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Evolving Costing Template for Investment in Environmental Engineering Public Projects

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Abstract

Environmental Engineering Public Projects are relatively non income producing but undertaken on the basis of social, political project- relative benefits and externalities on ascertaining value for money. The need arise to mitigate the impact of global warming on the environment by effecting among others landfills, storm water transportation. The uniqueness, complexity, specialized nature of emerging, environmental engineering projects requires alternative procurement method such as turnkey and associated project financing. Costing in this regard appears to lack non-uniformity of a result oriented technique. This work attempted evolving costing template for Investment Environmental Engineering Public Project through step by step approach, examining a hypothetical proposed dual carriage expressway to mitigate the effects of heavy rain/flood washed and damaged single carriage meandering road. The proposed project was reduced to various cost centers/variables such as initial and running costs, benefits and dis-benefits, all measured in monetary terms and discounted at a cost of capital over the project lifespan to obtain a Net Present Value (NPV). Reports of Benefits/Costs Ratio (BCR) and Analysis Interpreted thus: BCR>1 signifies investable, BCR<1 is no investable while zero is neutral. Recommendations such as government establishment of work study units to produce more realistic data, interventions on determinants of costs of capital, friendly legal framework and provision of adequate security were proffered.

Keywords: *Public projects, Global warming, Benefits/costs analysis, Environmental engineering projects, Template for costing.*

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Background of the Study
Global warming, the aftermath of human influence of emission of carbon dioxide(co_2)from fossil fuel combustion, cement production and land use changes such as deforestation. The phenomenon is also linked to the warning of the atmosphere and the ocean, changes in the global water cycle, in reduction in snow and ice, in global mean sea level rise and in changes in some climate extremes. As amelioration, actions such as mitigation by emission reduction, adaptation to its effects, building system resilient to global warming effects and possible future climate change become imperative(UNMD, 2015).

The implementation of these making good actions cut across professionals among which are the Environmental Engineers. Environmental Engineering, IE (2011) is the field of engineering concerned with environmental issues. The profession assesses and manages the effects of human and other activities on the natural and built environment. They apply their engineering knowledge and skill to such thing as environmental impact assessment, natural resources management and pollution control.

To actualize these, they provide practical solutions to the problems such as involved in the planning, design, repair and construction of mostly public infrastructure systems in the areas of water and sewage treatment plants, landfills, storm water transportation and river control works with a view to achieving environmental sustainability development that meets the needs of the present without compromising the ability of future generation to meet their own needs.

Infrastructure relating to environmental engineering appear mostly social, complex often non-income yielding with high degree of externalities consuming huge funds.
Resultant decision to invest revolves on outcome of costing based on benefits/costs analyses rather than the financial return on investment. Cost centers are unique attracting expertise, experience, reliable data and applicable techniques which have remained novel in the built environment

Objective of the Study
The effects of global warming, http:/en Wikipedia.org, includes more frequent extreme weather events including heat, waves, droughts and heavy rainfall, ocean acidification and species extinct among others.

These have brought concern for the carrying capacity of natural systems with social political and environmental challenges faced by humanity. In the circumstance the need arises to complement nature. Thus, the intervention of the human expertise through science, technological and engineering such as environmental road/flood drainages, water dam, sewage conflation, project products so as to achieve equilibrium in balancing natural resources. The complex nature of most of these interventions makes it near impossible for cost experts to undertake the costing using a uniform approach. Thus, this is an attempt to develop a common and workable template towards guiding the costing for investment in non-rival environmental engineering product.

Literature Review

Public Projects (Infrastructure)

The American Herthase dictionary defined infrastructure as the basic facilities, services and installations needed for the functioning of community or society such as transportation and communication systems, water, power line and public institutions including schools, post offices and persons.

As a contribution, IPCC (2009) refers to facilities with common characteristics of capital intensive and high investment at all levels of government. They are moreover due critical to the activity in the nations' economy. They include highways, public transit systems, waste water treatment plants, water resources, air traffic control airports, water supply and such social faculties as roads school, hospitals, persons and even individual capacity.
When any or a combination of the above projects is funded in part or wholly with taxpayers' money, the procured is termed public project.

