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# Economic Viability of a Proposed Run-off Scheme Small Hydropower Plant at Onuaku River, Abia State, Nigeria

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## Abstract

In this study the financial and economic feasibility of a proposed small hydropower plant at Onuaku River in Aku community of Abia state, Nigeria was evaluated using indicators like the Net Present Value (NPV), Payback Period, Benefit Cost Ratio (BCR) and Internal Rate of Return (IRR) to ascertain the feasibility and viability of the project. Here the breakeven point of the project, cash flow, present and future value of project as well as the expected yearly revenue of the project is shown in advance within the economic life or span of the project. With an investment cost of less than ₦12million, a NPV of three million six hundred and thirty thousand, fifty seven naira fifty eight kobo (₦3,630,057.58) was gotten at the 30 years life span of the project with an IRR of 14.25%. Also from the analysis a project Payback Period of ten years which is timely enough for the client or investor to recover the investment made on a project that can span up to thirty years (minimum) - fifty years (maximum). The BCR of the project from analysis is 1.23 which is above unity. Hence the results from the analysis above have provided additional information for the decision makers, client and the design engineer and scientist to see reasons why this project should be embarked on using the mentioned economic tools.

## Keywords

Small Hydropower, Feasibility, Renewable, Energy, Onuaku River

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## 1. Introduction

All living things depend on energy for survival, and modern civilizations will continue to thrive only if existing sources of energy can be developed to meet the growing demands, hence Energy is *"Life",* Energy is *"Existence",* it is the dividing line between the rich and the poor, between the developed, developing and the underdeveloped [10]. Energy and poverty reduction are not only closely connected with each other, but also with the socioeconomic development, which involves productivity, income growth, education, and health [9].

The standard of living of a given country can be directly related to the *per capita* energy consumption. The per capita energy consumption is a measure of the per capita income as well as a measure of the prosperity of a nation [11]. For a country to grow beyond its subsistence economy, tackle the problem of poverty, the country will need to have minimum access to energy services for the larger proportion of its population. However, in Nigeria energy supply has been epileptic in nature, causing the socio-economic status of the country to be downgraded. The Council for Renewable Energy of Nigeria estimates that power outages brought about a loss of 126 billion naira (US$ 984.38 million)

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annually [4]. Nigeria as a nation has started feeling the impact of adverse climate change, that may be attributed to the overdependence on fossil fuel fired power plants which is the main source of Greenhouse Gas emissions (GHG), coupled with activities of manufacturing industries, oil prospecting firms and deforestation, to mention but a few.

Renewable Energy (RE) has been identified as the only alternative of addressing these problems. RE is energy derived from an energy source that can regenerate itself through natural processes within a relatively short period; unlike fossil type resources that take millions of years to form and which is not regenerative. Examples of such energy sources include: Hydropower, wind, solar, tidal, biomass, wave, ocean thermal and geothermal. Hydropower amongst other renewable sources mentioned offers a clean and sustainable source for rural power, 24hours a day and even all through the year, provided there is water to power the turbines, causing little or no emissions to the ecosystem [10].

Inspite of abundance water resources that abound in all states and local government areas in Nigeria, hydropower remains an underutilized resources for electric power generation in Nigeria. Hydropower is the power generated by using the potential energy stored in flowing water. It is a renewable energy source suitable for rural electrification in developing countries like Nigeria. It is a proven technology that can be connected to the main grid, used as a stand- alone/ off-grid mode [8].

Countries all around the world are trying to supply their increasing demands for electricity with clean energy technologies. Hydropower as sustainable and renewable resource is one of the major sources of power, which the country looks forward to in the nearby future, though a significant portion of the economically viable hydropower potential of Nigeria has not been harnessed, thus very few hydropower plants are under construction and in program to harness this economically viable potential [8]. Hydropower is one of the most attractive sources of renewable energy, however the inability to convince investors through proper economic viability analysis or insufficient technical knowhow on the part of the design engineer to conduct proper economic feasibility and financial viability of such projects has greatly militated against the growth and development of the scheme in Nigeria, coupled with other factors, as there are many SHP projects abandoned and others yet to be harnessed. These set back has had its own fair share in the limited or total lack of access to electricity in rural communities, as SHP projects are mostly rural targeted projects, hence a major cause of underdevelopment and limited wealth generation capabilities amongst rural dwellers, as constant and available electric supply, drives the growth of cottage and small scale industries, by providing light, heat and power for productive uses and communication, that results in improved life styles and economies of rural dwellers.

