Economic Analyses of Water Resources for Kabul New City with Recycle Wastewater Treatment System

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1. Background and Objectives

Kabul is Capital City of Afghanistan which has 4.08 million populations and they are living with many challenges such as shortage of housing, inadequate safe drinking Water and wastewater discharge without treatment, Water contamination, traffic congestion, air pollution and so on. In the 2025 population will reach 6.74 million, and then it will raise more problems. Therefore, National government with international donors' agencies proposed master plan to build Kabul New City (KNC) by 2025. Kabul New City will have capacity of 1.5 million residents with necessary urban facilities but the water resource offer which is proposed by JICA and DCDA Water Team is economically not feasibility for new City after it has been reviewed by this research. The research will figure out economically appropriate water resource for Kabul new city, will choose sustainable water resources from JICA Proposals and last it will find upgraded wastewater treatment system to contribute water resource. And new propose of reclaimed wastewater system to reduce freshwater quantity which is consuming for non-potable applications. This study is focusing economic analysis of all water resources for KNC.

2. Previous Research

Japan International Cooperation Agency (JICA) and Dehsabz-Barikab City Development Authority (DCDA) proposals water resources and wastewater treatment plant. JICA, DCDA and Ministry of Water and Energy (MoWE) already have been done feasibility study for water resources. so, three resources were proposed by JICA and DCDA, first is Panjshir fan aquifer that will be built in two phases with 52.8 Million m3 per year water capacity, and two other sources either Gulbahar dam which would provide 52.4 Million m3 water per year, or Salang dam with 52.4 Million M3 water per year to the targeted area, and consultant and DCDA proposed lagoon and Oxidation Combined wastewater treatment plant. On the other hand, this research has proposed Dual Membrane technology for wastewater treatment plant based on Singapore NEWater Case with one option from JICA proposed water resources. Firstly, cost and benefit analysis has been done for individual infrastructures then combined water resources and wastewater treatment plant (WWTP).

3. Economic Analyses

This study classified water resources and wastewater treatment systems into four alternatives; First Panjshir fan aquifer and Gulbahar dam with combined (lagoon and oxidation) wastewater system; second Panjshir fan aquifer and Salang dam with combined wastewater system, third Panjshir fan aquifer and dual membrane wastewater treatment plant with transmitted energy and the last is Panjshir aquifer and dual membrane wastewater treatment plant with solar energy. This study has dissected cost and benefit analyses from 2% - 20% discount rate to choose one from these four alternatives. The first two alternatives are JICA and DCDA's 1, 2 (JICA and DCDA Proposals 1, 2) which includes dam construction and last two are new proposals 1, 2 which is proposed in this study without dam construction difference of new proposal is only in energy system. Afghanistan economic discount rate is (10-12) % according to World Bank project and JICA also picked 12% rate for the study.

3-1. Discounted Cost and Benefit

Discounted cost and benefit calculation has been fulfilled with excel spreadsheet for each water resource and wastewater treatment packages. And finally cumulative net cash flow has been found by each year sum of discount costs and benefits. Cost includes construction, maintenance, personal or wages, chemicals, energy and renewable cost and benefit is from monetary and non-monetary value. Revenue consists of domestic water, irrigation, power generation and money value of some non-monetary components. Each cost and benefit is multiply with Present value factor (PVf).

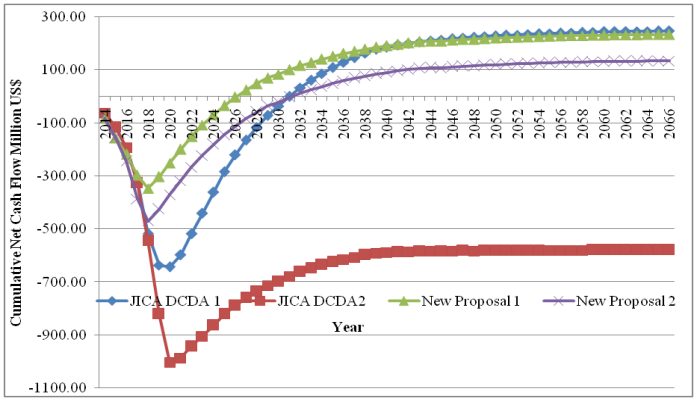

Figure 1: Cumulative net benefit of four alternatives by12% discount rate

PVf = 1/(1+r)^(n-1) , r = discount rate

n = number of period,

Discounted Cost= PVf x Cost

Discounted Benefit = PVf x Benefit

Figure.1is describing graphs' trends; new proposal 1, 2 and JICA and DCDA's Proposal 1 are crossing base line in 2025 and 2031 years. Profit is starting when graph change from negative to positive and JICA , DCDA proposal profit is more than new proposals , but JICA and DCDA proposal 2 graph's trend is below the base line it predict this proposal is not profitable in coming 50 years project life time.