Global Warming

Global warming, NOAA (2007) refers to the observed century-scale, rise in the average temperature of earths' climate system. Thus, global warming refers to increase in average temperature of the air and sea at earths' surface. As observed, since early 20^{th} century, the global air and sea surface temperature has increased to about $14^{\circ}f$ with about two third of the occurring since 1980.

According to ACC (2003), global warming is associated with Green House Grase (GHG) in the atmosphere which mostly comprise carbon dioxide (CO_2), methane, tropospheric ozone and nitro oxide and all these are produced by human activities.

As a result, the earth experiences more frequent extreme weather events including heat waves, droughts and heavy rainfall, ocean edification and species extinctions due to shifting temperature regimes culminating to decreasing crop yields and the loss of habitat from inundation. As a reaction the UNFCC (2005) convention charged relevant professionals to ensure that Green House Grase (GHG) concentrations are stabilized in the atmosphere at a level where ecosystems can adopt naturally to climate change, food production is not threatened and economic development can proceed in a sustainable fashion.

Benefits/Costs Analysis (BCA)

The benefits/cost analysis relies on the economic cost and benefits of any proposal. According to Rogers and Duffy (2013), private developers view and examine the benefits/cost analysis report from the narrow profit based point while the public examine the effect of the project on the society as a whole.

They further defined public project benefits, costs and dis-benefits as:

I. Costs- the construction, operating and maintenance cost of the project to the community.
ii. Benefits- the economic return or advantages accruing to members of the community arising from the project.
iii. Dis-benefits- the economic disadvantage incident on members of the community as a result of the project often linked Environmental Impact Analysis (EIA).

All are measured in monetary units.

As a matter of requirement all datain relation to benefits, cost and dis-benefits are reduced to the same values. As a submission, Rogers and Duffy (2012) stated that the limit can be the equivalent of future, present and annual worth of each constituent. Thereafter calculation is effective thus;
Benefits/cost ratio = benefits – disbenefits ÷ cost

If the ratio is equal or greater than one, then project is economically viable and when less than one it is uneconomical and not viable.

Environmental Engineering Projects
Environmental engineering public projects such as highway/flood drains, water dams, waste water treatment plants et cetera are mostly social, non-income yielding projects with high degree of externalities and public funded. This is explained as these products release basic goods and services, non-rival in consumption and not subject to exclusion. Hence the choices of investment are mainly on political, social, project relative benefits among others.

Basically, projects of this nature are complex, specialized and consume enormous fund and risks. Hence, alternative procurement methods such as a given model turnkey is usually employed. This is explained as CEM (2000) submits that's construction projects are better procured through turnkey if the size of a project tends to be complex and specialized requires single point responsibility, flexibility, contractors expertise input, certainty of cost, low level risk, control and improved communications.

This work adopted Build-Transfer-Services-Maintain (BTSM), turnkey model procurement for use. According to Morledge et al (2006) BTSM is used for projects where the host government takes possession of and pays for the facility once construction is completed, with the developer being responsible for maintenance and operation of the plant. As a characteristic; most turnkey projects attract enormous funds which is partly borrowed at cost by the developer.

Template for Costing
According to WCD 92002), template is a pattern for actualizing a given objective.
Costing, Onwusonye (2012), seeks to produce model for forecasting construction cost for clients and to estimating resource costs for contractors.

According to Ashworth (2010), the calculation of costs of proposed building or engineering project has traditionally consisted of applying appropriate units rates to measured quantities and descriptions of proposed works. However, as a social; non-profit investment, a result oriented analysis of obtained data on cost, becomes imperative so as to ascertain if the benefits from the proposed projects worth the costs in a quantitative form whereby, both cost and benefits are expressed in a common unit of measurement such as money. A suitable technique for this exercise is the benefit/cost analysis which attempts to select those projects for which there is a high surplus of social benefits over cost.

