APPROVED FINAL YEAR PROJECT PROPOSAL

BY

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ECONOMIC ANALYSIS OF A MUNICIPAL WATER SUPPLY SCHEME

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1.0 INTRODUCTION

Water supply network is a system of engineered hydrologic and hydraulic components which provide water supply for public utilities. It is an infrastructure which involves a series of processes ranging from collection, transmission, treatment, storage, and distribution of water for consumption. Water as an economic good meets and satisfy the needs of its various consumers' in homes, commercial establishments, industries, agriculture, as well as for such public needs for firefighting and street flushing. Municipal water supply scheme is most of time a responsibility of the Government as it is considered a social amenity.

The characteristic features of water supply include the following (ADB, 2009):

1. The benefit is greater than or equal to its cost to the consumers.
2. Markets for water may be subject to imperfection, with features like physical constraints, high costs of investment for certain applications, legal constraints, complex institutional structures, the vital interests of different user groups, limitations in the development of transferable rights to water, cultural values and concerns of resource sustainability.
3. Water is usually a location-specific resource and mostly a non-tradable output.
4. Investments are occurring in medium term (typically 10 years) phases and have a long investment life (20 to 30 years).
5. Pricing of water has rarely been efficient. Tariffs are often set below the average economic cost, which jeopardizes a sustainable delivery of water. If water availability is limited there will be competition for it among potential users (households, industries, agriculture).
6. Economies of scale in water supply projects (WSPs) are moderate in production and transmission but rather low in the distribution of water.

The above characteristics have implications on the design of WSPs considered as early as the planning and appraisal stages of project preparation.The pattern of human settlement from time has always been decided and controlled by certain natural but indispensable factors. Water is one of such factors. Apart from air, the availability of water in adequate quantity and quality is the most crucial factor to human existence (Sule and Okeola, 2010). Water makes life possible and civilization cannot develop or survive if there is no water. As man's standard of living increases; so does his need for consumption of water (Ufoegbune et al, 2010). In modern times, there is a close relationship between water availability and economic development; especially in the developing countries. In Nigeria, water availability controls population distribution.

In terms of personal needs, an average man requires 2.5 liters of water daily for drinking. Aside this, man requires water for various other uses such as cooking, washing, sanitation, agriculture, industrial production, hydro-electric power, etc. To provide for these various uses, the supply of water must meet the demand of the user, be satisfactory in quality and adequate in quantity, be readily available to users, and be relatively cheap and easily disposed of after it has served its purpose. A necessary works are waterworks or water supply systems or waste works or wastewater disposal systems (Ufoegbune et al, 2010). Municipal water systems generally comprise: (i) Collection or intake works (ii) Purification or treatment works and (iii) Transmission and distribution works

There are different views and aspects to municipal water supply schemes, this study takes care of the economic aspects. Economics consist of a set of analytical tools that can be used for balancing competing objectives by allocating the scarce resources (Mohammed et al., 2003). Engineering economy is concern with the economic aspects of engineering. It involves the systematic evaluation of costs and benefits of technical projects. Environmental economics is the application of the principles of economics to the study of how environmental resources are developed and managed. The entire process of planning, design, construction, operation, and maintenance of water resources system entails many important and complex decisions. Besides technological and environmental considerations, economic principles play a significant role in making these decisions. The principle of engineering economics gives guide in selecting the best planning and/or operational decisions.

Water resources development projects have two sides: on the one side, they create value and on the other side they encounter costs. The value side of the analysis is based on the fact that individuals have preferences for goods and services. The value of a good to a person is what that person is willing to pay for that good. Thus, the value of a good and services is tied to the willingness to pay. The costs associated with different economic activities can be classified as fixed and variable. Fixed costs are not affected by the range of operation or activity level. General management and administrative salaries and taxes on water supply facilities are some example of fixed costs while variable costs are those associated with the quantity of output or other measure of activity level (Mohammed et al., 2003).

Many state water agencies (SWA) are finding it difficult to operate and maintain water schemes in the face of escalating cost of production. Yet, the demand for water is rising with increasing population and the yearnings for economic growth and development (Sule and Okeola, 2010). The provision of water supply and sanitation services broadly conceived is a huge societal enterprise. In both industrialized and developing countries it often accounts for a substantial share of public sector investment (Whittington and Hanemann, 2006). The cost of reservoirs, canals, water transmission lines, urban distribution networks, pumping stations, water treatment facilities, sewerage collection and conveyance, wastewater treatment facilities and the land required for all these facilities makes this one of the largest "industries" in most industrialized economies.

