the project. The situation without the project is often not simply a continuation of the status quo since some changes in input and output levels and price are likely to take place anyway. In general, the assessment of the without case, should rest on the best judgment as to the future scenario if the proposed project were not undertaken.

Proper specification of the with and without situations; including a total understanding of the relationships between project inputs and outputs and their phasing over time, is a prerequisite to any cost – benefit analysis.

3.13.3 EXCLUDE NON-ECONOMIC BENEFITS

Non-economic items are those that do not influence the level of benefits from a project. Examples include interest income, investment income and subsidies. These are direct transfer payments from one entity to another and are not relevant to a benefit analysis.

3.13.4 VALUE ECONOMIC ITEMS

The 4th step in benefit analysis is to value all the benefits from an economic point of view. Financial benefits, such as sales revenue, often must be revalued to reflect their economic value. Economic prices are those that also take into account benefits such as the consumer surplus.

The consumer surplus represents the additional benefits to the community that are received free of charge. Consumer surplus is the difference between what consumers are prepared to pay for a product or service and what they actually pay. Such surplus is common in pubic utility projects such as power, water supply, sanitation and telecommunications.

In many developing countries, governments set regulated prices below the market clearing prices, as evidenced by large unsatisfied demand and queues for access to the service. In some cases estimating the consumer surplus posed serious problem. The usual practice for some analysis is to ignore the consumer surplus and equate the benefits with the revenues received from the consumers which can be estimated with some confidence.

It should be noted, however that, consumer surplus is an important part of the economic benefit, leaving it out can lead to serious underestimation of overall project returns. Therefore, efforts should be made to get at least a rough idea of its likely magnitude. One important method for estimating the consumer surplus is to multiply the sales revenue by a correction factor. Economic benefits are financial benefits in sales revenue corrected by a factor that takes into account the consumer surplus. The correction factor is obtained by adding the sales revenue and the value of the consumer surplus and dividing that sum by the sales revenue (see equation 3.1).

3.13.5 ESTIMATE EXTERNALITIES

The fifth step in benefit analysis is the estimate externalities associated with the project.

Externalities are benefits received by those who are not direct project beneficiaries. Externalities are often intangible and difficult to quantify, but they should be estimated, if possible and considered in the analysis. When externalities cannot be quantified, they should be discussed in qualitative terms. Contemporary discussions of secondary effects generally distinguish among these three types of benefits: (i) the customary variety of stemming, which are generally treated analytically by adjusting price relationships to reflect opportunity costs more adequately, (ii) those due to economics of scale, and (iii) dynamic secondary effects which actually changes the form or productivity of the resources involved.

The most commonly mentioned secondary benefits in developing countries are that of employment. By investing in a project new employment opportunities are created and new wealth is generated. Further, as newly employed people spend their wages additional employment is created as new service and production opportunities open up – a multiplier effect arising from the project investment which could properly be attributed to the project as a secondary benefit.

3.13.6 ADD BENEFITS BY YEAR

The sixth step is to obtain totals for the benefits in each project year. Then subtract the total costs from the total benefits in each project year to calculate the net benefits, or the net benefits streams.

3.14 NON-QUANTIFIABLE BENEFITS

Very often the benefits of a project cannot be fully quantified. It may be difficult to assess how much beneficiaries would be willing to pay for the project output on the base of observable market data. For example, in public utility projects there is the problem of lack of data for measuring the increase in consumers' surplus resulting from the project.

In cases, where the benefits cannot be quantified or can be quantified only partially, other approaches are often helpful. One approach is to analyze the plausibility of achieving the minimum benefits required for the project to be acceptable. Another is reliance on predetermined physical or cost standards for the service to be provided.

3.15 DOUBLE COUNTING

In calculating benefits (or costs) care should be taken that they are not recorded twice. It is very important to avoid double counting costs or benefits. Often external costs/benefits are no more than transfers of internal costs/benefits, which should not be included as this would be double counting. An example of this is development of a new railway linking two towns. The increase in value of houses in close proximity to the two railway stations may be accepted as a measure of the expected benefits of the railway. If this measure is used, it is important to not also include benefits such as reduced travel times, better access to shopping and other amenities, and an extension of job opportunities. To do so would be double counting because these benefits have been capitalized into the value of house prices. Careful consideration should therefore be given to the existence and relevance of possible externalities.

3.16 COMPARING COSTS AND BENEFITS

After costs and benefits have been analyzed, the next step in costs –benefit analysis is to compare them in order to determine the worthiness or profitability of the project. The benefits and the costs of most projects are spread over a fairly long period. Therefore, a decision has to be made as to the length of period over which project benefits and costs are going to be compared.

3.16.1 PROJECT LIFE / ANALYSIS PERIOD

The general rule is to choose a period of time which is roughly comparable to the economic life of the project.

The economic life of the project is established based on the technical life of the major investment items. However for some projects, even though the technical life of the major investment items is quite long, the economic life is considered shorter because the item may become obsolete after some time. This is particularly true with industrial projects, where rapidly changing technology can make the major investment item obsolete after some time.

Even where obsolescence of the major investment item is not a limiting factor, the economic analysis is not carried out for more than 20 to 25 years. This is because at high discount rates, which often prevail in developing countries, any return to investment beyond about 25 years will probably make on difference in the ranking of alternative projects. For instance, with a discount rate of 35% the discount factor becomes zero after 25 years. At the rate of 40% the discount becomes zero after 22 years, at 45% the discount factor is zero after 20years, etc.

3.16.2 SALVAGE VALUES

At the end of the project period, some of the capital items might not have been used up. For instance, in Ghana the economic life of a building is considered to be about 50 years. This means that if a project is analyzed over a period of say 25 years, at the end of that period, the building will still have some value, which is called the salvage value or residual value. The salvage is often added to the benefit received during the last year of the analysis.