As an illustration, considering: construction of a dual carriage expressway with adequate drainage system as environmental engineering intervention project to mitigate the effects of heavy rainfall flood washed and damaged several kilometers of single carriage meandering road which has brought about among others, frequent accidents, high operating and maintenance cost of vehicle, hold up and/or go slow on travel time and other related. Take 20 years lifespan at 12 percent cost of capital.

Data and Results Interpretation

1. COST

A. Initial cost (IC)

i. Construction Cost (CC)

CC = Labour (L) + material (M) + plant (P) + overhead (O)

=L + M + P + O ..... (1)

ii. Consultants Fee (CF)

CF = 10 -12 percent of Construction Cost ..... (2)

iii. Cost of Capital (COC) = Floating Cost (FC) + Risk Factor (RF)+ time (T) + inflation (Inf) + dummy variable (DV) + Tax (Tx) + Risk Free Interest Rate (RR)

COC= Fc+ RF + T +Inf + DV + Tax +RR ..... (3)

iv. Dummy Variable (DV)

DV = Political Instability + Curency Risk (CR)

DV = PI + CR..... (4)

B. Running Costs (RC)

Maintenance/ Repair Cost (MRC)

MRC = NPV of MRC for 20 years discounted at 12%

RC – MRC ..... (5)

C. Total Cost (TC)

TC = NPV (IC =MRC)

= NPV Σ ((1) + (2) +(3) +(4) +(5)).

Benefits

When the proposed project is completed, the following benefits are expected to be derived by the society. Lower operating maintenance/cost for vehicles, savings to travelling time and reduced frequency of accidents. The data to be used for the computation of this exercise is primarily obtained from work study of cost analysis updated.

Thus,

A. Savings on vehicle operating cost i.e. Operating Cost on Old (OCO) – Operating Cost on Analyzed (updated) OCA

Savings = OCO – OCA.....(6)

B. Reduction Frequency of Accident

i.e. Accident rate on existing road (ARR)- Accident rate on proposed road (ARA) x Accident Cost x Flow Savings

= (ARR – ARA) x AC x F.....(7)

C. Saving to Travelling Time

i.e. Time for Vehicle to Travel existing road (TER) less time taken for vehicle to travel existing road (TPR) x Value of time saved (VTS)

Savings = (TER – TOR) x VTS.....(8)

D. total benefits (TB)

TB= NPV Σ (6) + (7) + (8)

1. Total Dis-benefits (TD) = NPV Σ costs associated with Environmental Impact Analysis(EIA)

2. Benefits/Cost Ratio = $\frac{TB - TD}{TC}$

Interpretation

If the obtained Net Present Value (NPV) exceeds zero, it shows economic viability. This then shows that the project discounted at time zero parades monetary benefits to the society. Furthermore, if the Benefit/Cost ratio (BCR) is greater than one (1), it shows that the sum of the projects discounted benefits exceeds its discounted costs and hence of high economic value. However, where BCR is less than one (1), the project is not viable and if equal to zero, there is neutrality and should be rejected.

Conclusion

The efficacy of evolved template for costing of Investment in Environmental Engineering Pubic Projects is a function of result oriented data generated and managed by relevant professionals.

Recommendations

This work without prejudice to the positive contributions of existing templates for costing of Investment in Environmental Engineering Public Projects that;

Government should establish relevant units in Ministries with Specialized personnel to undertake work study with a view to producing reliable data bank for use in costing likely

benefits to be derived in any proposed public environmental engineering project. This will reduce the difficulty presently encountered in obtaining reliable cost analyses needed for updating and applications.

Cost of capital is critical in determining cost of construction of social nature turnkey project. Determinants such as floatation costs, risk, tax, et cetera affect cost of capital. Government intervention in this regard is hereby recommended.

Government should articulate relevant legal framework especially to accommodate contingent factors such as exchange rates and honoring inherited contract obligations. These actions will go a long way to instill confidence in private participants.
Government should ensure and provide adequate security, peace, stability and rule of law so as to achieve timely completion of projects.

This is explained as most parts of Nigeria are noted for unrest, assassination, abduction, and unfriendly environment which by any dimension is unhealthy for the generation of realistic costs of proposed project.

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