The payments an individual household makes for these assets; both in direct payments for services and indirect taxes, is often a significant household budget expenditure, and a household's share of these assets can represent a substantial portion of its net worth, albeit publicly owned and typically not easily tradable (Whittington and Hanemann, 2006).

The cost of a water supply infrastructure vary depending on individual circumstances, and estimates of what it will cost to provide a certain level of service may vary widely. Also, most investments are incremental in nature. Only rarely would a community incur the costs of complete ("full-service") piped water and sanitation systems at a single point in time (Whittington and Hanemann, 2006).

As earlier discussed, the existence of man is determined by the availability of water, it is therefore essential to carry out an economic analysis of water supply projects so that planners, policy makers, water enterprises and consumers are aware of the actual economic cost of scarce water resources and the appropriate level of tariff and cost recovery needed to financially sustain it.

2.1 SCOPE AND LIMITATION OF STUDY

The project shall be limited to carrying out an economic analysis of the municipal water supply facility with focus on its operation, maintenance & management. The study is confined to the existing water supply facility (Asa Dam Water Works) and its consumers (Ilorin metropolis).

2.2 CASE STUDY

The case study is Asa-Dam Water Works and its serving population in ilorin metropolis. Ilorin is the capital of Kwara State (Fig 1). It is located at $8.5°$ latitude and $4.55°$ longitude with an average elevation of 310 meters. It is occupying an approximate area of 100km² situated in the transition zone between the deciduous woodland of the South and the Savannah of the north, thus giving it a status of "Gate way city" in Nigeria (Adewale, 2013). Ilorin is a major Nigeria indigenous city which evolved through a period of traditional urbanization which took place in some parts of West Africa. It has passed through three stages, pre-colonial, colonial and post-colonial era (Ajadi, 1996). Ilorin metropolis has the tropical wet-dry climate; days are very hot during the dry season from November to April with temperatures typically ranging from 33°C to 37°C.

The daily range of temperature during the rainy season is 8°C to 12°C. Rainfall condition in Ilorin exhibits greater variability both temporarily and spatially. The mean annual rainfall has been estimated to be 1,318mm. It normally starts in April and ends in October. However, the rainfall intensity, frequency and amounts vary from month to month. The dry season is characterized by cold and dry conditions due to harmatan (Adewale, 2013).The main river in Ilorin is the Asa River which divides the city into two parts, the western part represent the core indigenous area and the eastern part consisting of the modern residential areas including the GRA. Generally, the elevation of the land in the western side ranges from 273m to 364m while the Sobi hill is a smooth, steep-sided, dome-shaped outcrop, the highest of a group of such hills that rise above the gently undulating savanna to the North of Ilorin (Adewale, 2013).

Fig 1: Map of Nigeria showing Kwara State.

Asa dam water works is situated in the northwestern part of Ilorin in the north central part of Nigeria. It was constructed by Julius Berger Nigeria PLC in order to increase the supply of potable water by approximately 50,000 cubic metres per day to the towns within the state. Asa dam water work is in one phase,which supplies over 300,000 m3 of water per daywhen the treatment plants are operational. Themaximum height of the dam is about 45 m. Theraw water intake from the dam reservoir isthrough pipe openings at different levels incircular concrete intakes tower located within thereservoir. There are eight different levels givingthe opportunity to select a particular level forraw water abstraction depending on itscharacteristics (Musa and Funmen, 2013). The Dam consists of three sections: a 400m long earth fill dam, a 150m long concrete gravity dam and a lateral earth dam with a length of 160m. The earth fill dam is 26m high above the bottom of the Asa River and has a width of 150m at the dam foot and of 5m at the crest.

3.0 AIM AND OBJECTIVES

The aim of this project is to carry out an economic analysis of Ilorin municipal water supply scheme. The specific objectives to accomplish this are as follow:

1. Identifying benefits, both quantifiable and nonquantifiable, and determining whether economic benefits exceed economic costs.
2. To investigate the operation, maintenance and management of the scheme.
3. To carry out an economic analysis of scheme.