The economic analysis compares and shows if a project should be embarked on, or abandoned. From an economic view point a hydropower plant, differs from a conventional thermal plant, because its investment cost per kW is much higher but the operating cost are extremely low, since there is no need for fuel [5].

This research work seeks to address basically the economic viability of SHP projects and its computation for financial investment decision using economic indicators like Net Present Value (NPV), Internal Rate of Return (IRR), Benefit Cost Ratio (BCR), to ascertain the breakeven point of the project, cash flow, present and future value of project as well as the expected yearly revenue of the project is shown in advance within the economic life or span of the project.

## 2. Materials and Methods

### 2.1. Study Site

River Onuaku is a stream and is located in Isuikwato local government Area of Abia State in Nigeria. The town is named after the river and is between latitude 5°54'2.63" and Longitude 7°32'45.56". The area is accessible through the Okigwe - Afikpo road or through the Lekweri – Obiagu road detouring from the Port Harcourt – Enugu Express way. It was estimated from the last census of 2006 to have a population of 8,500. The Onuaku area is located in the tropical forest zone described as the Guinea savannah. However the primary rain forest has been extensively modified athropogenic activities e.g farming, bush burning, etc hence replaced by the “desired” savannah. This consists mainly of tall grasses, shrubs and a few trees. Patches of forests still exist in the area.

The area is extensively a low-lying terrain of about 50 – 135m above sea level. The major stream is the Onuaku River from which the settlement took its name. The area has two distinct seasons; the rainy (wet) season and the dry season. The rainy season spans from April to October with a double maxima in July and September. A mean rainfall range of 1750m- 2000mm [7] is experienced. The air temperature range between 26.2 – 28°C, but lower temperature occur during harmattan periods of December and January and higher temperature in other times up to 30 – 32°C [8].

The dry season spans from November and March. However the months of November and March are not completely dry as some rainfall could be experienced periodically with a dry season minimum flow between the range of 2-3m$^3$/s. The Onuaku River is an all season river with the highest / full discharge during the rainy season between May and October. The river has its source from the Inyi Ike and flows south easterly and empties into Ivo River.

## 2.2. Technical Details

The detailed technical feasibility study was carried out by the team of Engineers and Scientists spanning from different discipline from the National Agency for Science and Engineering Infrastructure (NASENI), through field work. The power to be generated for the SHP was determined largely based on the demand of the local community and survey was carried in 2014 to collect information, regarding the demand for power in the locality and the villager's willingness to pay for the electricity supplied. In the demand survey the head count of the villagers according to households and rural demand, such as for offices, schools and so on were also calculated. The feasibility analysis also included the survey regarding hydrological, geographical and topographical information needed, prior to the actual design of the system components. The site survey was also carried out to determine the flow (Q), and head (H) required for the required power output of the project. The gross head was measured to be 7.8m by on field design survey by the use of a topographic map of that area and a digital altimeter with precision of (+/-1m to +/-5m). The flow of $0.04m^3/s$ (lean flow) and $0.346m^3/s$ (wet flow) were gotten using the Velocity Area Method of flow measurement amongst other methods, like the weir method, salt dilution method, slope area method. The method employed for the flow measurement is thought to be accurate and quick. The summary of the data available from the feasibility analysis is provided in table 1.

**Table 1.** Summary of Data Gotten from the Feasibility Analysis on for Onuaku SHP Project.

| Project Name | Onuaku SHP Project |
|---|---|
| Catchment Area | $4.28x10^6$ $m^2$ |
| Gross head | 7.8m |
| Net head | 6.99m |
| Penstock length | 166m each |
| Design discharge | 0.04 $m^3/s$ -0.346 $m^3/s$ |
| Number of turbines | 1 |
| Capacity | 17kW to be locally fabricated |
| Turbine type | Cross flow |
| Net Production | 92,845.44 |
| River source | Inyi-ike/ Evo river |
| No of households | |
| Length of weir | 3m |
| Scheme type | Run- off- river |

## 2.3. Economic Tools or Indicators

The various equations used to appraise the economic viability of this project were gotten from literature and certain assumptions were also made based on the economic realities of the time. Such equations are discussed below.