3.16.3 DISCOUNTING

In comparing costs and benefits it will be realized that they occur at different points in time during the life of the project. The question which arises is, how can the costs and benefits which occur at different periods be compared? Clearly, simple summation of the costs and the benefits would be inappropriate, since it will ignore the almost universal preferences of an individual, or society as a whole, to gain benefits earlier rather than later. What it means is that, a million cedis spent today represent a greater cost or sacrifice than a million cedis spent a year from now because the money could be invested elsewhere to earn an interest or profit. This leads to the concept of time preference, which relate to the fact that the values received earlier are worth more than those received later. With this in mind, it will be realized that comparing costs and benefits in project analysis is not straight forward matter, since the costs and benefits are to be realized at different points in time. To make the costs and benefits occurring at different points in time comparable, they have to be brought to a common period. Usually they are brought to the present value.

The technique for doing that is called time discounting. Time discounting is the technique by which the values to be realized at different points in time are adjusted to their present values to make them comparable.

The first step in discounting is to choose an appropriate discount rate. Discount rate is the rate by which benefits that accrues in some future time period must be adjusted so that they can be compared with values in the present. There are practical problems in determining the appropriate discount rate. Several different approaches are possible. One alternative is to refer to the returns available in domestic and international capital markets. Alternative approach is to consider rates of return on a representative sample of projects undertaken in the recent past or those estimates for projects proposed for implementation over the next few years.

However, none of these approaches seems to provide a very satisfactory solution. Thus, the most appropriate discount rate is the opportunity cost of capital. The opportunity cost of capital is a measure of the benefits forgone by applying resources to one use instead of the next best alternative use. This opportunity cost of capital is usually expressed as an annual interest rate.

Once the discount rate has been determined, the next step is to multiply the cost or benefit streams occurring in each year (year t) by the appropriate discount factor.

Mathematically, this can be expressed as;

$$PV = FV\left(\frac{1}{(1+r)^t}\right) \tag{3.3}$$

Where PV = the present value, FV = the future value occurring in the year t,

r = the discount rate/the opportunity cost of capital

t = time in (years/months) and t =1, 2, 3, …., n

3.16.4 ANNUAL RATE VERSUS MONTHLY RATE OF DISCOUNTING

The discount rate will usually be expressed in annual terms (percent per annum). If the expected cash flows are annual, the rate may be used directly. If however, expected cash flows are monthly, the discount rate needs to be converted to a monthly rate. Dividing the annual discount rate by 12 will give an approximate rate to use in the NPV calculation.

But a more precise monthly discount rate is determining by the given formula

$$\text{Monthly Rate} = \left(\left(1 + \frac{\text{Annual Rate}}{100} \right)^{\frac{1}{12}} - 1 \right) \times 100\% \qquad (3.4)$$

For example, if the annual rate is 10%, then the monthly rate will be calculated as follows;

$$\text{Monthly Rate} \;=\; \left(\left(1 + \tfrac{10}{100} \right)^{1/12} - 1 \right) \times 100\%$$

$$= 0.7974\%$$

Therefore, the monthly discount rate of annual rate of 10% is 0.7974%

3.17 COMMONLY USED METHOD OF MEASURES

Several measures are commonly employed to determine the value of a capital project. These are: (1) the payback, (2) discounted payback, (3) internal rate of return (IRR), (4) modified internal rate of return (MIRR) and (5) net present value (NPV). These sections detail how each measure is calculated and how each compares to the criteria.

3.17.1 PAYBACK METHOD

The payback method is the simplest measure to calculate and the least consistent with the criteria. The payback method simply calculates how many periods into the future it takes for a capital project to repay the initial investment. For example, suppose a potential projects give the following cost-benefit flow streams for each year.

Table 3.1: Example of how Payback is calculated

	Project A
Year	**Cost-Benefit Flow GH¢**
0	-1,000
1	400
2	400
3	300
4	100

The project would repay the initial investment of ¢1,000 during or at the end of year 3. Taking into account entire flow of costs, the sum of the costs exceeds the sum of the benefits by an undiscounted ¢100. The payback method for determining value does not take into account all cost and benefit flows. Further, the payback method does not take into consideration the time value of money. Finally, payback does not consider risk.

3.17.2 DISCOUNTED PAYBACK METHOD

The discounted payback method attempts to rectify one of the shortcomings of the payback method, by the incorporation of the time value of money and risk through the discount rate.

The cost-benefit flows are discounted to reflect the value of time. For example, suppose the appropriate discount rate is 5%. The net benefit stream for projects above can be recalculated to reflect this new piece of information. The present value (the value of some future amount in today's dollars given a discount rate) is calculated using the following formula:

$$PV = FV\left(\frac{1}{1+r}\right)^{t} \quad (3.5)$$

where the symbols represent present value *(PV)*, future value *(FV)* and the discount rate *(r)* expressed as a percentage. The number of periods from today (period 0) the net benefit accrues is the number of discounting periods, *t*. Again, let us examine the cost-benefit flow streams of projects.

Table 3.2: Example of how Discounted Payback is calculated

Year	Net Benefit GH¢	Discounted Cost-Benefit Flow GH¢ $PV = FV\left(\frac{1}{1+r}\right)^{t}$	Running Total GH¢
0	-1,000		
1	400	381	381
2	400	363	744
3	300	259	1,003
4	100	82	1,085

By incorporating the time value of money into our calculations, it can be seen that the project still pays back in year 3. While the discounted payback method is consistent with part of our criteria it fails to take into account all of the cost-benefit flows generated by the proposed projects.

Both the payback and discounted payback methods for determining value of capital projects are inconsistent with our criteria. Although occasionally employed in industry as a thumbnail measure of a project's value, neither is consistent or fully acceptable for evaluating capital projects.