4.0 LITERATURE REVIEW

The World Health Organization (WHO) carried out a survey in 1975 which revealed that only 22% of the rural population in developing countries had access to safe drinking water. The findings which were published in 1976, led to the declaration of 1981-1990 as the International Drinking Water Supply and Sanitation Decade, by the United Nations Water Conference (Dada *et al.*, 1988). The growing water scarcities and water pollution in developing and developed countries alike have plunged the world into a water crisis (Adewale, 2013). Establishing a small water scheme for the improvement of water supply in the rural areas is often associated with costs which the rural community may not be able to shoulder as a result of its heavy financial investment. The calculated financial investment needed globally for water and sanitation between 2010 and 2015 which is the MDGs target year for all countries to satisfy the drinkable water and sanitation requirements to achieve the goals target to be $145 billion (Ezenwaji and Enete,2013).

A development project was initiated on Obizi Regional Water Supply Scheme in Aguata, Anambra state Nigeria which serves 14 communities. The aim of the project was to assess the use of traditional microfinance method as an innovative approach to the development of the water supply facility. Data were generated through the use of questionnaire and others from secondary sources and the datas were analysed by use of factor scores from principal component analysis (PCA) to establish the performance of this innovation in all the component communities that benefited from the water scheme. PCA output revealed that the innovation is performing well in some communities but not in some others. Some of the variables employed are amount of money contributed monthly through microfinance approach for the development and extension of the scheme, the population of water consumers in the area, government assistance, daily water consumption amount, cost of developing water infrastructure etc. (Ezenwaji and Enete, 2013).

The people of Aguata in Anambra state are one such area where the State Government has invested Three hundred million Naira (₦300,000,000) on its Obizi water supply scheme to serve the water scarce Local Government Area. But after 2 years of the commissioning of the scheme, some parts of it started breaking down. This leads to the establishment of Water Consumers Associations (WCAs) in the communities to facilitate sustainability of the scheme. Some of the roles of the WCAs include organizing financial contributions and controlling the gathered funds, appoint staff to monitor the water scheme and oversee the collection of the user payments, discussing with agency staff on how best to rehabilitate or extend water system to meet the changing needs etc. The findings highlighted the adequacy of the model to ensure sustainability of regional water supply schemes in Nigeria. It encourages minimal external assistance in the long run, financing of regular operation and maintenance costs of users and continued flow of benefits over a long period. The findings also indicated that the model has its good performance in only 4 out of 14 communities due to poor mobilization of the community members to support the WCAs (Ezenwaji and Enete, 2013).

The history of improved water supply in Kwara state dated back to the early 1900s, when the colonialist and Christian missionaries established small dams, motorized well and rain harvesting devices in their various centers. However the first attempt by the State Government started with commissioning of Agba Dam in 1952. With the creation of Kwara State Water Corporation (KWWC) in 1972, the supply system extended to many parts of the State particularly with the commissioning of Asa Dam in 1978(Adebisi and Ifabiyi, 1999).

Sule and Okeola (2010) conducted an assessment on the performance of the Oyun River Regional Water Supply Scheme (ORRWSS) serving seven towns with population of 183927 people. The findings indicated that only 70% of this population was actually supplied to a reasonable extent. The capacity of the treatment plant is 20000m^3/day, but the production rate is 15,000m^3/day. After allowing 20% for UFW, the available supply is 12,000m^3, whereas the demand is 23,000m^3/day. Hence the supply is only satisfying 53% of the demand. The tariff is low and revenue generation is only 13% of the production cost of water. The degree of service in terms of supply is not satisfactory because five towns out of the seven towns are not getting adequate supply.

Olutimaleyin (1986) carried out an economic analysis of a city water supply scheme in Kwara State.The study examined the economics analysis of water supply in Ilorin Township from the year 1976 to 1986. The analysis covered stages of investment made, interest rate on funds made available to Water Board, the amount of water produced, the production cost, its mode of organization, rates for their services and revenue generated. The methodology approach considered present worth, annual worth, future worth, the payback period, internal rate of return, the benefit cost ratio and the benefit less cost. The findings indicated that from 1976-1984 the operating and maintenance cost of the scheme is higher than the revenue generated, until 1985 when the benefit-cost ratio was greater than one. This indicated that the revenue was greater than the operating and maintenance cost. The result seen in 1985 indicates a good cost recovery and response of the water consumers to payment of water tariff which bring in a revenue which can facilitate economic viability of the scheme.