a) **Present Value**; it describes a monetary amount now, i.e. at a point in time other than that at which it is paid or received. It is mathematically given as [3]

$$= \frac{1}{(1+r)^n} \quad (1)$$

Where

r = Discount rate (%)

n = time (years)

b) **Payback Method (PBP)**; the PBP method determines the number of years required for the investment capital to be offset by resulting benefits. It is mathematically given as [1]

$$\text{Payback Period} = \frac{\text{capital investment cost}}{\text{Annual Cash inflows}} \quad (2)$$

c) **Net Present Value**; in the NPV method, the revenues and cost of a project are estimated and then discounted and compared with the initial investment. The preferred option is that with the highest Net Present Value. Projects with negative NPV should be rejected, because the Present Value of the Stream of benefits is insufficient to recover the cost of the project. The NPV is mathematically given as [6];

$$NPV = \sum_{j=1}^{30} \frac{(B_j - C_j)}{(1+i_s)^j} \quad (3)$$

Where

n = Project life Span of 30 years

j = Increment in years

$B_j$ = Benefit at j years

$C_j$= Cost of O & M at j years

$i_s$= Discount rate

d) **Internal Rate of Return (IRR)**; the IRR is the discount rate, at which the present value of the periodic benefits (revenues less operating and maintenance cost) is equal to the present value of the initial investment [5]. In other words, the method calculates the rate of return an investment is expected to yield. The preferred option is that with the IRR greatest in excess of a specified rate of return or discount rate. Mathematically the IRR is given as [6]:

$$NPV = \sum_{j=1}^{30} \frac{(B_j - C_j)}{(1+EIRR_s)^j} = 0 \quad (4)$$

Where

EIRR = the value or rate of IRR that equals the NPV to zero.

Hence we calculate by interpolation the discount rate that makes the NPV to be Zero by the formula below;

e) **Benefit Cost Ratio (BCR) or Profitability index**; the BCR or Profitability index is the discounted net revenues divided by the initial investment. The preferred option is that with the ratio greatest in excess of one. In any event, a project with a benefit cost ratio of less than one should generally be discarded. Mathematically the IRR is given as [5]

$$B/C = \frac{\sum_{j=1}^{30} \frac{B_j}{(1+i_s)^j}}{\sum_{j=1}^{30} \frac{C_j}{(1+i_s)^j}} \quad (5)$$

Where the parameters have the same meaning as previous equation above.

Furthermore the computations were successfully carried out using an excel based platform to show the different cash flow analysis of the respective indicators used.

# 3. Results and Discussion

## 3.1. Results

The results of the cost of the project after a proper bill of engineering measurement and evaluation, the estimated cost of the project is summarised in Table 2.

**Table 2.** Estimated cost of project.

| Items | Cost (₦) |
|---|---|
| Direct costs | |
| Civil Engineering | 7,602,722.85 |
| Turbine- generator (Locally Fabricated) | 1,209,155.85 |
| Total Direct cost Foreseen | 8,812,155.85 |
| Contingencies (unforseen) | |
| 10% of electromechanical cost | 120,943.3 |
| 10% of civil engineering | 760,272.285 |
| Total direct cost (contingencies plus total direct cost foreseen) | 9,693,371.43 |
| Indirect Cost | |
| Engineering cost (12% of direct & contingencies) | 1,163,204.57 |
| Admin &others (5% of direct & contingencies) | 969,373.143 |
| TOTAL CAPITAL COST | 11,232,184 |

### 3.1.1. Expected Revenue

With a net production of 92,845.44kWh, all year round, the power generation is projected using a tariff rate of 12.38 Naira per kWh of electricity as at 2014 [2]

Hence the expected yearly revenue is calculated thus as

= Energy produced yearly x tariff rate

= 92,845.44 x 12.38

= ₦1, 149,426 Naira

### 3.1.2. Payback Period

With a project cost of ₦11.2 million, and a varied net cash flow as shown in table 3 below, the project would be completely paid for in;

$$\text{Payback period} = \frac{\text{Investment cost}}{\text{Annual cash flow}}$$

$$= \frac{11{,}232{,}184}{1{,}149{,}421}$$

= 10years (approx)