3.17.3 NET PRESENT VALUE (NPV) METHOD

Net present value (NPV) is similar to the discounted payback method in that the cost-benefit flows are discounted to reflect the time value of money. However, unlike the discounted payback method, NPV considers all future cost-benefit flows. The method yields one value that is easily interpreted. If the value is positive, the project yields benefits that exceed its costs. If the value is negative, costs exceed benefits. The discounting calculations are based on the same formula

$$PV = FV\left(\frac{1}{1+r}\right)^t \qquad (3.6)$$

that is, used to discount cost-benefit flows in the discounted payback method. The method is illustrated by the following example. In this case a discount rate of 10 percent is assumed.

Table 3.3: Example of how Net Present Value (NPV) is calculated

Year	Net Benefit GH¢	DiscountedCost-Benefit Flow GH¢ $PV = FV\left(\frac{1}{1+r}\right)^t$
0	-10,000	-10,000
1	5,000	4,545
2	5,000	4,132
3	5,000	3,757
4	5,000	3,415
	Present Net Value	**5,849**

From table 3.3, the project has positive NPV of ¢5,849 and is considered beneficial. However, NPV easily allows us to compare projects. NPV is also consistent with our criteria. The method accounts for the time value of money through discounting. It also considers all of the expected future cost-benefit flows. Further, the discount rate can be adjusted on a project by project basis to reflect the inherent risk of each.

3.17.4 INTERNAL RATE OF RETURN (IRR) METHOD

It is often difficult to determine the rate at which future benefits should be discounted to today's dollars. In addition, decision makers are often more comfortable with value expressed in percentage terms rather than some other metric. The internal rate of return (IRR) is a method for determining value that does not depend on the determination of a discount rate and that expresses value in terms of a percentage. Essentially, the method requires the calculation of a discount rate such that the discounted value of future cost-benefit flows exactly equals the initial investment. In other words, the present value of costs minus the present value of benefits equals zero. Let's look again at example in table 3.4 below.

Table 3.4: Example of how Internal Rate of Return (IRR) is calculated

Year	**Net Benefit GH¢**	**Discounted Cost-Benefit Flow GH¢** $PV = FV\left(\frac{1}{1+r}\right)^t$
0	-10,000	-10,000
1	5,000	4,545
2	5,000	4,132
3	5,000	3,757
4	5,000	3.415
	Net Present Value	**5,849**

To calculate the IRR it is necessary to find the discount rate that would equate the initial investment with the future cost-benefit flows. This can be expressed mathematically as

$$Cost_{total} = \sum_{t=1}^{4} B_t \left(\frac{1}{1+irr}\right)^t \qquad 3.7$$

where,

$Cost_{total}$ = Initial Investment, B_t = Benefit at time (t),

irr = internal rate of return and t = time (t = 1, 2, 3, 4)

Therefore, from table 3.4, we have,

$$¢10{,}000 = ¢5000 \times \left(\frac{1}{1+irr}\right)^1 + ¢5000 \times \left(\frac{1}{1+irr}\right)^2 + ¢5000 \times \left(\frac{1}{1+irr}\right)^3 + ¢5000 \times \left(\frac{1}{1+irr}\right)^4$$

This calculation requires a financial calculator, computer, or trial and error. The calculated value of Internal Rate Return (IRR) is about 35%. To determine whether the project a viable, the calculated IRR must be compared to a minimum acceptable rate of return that should reflect the time value of money, risk, etc. The minimum acceptable rate of return is referred to as the “hurdle rate” or “cut-off rate”. The decision to accept or reject project depends upon whether or not the IRR exceeds the hurdle rate.

Any project that has relatively large positive cost-benefit flows early in its life will generate a relatively large IRR.

Finally, the use of IRR as a measure for choosing between projects is inappropriate when capital rationing exists. Capital rationing refers to the existence of a fixed capital budget, with an inability to exceed that budget, even if the chosen projects would yield positive returns to the company.

For example, a city may have a fixed budget for the creation of a recreational center and cannot exceed that budget even though the social benefits of recreational center exceed the costs. This problem is again due to the assumption that the cost-benefit flows are reinvested at the internal rate of return rather than at the cost of capital as in NPV. What this implies for the decision maker is that the ranking of projects will depend as much on their relative size and the timing of their cost-benefit flows as it will on the actual cost-benefit flows, where the actual flows should be the only determinant of acceptance or rejection. For example, suppose we are comparing the following set of projects:

Table 3.5: Comparing with Projects difference IRR

Project	**Investment GH¢**	**NPV GH¢**	**IRR/Year**
A	1,000,000	50,000	20%
B	2,000,000	150,000	18%
C	4,000,000	300,000	16%
D	7,000,000	800,000	15%

If there were no capital rationing, we would select all four projects since each has a positive NPV and would increase our wealth by ¢1.3 million. However, if we impose a capital budget of ¢7 million, the choice depends on the method of examination. If we use internal rate of return, projects A, B, and C would be chosen. However, if we use NPV, project D would be chosen. The choice of Project D is optimal because it increases our wealth by ¢800,000 rather than ¢500,000.

The inconsistency implies that the usefulness of the IRR method is limited. Further difficulty arises when calculating the IRR of a project that has negative cost-benefit flows after the first period. Due to the mathematics of the calculations, it is possible under these circumstances to calculate multiple IRR that equate the net present value of costs with the net present value of benefits.

3.17.5 MODIFIED INTERNAL RATE OF RETURN (MIRR)

Modified internal rate of return is a technique that allows for the calculation of an internal rate of return when negative expected cost-benefit flows occur after the initial period. The method requires the compounding of all positive cost-benefit flows to the last period of project life and the discounting of all negative cost-benefit flows to the first period, at a given discount rate. The formula for compounding values forward is:

$$FV = PV(1+r)^{T-t} \tag{3.8}$$

Again, FV is the future value, PV is present value, r is the appropriate discount rate, t is the number of compounding periods, and T is the final period (4 in the example below). Once the positive cost-benefit flows have been compounded forward and the negative cost-benefit flows have been discounted back, the MIRR can be calculated.