5.1 METHODOLOGY

The methodology involves both the field and desk study. The field study involves a reconnaissance survey of both the scheme and ilorin metropolis to obtain basic and technical informations needed for economic analysis of the scheme.The reconnaisance survey would be done through oral interview and field observations. The desk study comprises : (i) investigation of the operation, maintenance and management of the scheme (ii) identification of benefits of the scheme to determine if its economic benefits exceed economic costs (iii) economic analysis of the scheme.

5.1.1 Operation and Maintenance Cost (O&M)

This cost includes all expenses incurred in treatment of water from raw water to potable water. It includes the cost of chemicals, energy, salaries and wages, repairs and replacements cost, etc. The O&M cost is also refers to as the running cost, which is the various input costs of producing one cubic meter (m^3) of water as an output for consumers utility. As one of its objectives, this study shall be interested in investigating the operation & maintenance cost of the scheme annually and the recurrent expenditure for a sustainable service delivery.

5.1.2 Benefit-Cost ratio

The benefit-cost ratio method has been widely used in the economic analysis of water resources projects. The method is based on the calculation of the ratio of benefits to costs; it holds that the ratio should be estimated based on the equivalent worth of discounted benefits and costs. It considers the time value of money.Therefore the annual worth, present worth, or future worth of benefits and costs would be used. The following are the basic formulations for benefit-cost ratio:

$$Benefit - Cost\, ratio = \frac{B}{C} \quad \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (1)$$

Where B is the net equivalent benefits, which is the revenue of the scheme from water tariff, C is the net equivalent annual cost (operation and maintenance costs of the scheme).For any project to be economically viable, its benefit-cost ratio should exceed one (1) therefore,

$$\frac{B}{C} > 1 \qquad and \qquad B - C > 0$$

The Benefit-Cost ratio shall be use in this study to evaluate the economic viability of Asa-Dam water works by using equation…(1) to obtain the ratio of its revenue and expenditure per time.

5.1.3 Economic Analysis

The economic analysis shall be done through Discount Cash Flow (DCF) method, capital recovery factor, sinking fund factor and average investment cost. They shall be limited to the recurrent expenditure of the Asa-Dam water scheme. The fomulations are as follows:

(i) Discount Cash Flow (DCF)

The DCF techniques are generally proposed for evaluating profitability of various kinds of projects and can be use to appraise the scheme this study is considering. The two methods of DCF techniques are Net Present Value (NPV) and Internal Rate of Return (IRR) which have two common features namely the use of cash flows and time value of money (Okeola, 2009). The NPV and IRR both yields the same decision, perhaps NPV has advantages over IRR. The DCF in this study shall be limited to the recurrent expenditures of the period. This is the value of annual series of cost and associated benefits. The cost herein refers to all operational cost for the provision of water supply service while the benefits are the returns from all categories of water tariff revenues.

$$NPV = \sum_{i=1}^{n} \frac{R_i - C_i}{(1 + r)^i} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots. (6)$$

Where R_i is the revenue in period i, C_i is the operation cost in period I, i is the period number, r is the discount rate. The hypothesis is that a positive NPV is an indication of financial viability while a negative NPV IS non viability.

(ii) Internal Rate of Return (IRR)

This can be defined as the discount rate that will set the net present value or the net future value of the cash flow equal to zero. It is also the rate of interest earned on the unrecovered balanced of an investment. Its relation is as follows:

$$IRR = F\left(\frac{1}{1 + i}\right)^n - \mathrm{Ct} = F\left(\frac{P}{F}, i\%, n\right) - \mathrm{Ct} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots. (5)$$

Where C_t is the capital invested on the scheme in year t, n is the life span of the scheme

(iii) Capital recovery factor (A/P, I, n)

This calculates the uniform series amount A that will recover a capital P invested on a project in periods (n).

$$A = P\left[\frac{i(1 + i)^n}{(1 + i)^n - 1}\right] \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. (2)$$

Where A is amount to be recovered as payback for the capital (either loan or debt) use for the running cost of the project, P is recurrent expenditure, i is interest rate and n is life span of the project

(iv) Average Investment Cost (AIC)

This is the cost of present and future investment in order to produce and distribute one cubic meter of water (François and Johnny, 2001)

$$AIC = \frac{(INI + FIN)(1 - C)}{TWP} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots. (4)$$

Where INI is the present operating capital, FIN is the future worth of operating capital to be invested on the project, TWP is the total volume of water produce in a period and C is the cost recovery. Average investment cost shall be incorporated in this study mainly to evaluate the future and present amount of capital(recurrent cost) to operate the scheme effectively.