### 3.1.3. Net Present Value

Table 3 below shows that the cash flow analysis gave an NPV of 3,630,057.58 at the 30 years life span of the project base on the following assumptions.

a) 12% discount rate [13]

b) Project life span of 30 years (5)

c) 9.5% of energy escalation on annual benefits [7]

**Table 3.** Cash Flow Analysis for Project NPV: from equation (3).

| YEAR | CAPITAL COST (₦) | O&M(5% Capital cost) (₦) | ANNUAL BENEFIT(9.5% Escalation) (₦) | NET ANNUAL BENEFIT (₦) | PRESENT VALUE FACTOR (i=12%) | NET PRESENT VALUE(NPV) (₦) |
|---|---|---|---|---|---|---|
| 1 | 11,232,184 | | | -11,232,184 | 0.892857 | -10028735.71 |
| 2 | | 561,609.20 | 1,149,421 | 587,811.80 | 0.797194 | 468599.9681 |
| 3 | | 589689.66 | 1258616 | 668,926.30 | 0.71178 | 476128.5525 |
| 4 | | 619174.143 | 1378185 | 759,010.40 | 0.635518 | 482364.8128 |
| 5 | | 650132.85 | 1509112 | 858,979.20 | 0.567427 | 487407.8628 |
| 6 | | 682639.493 | 1652478 | 969,838.20 | 0.506631 | 491350.212 |
| 7 | | 716771.467 | 1809463 | 1,092,691.60 | 0.452349 | 494278.1881 |
| 8 | | 752610.041 | 1981362 | 1,228,752.00 | 0.403883 | 496272.3317 |
| 9 | | 790240.543 | 2169591 | 1,379,350.90 | 0.36061 | 497407.7669 |
| 10 | | 829752.57 | 2375703 | 1,545,950.10 | 0.321973 | 497754.5487 |
| 11 | 11,821,464.70 | 871240.198 | 2601394 | 1,730,154.20 | 0.287476 | 497377.9877 |
| 12 | | 914802.208 | 2848527 | 1,933,724.70 | 0.256675 | 496338.9552 |

| YEAR | CAPITAL COST (₦) | O&M(5% Capital cost) (₦) | ANNUAL BENEFIT(9.5% Escalation) (₦) | NET ANNUAL BENEFIT (₦) | PRESENT VALUE FACTOR (i=12%) | NET PRESENT VALUE(NPV) (₦) |
|---|---|---|---|---|---|---|
| 13 | | 960542.319 | 3119137 | 2,158,594.60 | 0.229174 | 494694.1681 |
| 14 | | 1008569.44 | 3415455 | 2,406,885.50 | 0.20462 | 492496.4571 |
| 15 | | 1058997.91 | 3739923 | 2,680,925.20 | 0.182696 | 489795.0165 |
| 16 | | 1111947.8 | 4095216 | 2,983,268.00 | 0.163122 | 486635.6395 |
| 17 | | 1167545.19 | 4484261 | 3,316,716.10 | 0.145644 | 483060.9375 |
| 18 | | 1225922.45 | 4910266 | 3,684,343.70 | 0.13004 | 479110.5467 |
| 19 | | 1287218.57 | 5376741 | 4,089,522.90 | 0.116107 | 474821.3206 |
| 20 | | 1351579.5 | 5887532 | 4,535,952.40 | 0.103667 | 470227.5107 |
| 21 | | 1419158.48 | 6446847 | 5,027,688.90 | 0.09256 | 465360.9363 |
| 22 | | 1490116.4 | 7059298 | 5,569,181.50 | 0.082643 | 460251.1422 |
| 23 | | 1564622.22 | 7729931 | 6,165,309.00 | 0.073788 | 454925.5482 |
| 24 | | 1642853.33 | 8464275 | 6,821,421.40 | 0.065882 | 449409.5872 |
| 25 | | 1724996 | 9268381 | 7,543,384.80 | 0.058823 | 443726.8361 |
| 26 | | 1811245.8 | 10148877 | 8,337,631.20 | 0.052521 | 437899.1376 |
| 27 | | 1901808.09 | 11113020 | 9,211,212.20 | 0.046894 | 431946.7143 |
| 28 | | 1996898.49 | 12168757 | 10,171,858.70 | 0.041869 | 425888.2756 |
| 29 | | 2096743.42 | 13324789 | 11,228,045.70 | 0.037383 | 419741.1181 |
| 30 | | 2201580.59 | 14590644 | 12,389,063.50 | 0.033378 | 413521.2191 |
| | | | | | | 3,630,057.58 |

### 3.1.4. Internal Rate of Return

The IRR is an indicator to measure the financial return on investment of an income generating project and is used in investment decision. In general the decision rule is that as long as the IRR of the project is greater than discount rate or the hurdle rate, then you accept the project.