An example will illustrate the steps employed in the calculation. A discount rate of 6 percent is assumed.

Table 3.4: Example of how Modified Internal Rate of Return (MIRR) is calculated

Year	Cost-Benefit Flow GH¢	Present Value GH¢	Future Value GH¢
0	-1,000	-1,000	
1	400		476
2	500		562
3	600		636
4	-200	-158	
Total		-1,158	1,674

Once the initial calculations have been completed, the final step is to determine a MIRR that equates the positive cost-benefit flows with the present value of the negative cost-benefit flows. This can be mathematically expressed as:

$$¢1{,}158 = ¢1{,}674\left(\frac{1}{1+\text{MIRR}}\right)^{4} \qquad (3.9)$$

In this instance, the MIRR equals approximately 9 percent. This does not in and of itself indicate whether the project is a viable. The decision rule for utilizing the MIRR method is similar to the decision rule employed for the IRR method. If the MIRR is greater than the hurdle rate, accept. If it is less than the hurdle rate, reject.

While the MIRR method does eliminate the potential for calculating multiple IRR when projects have negative cost-benefit flows late in their useful lives, it does not eliminate the problems that arise from mutually exclusive projects or capital rationing.

3.18 INVESTMENT DECISION CRITERIA

A number of techniques have been developed for expressing the worthiness or profitability of a project by a single number or index. The index can be used to decide whether a project is acceptable or not, and to compare one project to another.

The three most commonly used indices are;

i. the Benefit-Cost Ratio (BCR),

ii. the Net Present Value (NPV) or Net Present worth,

iii. the Internal Rate of Return (IRR).

3.18.1 BENEFIT – COST RATIO (BCR) AS A DECISION CRITERION:

The benefit –Cost Ratio is obtained by dividing the present value of gross benefits by the present value of gross costs.

$$BCR = \frac{\text{Sum of Present Values of Benefits (Cash inflows)}}{\text{Sum of Present Values of Costs (Cash outflows)}} \quad (3.10)$$

Mathematically, this can be expressed as;

$$BCR = \frac{\sum_{t=1}^{n} \frac{B_t}{(1+r)^t}}{\sum_{t=1}^{n} \frac{C_t}{(1+r)^t}} \quad (3.11)$$

Where B_t = benefits in each year, C_t costs in each year, t = 1, 2… n, and n = number of years and r = discount rate.

When the benefit – cost ratio is used to evaluate projects the formal decision criterion is to accept all projects with a ratio of one or greater.

Though projects with higher Benefit-Cost Ratios are often regarded as being preferable, ranking by benefit –cost ratio can lead to an erroneous investment choice in practice. This is because the BCR discriminates against projects with relatively high gross returns and operating costs even though there may be shown to have a greater wealth generating capacity than alternatives which have a higher benefit-cost ratio.

BCR is sensitive to the way costs and benefits are classified, and there is no fixed rule in this respect. Simply by grouping costs separately or deducting them from gross benefits, the benefits - cost ratio for the same project can be changed substantially.

When the benefit – cost ratio is used as a criterion for evaluating projects in a country, it is desirable that all analysis follow common netting out convention to derive their cost and benefit streams

3.18.2 NET PRESENT VALUE (NPV) AS A DECISION CRITERION

There are two alternative ways of calculating NPV. (i). it can be calculated as the difference between the present value of total benefits and the present value of total costs. (ii). by calculating the present value of the net cash flow.

Mathematically,

$$\text{NPV} = \sum_{t=1}^{n} \frac{B_t}{(1+r)^t} - \sum_{t=1}^{n} \frac{C_t}{(1+r)^t} \quad (3.12)$$

or

$$\text{NPV} = \sum_{t=1}^{n} \frac{B_t - C_t}{(1+r)^t} \quad (3.13)$$

Where B_t = benefits in each year, C_t = costs in each year, t = 1, 2… n, and n = number of years and r = discount rate.

The formal selection criterion for the net present value index is to accept all projects with an NPV greater than or equal to zero when discounted at the opportunity cost of capital.

3.18.3 INTERNAL RATE OF RETURN (IRR) AS A DECISION CRITERION

The IRR is the discount rate which would give an NPV of zero, given expected cash flows. It presents the average earning power of money used in the project over the project life.

The IRR can be calculated by discounting the net-benefit streams at different rate until finding the rate at which the present of the net benefits equals zero. Under many typical circumstances the IRR produces sensible results, and may be calculated easily using a spreadsheet package or the formula below;

$$C_{Total} = B_1 \times \left(\frac{1}{1+irr}\right) + B_2 \times \left(\frac{1}{1+irr}\right)^2 + B_3 \times \left(\frac{1}{1+irr}\right)^3 + \dots\dots\dots + B_n \times \left(\frac{1}{1+irr}\right)^n$$

(3.14)

$$\text{Cost}_{\text{Total}} = \sum_{t=1}^{n} \frac{B_t}{(1+irr)^t} \quad (3.15)$$

$\text{Cost}_{\text{Total}} =$ Total initial capital investment, $B_t =$ Benefit for each period,

$t = 1, 2, \dots, n$ and $\text{irr} =$ internal rate of return.

The formal selection criterion for the IRR index is to accept all projects having an internal rate of return above the opportunity cost of capital. Projects can be ranked in order of the value of the IRR. The lowest acceptable IRR is often referred to as the "cut-off rate" or "hurdle rate" and normally is set slightly above the opportunity cost of capital.

3.19 SENSITIVITY AND RISK ANALYSIS

The economic analysis of projects is based on assumptions about future events. Again, the data on cost and benefit evaluations are generally imperfect. Therefore, in cost –benefit analysis, it is desirable to take into consideration the range of possible variations in the values of the basic elements, and the extent of the uncertainties attaching to the outcome be clearly reflected in the presenting the analysis. Sensitivity analysis is a form of quantitative analysis that examines how net present values, total cost, or other outcomes vary as individual assumptions or variables are changed.