6.0 EXPECTED RESULT

- Economic analysis of Asa Dam water works.
- The demand and supply from existing facility would be known.
- Economic costs (recurrent expenditure) of the facility and the appropriate levels of tariff and cost recovery needed to financially sustain it would be determined.
- Benefit – cost ratio of the scheme under consideration.
- Operation, maintenance and management of the scheme.
- Recommendations for the effective operation and sustenance of the scheme.

7.0 TIME FRAME

Table7.1: Project Work Breakdown Structure (WBS)

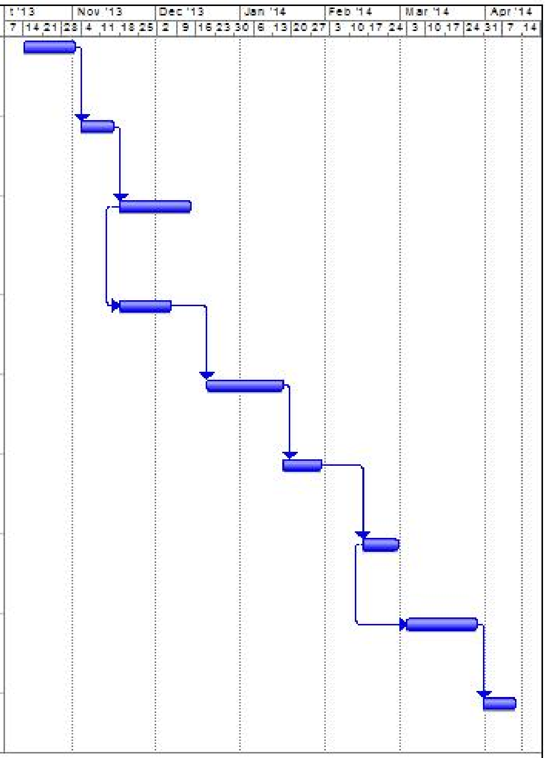
S/N	Task	Duration (Weeks)	Start Date	Finish Date
1	Selection of final year project topic	3	14/10/13	01/11/13
2	Search of materials on the project	2	04/11/13	15/11/13
3	Reading and Studying of relevant Literature	4	08/11/13	05/12/13
4	Writing final year project proposal	3	08/11/13	28/11/13
5	Analysis/Assessment of Asa-Dam water works	4	20/12/13	01/01/14
6	Survey on the study area	2	01/17/14	01/30/14
7	Computation of Results and Datas	2	02/15/14	02/27/14
8	Economic Analyses of the Data obtained	4	03/03/14	04/04/14
9	Project Documentation	2	07/04/14	18/04/14

8.0 BUDGET

Table8.1: Project budget

S/N	Activity		Estimated cost (Naira)
1	Relevant Textbooks		4000.00
2	Internet facility		8000.00
3	Transportation		2000.00
4	Documentation		10000.00
5	Miscellaneous		6000.00
	Total	**30000**	

ID	Task Name	Duration	Start	Finish	Predecessors
1	Selection of final year project topic	3 wks	Mon 10/14/13	Fri 11/1/13	
2	Searching for materials on the project	2 wks	Mon 11/4/13	Fri 11/15/13	1
3	Reading and Studying of relevant Materials on the Project	4 wks	Mon 11/18/13	Fri 12/13/13	2
4	Writing final year project proposal	3 wks	Mon 11/18/13	Fri 12/6/13	3SS
5	Assessment/ analyses on Asa-Dam water works	4 wks	Fri 12/20/13	Thu 1/16/14	4
6	Survey on a specific area receiving water supply from the facility under consideration	2 wks	Fri 1/17/14	Thu 1/30/14	5
7	Computation of Results and Datas	2 wks	Sat 2/15/14	Thu 2/27/14	6
8	Economic analyses on the data obtained	4 wks	Mon 3/3/14	Fri 3/28/14	7SS
9	Project Documentation	2 wks	Mon 3/31/14	Fri 4/11/14	8



Project: project proposal gannt chart
Date: Mon 4/14/14

Task | Split | Progress | Milestone | Summary | Project Summary | External Tasks | External Milestone | Deadline

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