Table 4 shows that the upper and lower limit of discount gotten by Trial and error method are 12% - 14.52%, hence we calculate by interpolation the discount rate that makes the NPV to be zero.

$$\text{Lower Discount Rate} + \text{Diff of two discount rate}\left[\frac{\text{NPV at lower disc rate}}{\text{Sum of NPV at two disc rate}}\right]$$

But lower rate = 12%

Difference of two disc rate = 14.52% -12 = 2.52%

NPV at hurdle discount rate of 12% = ₦3, 630,057.54

NPV at upper discount rate = ₦-313.208

We have

$$\text{IRR} = 12 + 2.52\left[\frac{3,630,057.54}{3,630,057.54+313.208}\right]$$

$$= 12 + 2.25$$

IRR = 14.25%

Therefore with an IRR of 14.25%, the project NPV becomes zero.

**Table 4.** Cash Flow Analysis for Project IRR: from equation (4).

| Year | Capital Cost(₦) | Net Annual Benefit(₦) | Present Value (i=12%) | Net Present Value(₦) | Present Value For IRR (i=14.52%) | Net Present Value For IRR(₦) |
|---|---|---|---|---|---|---|
| 1 | 11,232,184 | -11,232,184 | 0.892857 | -10028735.71 | 0.873202295 | -9807968.844 |
| 2 | | 587,811.80 | 0.797194 | 468599.9681 | 0.762482248 | 448196.0624 |
| 3 | | 668,926.30 | 0.71178 | 476128.5525 | 0.665801248 | 445371.9889 |
| 4 | | 759,010.40 | 0.635518 | 482364.8128 | 0.581379178 | 441272.8258 |
| 5 | | 858,979.20 | 0.567427 | 487407.8628 | 0.507661632 | 436070.7793 |
| 6 | | 969,838.20 | 0.506631 | 491350.212 | 0.443291302 | 429920.8364 |
| 7 | | 1,092,691.60 | 0.452349 | 494278.1881 | 0.387082982 | 422962.3236 |
| 8 | | 1,228,752.00 | 0.403883 | 496272.3317 | 0.338001749 | 415320.3308 |
| 9 | | 1,379,350.90 | 0.36061 | 497407.7669 | 0.295143902 | 407107.0111 |
| 10 | | 1,545,950.10 | 0.321973 | 497754.5487 | 0.257720333 | 398422.7675 |
| 11 | 11,821,464.70 | 1,730,154.20 | 0.287476 | 497377.9877 | 0.225041986 | 389357.3365 |
| 12 | | 1,933,724.70 | 0.256675 | 496338.9552 | 0.196507179 | 379990.776 |
| 13 | | 2,158,594.60 | 0.229174 | 494694.1681 | 0.171590519 | 370394.3676 |
| 14 | | 2,406,885.50 | 0.20462 | 492496.4571 | 0.149833235 | 360631.4392 |
| 15 | | 2,680,925.20 | 0.182696 | 489795.0165 | 0.130834725 | 350758.1151 |
| 16 | | 2,983,268.00 | 0.163122 | 486635.6395 | 0.114245182 | 340823.9995 |
| 17 | | 3,316,716.10 | 0.145644 | 483060.9375 | 0.099759155 | 330872.8006 |
| 18 | | 3,684,343.70 | 0.13004 | 479110.5467 | 0.087109923 | 320942.898 |
| 19 | | 4,089,522.90 | 0.116107 | 474821.3206 | 0.076064585 | 311067.8598 |
| 20 | | 4,535,952.40 | 0.103667 | 470227.5107 | 0.06641977 | 301276.9143 |