It determines how sensitive the present value or internal rate of return is to vary in selected costs and benefits.

Sensitivity analysis helps us to test what happens to earning capacity if something goes wrong. For instance, how sensitive is a projects' IRR to increased project costs? How sensitive is a projects' IRR to stretch – out or delays in implementation period, fall in prices, etc.

Sensitivity analysis involves reworking an analysis to see what happens under these changes. It is desirable that all projects are subjected to sensitivity analysis, because in reality the projections in project analysis are subject to a high degree of uncertainty about what will happen.

3.19.1 SENSITIVITY ANALYSIS OF BENEFITS

There are many factors that influence the level of benefits that a project will actually produce. Some of these factors are: the average tariff and any expected increases or decreases; the realism of projected water sales revenue; the realism of assumptions about population and demand growth; and the likelihood of project delays and postponed benefits.

3.19.2 SENSITIVITY ANALYSIS OF COSTS

Project costs are also influenced by a number of factors that are important to analyze. Some of these factors are: the availability of project management and control over investment costs; and budgeting and cost control to manage operations and maintenance costs.

CHAPTER FOUR

ANALYSIS OF DATA

4.1 DATA ANALYSIS

This chapter seeks to discuss monthly cost and benefit streams from Ghana Water Company Limited (GWCL) Ashanti.

The years under discussion are 2006 and 2007 monthly costs on operating, maintenance, distribution, treatment and monitoring and monthly billing as cash inflow (benefit).

4.2 DISCOUNTING RATE

To make the costs and benefits occurring at different points in time comparable, they have to be brought to a common period. This is considered as the opportunity cost of capital which is usually expressed as an annual interest rate. The Government of Ghana 91-day Treasury bill rate of 11.27% per annum (Bank of Ghana) is used for the analysis.

There would be one net cash flow for each year, for example, or one for each month for shorter proposals. For proposals of less than four years, it is a good idea to use monthly flows. The formula is given by equation (3.4) is used to calculate the precise monthly rate, knowing the annual rate. Therefore for 11.27% per annum,

$$\text{Monthly discounted rate} = \left(\left(1 + \tfrac{11.27}{100}\right)^{\frac{1}{12}} - 1 \right) \times 100\%$$

$$= 0.8939\%$$

Computing it would give monthly discount rate of 0.8939% to be used for the analysis.

4.3 PRESENT VALUE (PV)

The Net Present Value (NPV) is the sum of discounted net cash flows over the period, but Present Value (PV) is the value of the discounted value of each of the yearly or monthly costs/benefit streams.

$$PV = FV\left(\frac{1}{1+r}\right)^{t},$$

where PV = present value, FV = future value, r = the discount rate and it is expressed as a percentage and t = the number of periods from today (period 0) the net benefit accrues.

and $$NPV = \sum_{t=1}^{n} \frac{FV_t}{(1+r)^t}$$

4.2.1 PRESENT VALUES OF THE COST CASH FLOWS

Table 4.1: Monthly cost present values (C_t)

Month (t)	Cost Cash outflow (C_t) GH¢	C = $C_t\left(\frac{1}{1+0.8939\%}\right)^t$ GH¢
1	520,357.36	515,747.10
2	511,882.99	502,852.81
3	504,972.45	491,669.15
4	431,286.4	416,203.88
5	510,873.96	488,640.23
6	525,415.44	498,096.36
7	522,198.18	490,660.37
8	528,632.70	492,305.57
9	518,969.37	479,024.29
10	531,861.51	486,574.63
11	516,048.77	467,925.53
12	532,930.15	478,951.32
13	633,892.25	564,639.97
14	646,201.12	570,504.36
15	652,360.13	570,839.17
16	652,737.13	566,108.61
17	653,302.32	561,578.84
18	653,097.50	556,428.86
19	653,202.55	551,587.72
20	653,500.20	546,949.88
21	653,693.57	542,264.42
22	628,060.59	516,384.89
23	654,193.74	533,105.86
24	656,295.82	530,080.47
	NPV	**12,419,124.27**

4.2.2 PRESENT VALUES OF THE BENEFIT CASH FLOWS

Table 4.2: Monthly benefit present values (B_t)

Month (t)	Benefit Cash inflow (B_t) GH¢	B = $B_t(\frac{1}{1+0.8939\%})^t$ GH¢
1	747,489.03	740,866.43
2	681,321.76	669,302.49
3	658,415.00	641,069.31
4	704,746.25	680,100.56
5	642,655.00	614,686.03
6	585,230.11	554,800.96
7	680,192.93	639,113.14
8	674,636.97	628,276.56
9	715,065.00	660,026.44
10	765,900.51	700,685.71
11	729,197.37	661,197.32
12	730,013.68	656,072.87
13	734,435.00	654,198.49
14	819,999.00	723,943.35
15	769,621.00	673,446.75
16	808,132.00	700,880.13
17	861,842.00	740,839.60
18	890,456.00	758,654.59
19	834,743.00	704,887.00
20	887,936.00	743,161.95
21	755,766.00	626,937.50
22	777,346.00	639,125.81
23	1,179,732.00	961,369.71
24	1,176,427.46	950,183.14
	NPV	**16723825.84**

4.3 CRITERIA FOR DETERMINED THE VIABILITY OF A PROJECT

4.3.1 CALCULATION USING BENEFIT – COST RATIO (BCR)

$$\text{BCR} = \frac{\sum_{t=1}^{24} \frac{B_t}{(1+r)^t}}{\sum_{t=1}^{24} \frac{C_t}{(1+r)^t}} = \frac{16{,}723{,}825.84}{12{,}419{,}124.27} = 1.3466$$

where, B_t = benefits in each year, C_t = costs in each month, t = number of months,

$t = 1, 2, \ldots, 24$ and r = monthly discount rate = 0.8939%

Since the calculated BCR is greater than 1, which is 1.3466. It implies that the operation of the Ghana Water Company Limited (GWCL) Ashanti is considered viable.

4.3.2 CALCULATION USING NET PRESENT VALUE (NPV)

There are two alternative ways of calculating Net Present Value (NPV).

i. It can be calculated as the difference between the present values of the total benefits and the present value of the total costs.

Therefore,

$$\text{NPV} = \sum_{t=1}^{n} \frac{B_t}{(1+r)^t} - \sum_{t=1}^{n} \frac{C_t}{(1+r)^t},$$

where B_t = Benefits in each year, C_t = Costs in each month, t = 1, 2, ……, n, and n = number of months and r = monthly discount rate;

$$\therefore \text{ NPV} = \sum_{t=1}^{24} \frac{B_t}{(1+r)^t} - \sum_{t=1}^{24} \frac{C_t}{(1+r)^t}$$

GH¢16,723,825.84 - GH¢12,419,124.27 = GH¢4,304,701.50

ii. Calculating the present values of the net cash flow,

$$\text{NPV} = \sum_{t=1}^{n} \frac{B_t - C_t}{(1+r)^t},$$

The calculation of this alternative method is done in the table 4.3 below.

Table 4.3: Net Cash flow method of computing NPV

Month	Cost (cash outflow) C_t GH¢	Benefit (cash inflow) B_t GH¢	Net cash flow $B_t - C_t$ (GH¢)	Discounted Value (PV) GH¢
1	520,357.36	747,489.03	227,131.67	225,119.33
2	511,882.99	681,321.76	169,438.77	166,449.68
3	504,972.45	658,415.00	153,442.55	149,400.16
4	431,286.40	704,746.25	273,459.85	263,896.68
5	510,873.96	642,655.00	131,781.04	126,045.80
6	525,415.44	585,230.11	59,814.67	56,704.59
7	522,198.18	680,192.93	157,994.75	148,452.76
8	528,632.70	674,636.97	146,004.27	135,971.00
9	518,969.37	715,065.00	196,095.63	181,002.15
10	531,861.51	765,900.51	234,039.00	214,111.08
11	516,048.77	729,197.37	213,148.60	193,271.79
12	532,930.15	730,013.68	197,083.53	177,121.55
13	633,892.25	734,435.00	100,542.75	895,58.52
14	646,201.12	819,999.00	173,797.88	153,438.99
15	652,360.13	769,621.00	117,260.87	102,607.58
16	652,737.13	808,132.00	155,394.87	134,771.52
17	653,302.32	861,842.00	208,539.68	179,260.76
18	653,097.50	890,456.00	237,358.50	202,225.73
19	653,202.55	834,743.00	181,540.45	153,299.28
20	653,500.20	887,936.00	234,435.80	196,212.07
21	653,693.57	755,766.00	102,072.43	846,73.08
22	628,060.59	777,346.00	149,285.41	122,740.91
23	654,193.74	1,179,732.00	525,538.26	428,263.84
24	656,295.82	1,176,427.46	520,131.64	420,102.66
TOTAL	**13,945,966.20**		**NPV**	**4,304,701.50**

For both computation the NPV is the same, that is GH¢4,304,701.50

The formal selection criterion for accepting a project as economically viable is when the NPV index of the project is greater than or equal to zero. From the above calculation in table 4.3 the NPV is equal to GH¢4,304,701.5 which is positive (i.e. greater than zero) and satisfy the criterion.

4.3.3 CALCULATION USING INTERNAL RATE OF RETURN (IRR)

Internal Rate Return is a discount rate such that the discounted value future cost-benefit flows exactly equal the initial investment. In other words, the present value of costs minus the present value of benefits equal zero. Calculation of IRR requires a financial calculator, computer spreadsheet, or trial and error.

Using the equation, 3.14 or 3.15 and total cost of investment and the monthly benefit streams would lead to the equation below;

$$13945966.20 = 747489.03 \times \left(\frac{1}{1+r}\right) + 681321.76 \times \left(\frac{1}{1+r}\right)^{2} + \ldots\ldots\ldots + 1176427.46 \times \left(\frac{1}{1+r}\right)^{24}$$

By computation, using Microsoft Math software the Internal Rate of Return (IRR) give 1.995% per month. Then the annual rate of IRR can be calculated, using equation 3.4.

$$\text{Monthly (discount rate)} = \left(\left(1 + \frac{\text{Annual Rate}}{100}\right)^{\frac{1}{12}} - 1\right) \times 100\%$$

$$1.995 = \left(\left(1 + \tfrac{r}{100}\right)^{\frac{1}{12}} - 1\right) \times 100\%$$

This implies that IRR approximately equal to 27% p. a.

Therefore annual rate of IRR is 27% of the monthly rate of 1.995%. This is rate at which the present value of costs minus the present value of benefits equal zero. That is to say a rate at which the discounted value future cost-benefit flows exactly equals the initial investment.

The formal selection criterion for the IRR index is to accept project with an internal rate of return (IRR) above the opportunity cost of capital.

CHAPTER FIVE

DISCUSIONS, CONCLUSIONS AND RECOMMENDATIONS

5.1 DISCUSSIONS

This chapter seeks to discuss the results of the analysis of the monthly costs and benefits of cash flows of the Ghana Water Company Limited (GWCL) –Ashanti. The analysis uses Benefit- Cost Ratio (BCR), Net Present Value (NPV) and Internal Rate of Return (IRR) as the criteria for selecting a project as economically viable at a discount rate of 11.27% p.a. 91-day Treasury bill rate (Bank of Ghana)

In the cost-benefit analysis, all the criteria considered clearly indicate that the operations of GWCL –Ashanti are economically viable at a discount rate of 11.27% per annum.