| Year | Capital Cost(₦) | Net Annual Benefit(₦) | Present Value (i=12%) | Net Present Value(₦) | Present Value For IRR (i=14.52%) | Net Present Value For IRR(₦) |
|---|---|---|---|---|---|---|
| 21 | | 5,027,688.90 | 0.09256 | 465360.9363 | 0.057997896 | 291595.3783 |
| 22 | | 5,569,181.50 | 0.082643 | 460251.1422 | 0.050643896 | 282045.0472 |
| 23 | | 6,165,309.00 | 0.073788 | 454925.5482 | 0.044222366 | 272644.55 |
| 24 | | 6,821,421.40 | 0.065882 | 449409.5872 | 0.038615071 | 263409.6721 |
| 25 | | 7,543,384.80 | 0.058823 | 443726.8361 | 0.033718769 | 254353.6482 |
| 26 | | 8,337,631.20 | 0.052521 | 437899.1376 | 0.029443306 | 245487.4286 |
| 27 | | 9,211,212.20 | 0.046894 | 431946.7143 | 0.025709963 | 236819.9214 |
| 28 | | 10,171,858.70 | 0.041869 | 425888.2756 | 0.022449998 | 228358.2117 |
| 29 | | 11,228,045.70 | 0.037383 | 419741.1181 | 0.01960339 | 220107.7605 |
| 30 | | 12,389,063.50 | 0.033378 | 413521.2191 | 0.017117725 | 212072.5852 |
| | | | | 3630057.584 | | -313.2083908 |

### 3.1.5. Benefit Cost Ratio

The benefit cost ratio of the project from discounted O & M cost, discounted investment cost and the discounted Annual benefit from the Table 5 is given by

Total Discounted Cost = ₦6,061,119.81 + ₦10,028,735.71

= ₦16,089,855.52

and

Discounted benefit= ₦19,719,913.11

Hence b/c ratio = $\frac{19,719,913.11}{16,089,855.52} = 1.23$

**Table 5.** Cash Flow Analysis For Benefit Cost Ratio: from equation (5).

| YEAR | O&M (5% Capital cost)(₦) | Annual Benefit (9.5% escalation)(₦) | Present Value (i=12%) | Discounted Capital Cost (₦) | Discounted O&M(₦) | Discounted Annual Benefit (₦) |
|---|---|---|---|---|---|---|
| 1 | | | 0.8928571 | -10028735.71 | | |
| 2 | 561,609.20 | 1,149,421 | 0.7971939 | | 447711.4158 | 916311.3839 |
| 3 | 589689.66 | 1258616 | 0.7117802 | | 419729.4523 | 895858.0048 |
| 4 | 619174.143 | 1378184.5 | 0.6355181 | | 393496.3616 | 875861.1744 |
| 5 | 650132.8502 | 1509112 | 0.5674269 | | 368902.839 | 856310.7017 |
| 6 | 682639.4927 | 1652477.7 | 0.5066311 | | 345846.4115 | 837196.6236 |
| 7 | 716771.4673 | 1809463.1 | 0.4523492 | | 324231.0108 | 818509.1989 |
| 8 | 752610.0407 | 1981362.1 | 0.4038832 | | 303966.5726 | 800238.9043 |
| 9 | 790240.5427 | 2169591.5 | 0.36061 | | 284968.6618 | 782376.4288 |
| 10 | 829752.5698 | 2375702.6 | 0.3219732 | | 267158.1205 | 764912.6692 |
| 11 | 871240.1983 | 2601394.4 | 0.2874761 | | 250460.7379 | 747838.7257 |
| 12 | 914802.2082 | 2848526.9 | 0.2566751 | | 234806.9418 | 731145.897 |
| 13 | 960542.3186 | 3119136.9 | 0.2291742 | | 220131.508 | 714825.6761 |
| 14 | 1008569.435 | 3415454.9 | 0.2046198 | | 206373.2887 | 698869.7458 |
| 15 | 1058997.906 | 3739923.1 | 0.1826963 | | 193474.9582 | 683269.9747 |
| 16 | 1111947.802 | 4095215.8 | 0.1631217 | | 181382.7733 | 668018.4128 |
| 17 | 1167545.192 | 4484261.3 | 0.1456443 | | 170046.35 | 653107.2875 |
| 18 | 1225922.451 | 4910266.2 | 0.1300396 | | 159418.4531 | 638528.9998 |
| 19 | 1287218.574 | 5376741.5 | 0.1161068 | | 149454.7998 | 624276.1203 |
| 20 | 1351579.503 | 5887531.9 | 0.1036668 | | 140113.8748 | 610341.3855 |
| 21 | 1419158.478 | 6446847.4 | 0.0925596 | | 131356.7576 | 596717.6939 |
| 22 | 1490116.402 | 7059297.9 | 0.0826425 | | 123146.9603 | 583398.1025 |
| 23 | 1564622.222 | 7729931.2 | 0.073788 | | 115450.2752 | 570375.8234 |
| 24 | 1642853.333 | 8464274.7 | 0.0658821 | | 108234.633 | 557644.2202 |
| 25 | 1724995.999 | 9268380.8 | 0.0588233 | | 101469.9685 | 545196.8046 |
| 26 | 1811245.799 | 10148877 | 0.0525208 | | 95128.09544 | 533027.2331 |
| 27 | 1901808.089 | 11113020 | 0.0468936 | | 89182.58948 | 521129.3037 |
| 28 | 1996898.494 | 12168757 | 0.0418693 | | 83608.67763 | 509496.9532 |
| 29 | 2096743.418 | 13324789 | 0.0373833 | | 78383.13528 | 498124.2534 |
| 30 | 2201580.589 | 14590644 | 0.0333779 | | 73484.18933 | 487005.4084 |
| | | | | -10028735.71 | 6061119.813 | 19719913.11 |

# 4. Discussion and Conclusion

## 4.1. Economic Indicators or Ratios

When appraising a project, it is pertinent not to use one method or indicator to show if the project is economically viable, hence several economic tools or indicators were used to ascertain the economic viability of Onuaku SHP project. These tools will be discussed below as they support in determining the viability of the project according to their specific decision rules that support them

**a. Payback Period or Breakeven point**

With a project cost of ₦11,234,184 million, and a varied net cash flow as shown in Table 3, the project would be completely paid for in 10 years (Year 2021), meaning that an investor will recoup its initial capital within a ten years period, if the project is implemented and put into full operation. This method is the fastest and most used method to show the economic potential of a project, but cannot be relied alone on to ascertain the viability of a project, because it does not show the year to year variations in cash flow and does not take into account the time value of money. According to the rule of dump, the shorter time for the project to pay back its initial investment, the better. From our analysis here, ten years is considerable short a period for an investment that spans over 30 years minimum and 50 years and above, to yield. Hence it is very key to undertake this project.

**b. Net Present Value**

From table 3 the project net present value was estimated at ₦3, 630,057.54. Having returned a positive NPV is an indication that the project is viable according to our decision rule from our literature review. The implication of returning a positive NPV after all discounting have been made to carter for the time or present value of money, is an indication that the project can pay for all its cost and able to withstand variations and fluctuations in price indices. Compared to other investment appraisal techniques such as the IRR and the discounted payback period, the NPV is viewed as the most reliable technique to support investment appraisal decisions.

**c. Internal Rate of Return**

The IRR is an indicator to measure the financial return on investment of an income generating project. From table 4, the IRR of the project is 14.25% higher than the hurdle rate of 12% that correspond to the opportunity cost of capital; this states that as long as the IRR of the project is greater than the discount rate, the project is viable. The implication of this statement goes as far as letting the investor understand, that even at a higher hurdle rate, say 14.25%, the project will still break even.

**d. Benefit Cost Ratio or the profitability index**

From table 5, we got that the profitability index of the project is 1.23. According to our decision rule, a project with a benefit of less than one should be discarded. Hence the profitability index of Onuaku SHP site is above unity from calculation. This implies that on every one naira invested in this project, a benefit of 0.23 kobo is realized, which is an 18.7% benefit on every one naira spent. Hence from our decision rule this project is viable based on the result from our calculation.

### 4.2. Conclusion

A project payback period of ten years is timely enough for the client or investor to recover its initial investment made on a project that can span beyond 50 years with a positive NPV of three million six hundred and thirty thousand, fifty seven naira fifty eight kobo only, (₦3, 630,057.58) and an IRR of 14.25% higher than the hurdle rate 12%, and a benefit cost ratio above unity of 1.23 an indication of positive returns on investment.

Hence, the results from the analysis above have provided additional information for the decision makers, client and the design engineer to see reasons why this project will be economically viable based on the economic indicators used.

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