The criteria for selecting a project as economically profitable, when using BCR is obtained when Benefit- Cost Ratio (BCR) is greater than one (1). The monthly cost and benefit cash stream from January, 2006 to December, 2007 at a discount rate of 11.27% give BCR of 1.3466 (page 53, chapter 4). This figure is greater than one, and it implies that the benefits the societies drive from having water readily available to them by the water company exceed the cost the company incur to provide the water.

The criterion for selecting a project as economically efficient or viable using the Net Present Value (NPV) is obtained when the NPV is positive; that is greater than zero. The monthly cost and benefit cash flow at a discounted rate of 11.27% give a Net Present Value of GH¢ 4,304,701.50 (page 54, chapter 4). This value is far greater than zero and therefore it confirms the earlier conclusion for using the Benefit-Cost

Ratio. It is essential to note that, a large NPV value suggests a very high return (benefits) to the societies.

Again, when the Internal Rate of Return (IRR) is used as criterion to accept a project as profitable, then IRR should be greater than the discount rate. At this rate of return, the initial cost of investment is exactly equal the future benefit flows.

In the analysis using the monthly cost and benefit cash stream from January, 2006 to December, 2007, the IRR calculated is 27%. This figure is greater than the interest rate of 11.27% and therefore it makes the operation GWCL viable.

The values derived from the three (3) decision criteria – the BCR, NPV and IRR at a discount rate of 11.27% per annum, indicate that the operations of GWCL –Ashanti are considered economically viable. This implies that the benefits that are realized per month by the societies from the water company always out weigh the total cost per month incurred by the water company.

The cost of the water company includes production cost and investment cost. The production cost comprises of: operating cost, maintenance cost, distribution, and monitoring which also includes labour, repairs, and other overheads costs. Investment cost involves the cost of land, cost of machinery/equipment and all civil engineering works. The investment cost was excluded from this analysis because returns on investment beyond 25 years will probably make no difference in the ranking of the project. Some of these investment costs have been in existence for more than four decades.

The benefits of improved water supply by the water company are enormous. The individual, the society, the community and the nation as a whole benefit tremendously. During an acute water shortage, workers scramble for water for long hours before going to work, resulting in the loss of significant and productive hours. School children also waste precious time and study hours looking for water. When there is improvement in the water supply, there would be high productivity at the work place and school attendance would also increase. The communities would avoid lost days and time for daily activities due to less illness.

Also there would be general improvement in sanitation at the ministries, Government departments, health sectors and educational institutions and homes. All these benefits would have economic impacts on us now and in the future.

Negative impacts of water supply Ghana is facing now, especially in most parts of the regional capitals, should have been a thing of the past. But sometimes the problem becomes too alarming. Residents roam from one location to another, and even buy water from second hand dealers and water tankers at exorbitant prices.

The problem of water shortages in most parts of the country is as a result of population growth, leakages, power outages, pipe burst, wastage, inadequate pressure and some developmental issues.

Population growth has increased the demand for water supply. Due to rural-urban migration, the population in the cities and regional capitals keep swelling. These dwellers end up putting up new structures which they use the same mains that were meant for relative fewer populations.

Leakages and pipe burst reduce the volumes of water supply to residents. The wastage from these leakage and pipe burst are sometime too alarming. Burst taps, leak meters and main distribution lines are left to run for several hours or days before they are mended. Household also waste a great amount of water through washing of cars, watering gardens,

flushing to mention a few. They sometime leave their tap running for several hours and these accounts for the water wastage.

Inadequate pressure reduces the rate of water distribution. The gravity the water drops from the storage elevation provides enough pressure to aid distribution or pressure is provided at a pumping station. Adequate pressures to enhance distribution range between 30-100 pounds per square inch. But these pressure ranges are often disrupt by the action of pipe burst, leakages from taps, mains, meters and illegal connection which intend reduce the supply rate of water to consumers.

Power outages also play a major role in continuous flow of water. Inadequate power supply stops treatment and distribution for several hours or days. It is important to note that 5 minute power outage takes at least five hours to restore water flow. (*Abubakar Saddique B., 2008*). Therefore, power supply plays an important factor in ensuring availability and continuity in water supply.

Developmental projects are on ascendancy and these result in continuous damage mains and delivery pipes to some residents. That is to say dugout, foundations of new buildings, and road constructions are rampant activities which normally obstruct delivery systems and cause the system to lose greater amount of water to be supplied to the society.

All these are factors that affect the operations of the water companies, but do not render it unviable. This is because, when each of these set backs is checked it would increase the productivity capacity and that intend would increase revenue. Increase in revenue means increase benefits to society, government and the general economy at large.

5.2 CONCLUSIONS

This study sought to investigate using the cost-benefit analysis (CBA) on the operations of the water company, to first ascertain whether it is worthwhile or not. It used the opportunity cost of capital. This is the investment return of the capital on other alternative projects which is commonly refer to as the interest rate.

The Government of Ghana 91-day Treasury bill of 11.27% (Bank of Ghana) was used for the analysis on 24 monthly costs and benefits (revenue) from Ghana Water Company Limited, Ashanti Region for the year 2006 and 2007.

The analysis used the Benefit – Cost Ratio (BCR), Net Present Value (NPV) and Internal Rate of Return (IRR) as cost – benefit analysis determine of criteria.

The analysis shown by the three criteria indicate that the operations for Ghana Water Company Limited (GWCL) to supply potable water to the people are judged viable.

The BCR gives the ratio of 1.3466, the Net Present Value is GH¢4,304,701.50 and IRR is 27%, all of these values satisfy the criteria proven that, the project is viable.

This is to conclude that, the benefits enjoyed by the societies for improved water supply are enormous. The societies save time for having water closed to their homes. They would not cut their sleep to search for potable water at every nook and cranny of the metropolis which has serious repercussions on the society and government as a whole. Workers would not report to work very late, and students would not follow their parents and other siblings to search for water and for that matter miss precious study hours. There are other dangers when children or even parents walk on the highway and even in caves and mountains in villages in search of water.

Also improved water supply systems would improve sanitation at homes, clinics, hospitals and other places of interest. On health, there would be complete eradication of guinea worm infestation and other related waterborne diseases such as bilharzia, and diarrhoea by constant provision of potable water supply for the people.

5.3 RECOMMENDATIONS

To make the provision of potable water supply sustainable to meet the growing population of our time.

Government should make it as a policy to rehabilitate and expand all the water projects in the country from time to time. There must be policies outlined to check continuous encroachment and degradation vegetation of the catchment areas. For example, Weija and Owabi catchment areas have been faced with continuous encroachment and degradation over the years.

Also, there must be a policy which gears towards the Millennium Development Goal (MDG) of attaining improved water supply and sanitation for all by the year 2015. Individuals in the society must be educated on the importance of water resources.

The seriousness of the issue is that the amount of water in circulation remains constant, but world population keeps swelling which Ghana is not an exception. This should put some fear and panic moment in us to be very conscious and positive to the use of any water available prudently.

Water used for washing of clothes, utensils, bathing, brushing and washing of hand and face should be recycled and re-used for flushing of toilet, washing of cars and watering flowers.

Policy on energy (power) supply to the water companies to enable continuous flow of water should be worked on seriously so that Electricity Company of Ghana (ECG) and Volta River Authority (VRA) supply efficient and right amount of energy needed for water treatment and distribution.

The Water Company should increase their monitoring network to be able to rectify and repair all faults and leakages promptly.

REFERENCES

Abubakar Saddique B., (March, 2008), Meet – the Press Accra.

Allen J. L.(2002), Annual Editions, Environment 02/03, 21st edition, McGraw-Hill/Dushkin.

Ali B., (2007) Water Resource Management Lecture Notes.

Bhattachariya A. (2002), Water Resources Engineering Reprint Edition, Satya Prakashan.

Balchin P. N. and Kieve .L.J. (1982) Urban Land Economics, 2nd ed., Published by Macmillan Press Ltd.

Britannica Encyclopedia Reference Library Premium, 2006.

Clarke Robin (1993). Water: The International Crisis. Massachusetts Institute of Technology Press.

Cunningham W. P. and Saigo B.W., (1990) Environmental Science: A Global Concern, W.M.C. Brown Publishing Co. Ltd. (Pages 286 to 309).

Flyvbjerg B., et al (2003), Megaprojects and Risk: An Anatomy of Ambition (Cambridge University Press,).

Gleick Peter (Nov., 2006) The World's Water: The Biennial Report on Freshwater Resources. Washington: Island Press ISBN-13: 9781597261050.

Hutton G. and Haller L. Evaluation of the Costs and Benefits of Water and sanitation Improvememt at the Global level, 2004, World Health Organisation. WHO/SDE/WSH/04.04.

Kamala A., and Kanthrao D. L. (2002), Environmental Engineering, Water Supply, Sanitary Engineering and Pollution, 13 Reprint, Tata McGraw-Hill Publishing Co. Limited.

Mensah –Bonsu I.F., (2000) Investment Criteria: Programme and Project Identification, Lecture Notes.

Postel S. (1997), Last Oasis: Facing Water Scarcity, second edition. New York: Norton Press.

Rogers P., World Water Crisis: Is There a Way Out? Encyclopedia Britannica 2006 Ultimate Reference Suite DVD 7 Sept. 2007. (Year in Review 2003).

http://en.wikipedia.org/wiki/cost-benefitanalysis http://greenbook.treasury.gov.uk/

http://www.treasury.govt.nz/costbenefitanalysis/

UK Green Book glossary, http://greenbook.treasury.gov.uk/glossary.htm

Cost-Benefit Analysis and Environmental Decision Making: An Overview http://sunsite.utk.edu/ncedr/default.html

APPENDIX 1

TABLE 1: MONTHLY COSTS AND BENEFITS (REVENUE) FROM GHANA WATER COMPANY LIMITED ASHANTI REGION-KUMASI

Cost of Operating, Maintenance, Distribution, Treatment and Monitoring		
	Year 2006	Year 2007
Month	GH¢	GH¢
JANUARY	520,357.36	633,892.25
FEBRUARY	511,882.99	646,201.12
MARCH	504,972.45	652,360.13
APRIL	431,286.40	652,737.13
MAY	510,873.96	653,302.32
JUNE	525,415.44	653,097.50
JULY	522,198.18	653,202.55
AUGUST	528,632.70	653,500.20
SEPTEMBER	518,969.37	653,693.57
OCTOBER	531,861.51	628,060.59
NOVEMBER	516,048.77	654,193.74
DECEMBER	532,930.15	656,295.82
GRAND TOTAL	**6,155,429.28**	**7,790,536.92**
	Billing (Revenue)	
MONTH	YEAR 2006	YEAR 2007
	GH¢	GH¢
JANUARY	747,489.03	734,435.00
FEBRUARY	681,321.76	819,999.00
MARCH	658,415.00	769,621.00
APRIL	704,746.25	808,132.00
MAY	642,655.00	861,842.00
JUNE	585,230.11	890,456.00
JULY	680,192.93	834,743.00
AUGUST	674,636.97	887,936.00
SEPTEMBER	715,065.00	755,766.00
OCTOBER	765,900.51	777,346.00
NOVEMBER	729,197.37	1,179,732.00
DECEMBER	730,013.68	1,176,427.46
GRAND TOTAL	**8,314,863.61**	**10,496,435.46**
TOTAL NUMBER OF STAFF		
JUNIORS	244	
SENIORS	79	
TOTAL	**323**	