3-2. Key Economic Parameters:

For better judgment to find appropriate option, only one approach cumulative discounted cost and benefit analysis is not enough, there is other key economic parameters which need to be accomplished to select the economical feasible water resource for drinking water supply system with sustainable development and wastewater management for Kabul New City project. Key economic parameters are important for decision making. So, four alternatives have been estimated in the spreadsheet in table 1.

The table clarify key economic parameters, economic internal rate of return (EIRR) for New Proposals is greater than 12%

Table 1: Economic net present value, internal rate of return and benefit and cost ratio

and economic net present value (ENPV) is positive, it is

Economic key Parameters	JICA DCDA 1	JICA DCDA 2	New Proposal 1	New Proposal 2
ENPV (Mil US$)	246.95	-578.85	233.60	133.80
EIRR%	15.30	-10.00	17.81	14.71
B/C	2.36	1.20	2.37	2.33
Economic discount rate	12%	12%	12%	12%

economically feasible in investment returning, in contrast, JICA,DCDA's proposal 1 is also feasible because of EIRR>12% and ENPV>0 but proposal 2 economic parameters EIRR< 12% and ENPV<0,it is not feasible option for the project development . Benefit and cost ratio (B/C) of new proposals 1,2 are also greater than JICA , DCDA proposal 1.

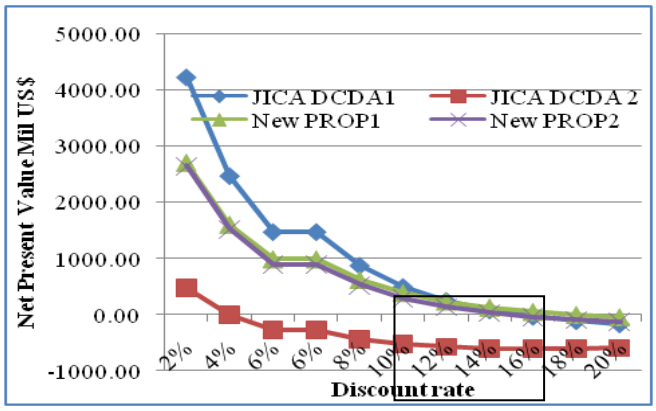

Figure 2a: Sensitivity analysis of discount rate for four alternatives

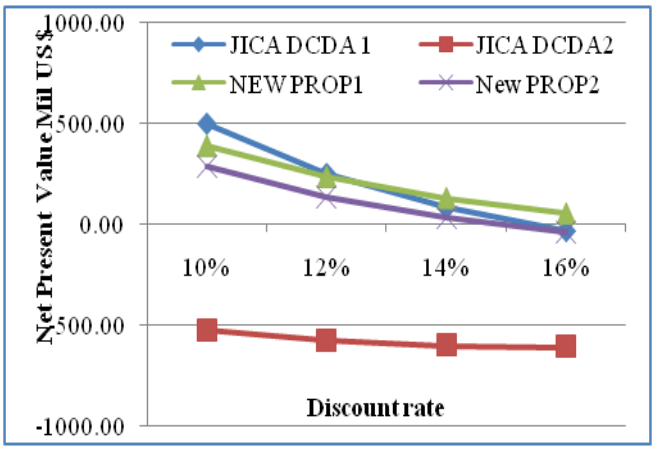

Figure 3b: Sensitivity analysis for four alternatives graphs intersections.

Figure 2a simplify sensitivity analysis for net present value according to discount rate from (2 – 20) %. By 10% rate JICA and DCDA proposal 1 has more profit than other three alternatives 2b but when discount rate change to 12.3% new proposal 1 has more profit than JICA proposal 1so even after 16% rate new proposal three has more benefit than JICA proposal 1.

4. Conclusion and Recommendation:

Result of economic analysis of this study is to find out the most economically feasible option. After performing benefit and cost analyses it becomes clear those new proposals 1 which is Panjshir fan aquifer and recycle water system with transmitted energy is feasible alternative among those four alternatives. According to accomplished analyses IRR, B/C new proposal 1 is suitable but cumulative benefit and sensitivity analysis is JICA proposal is more profitable. It predicts JICA and DCDA Proposal 1 is feasible in case if there was not risk of quaternary fault area and require more resource to do research to find out risk level . So, final decision is new proposal 1. It will supply potable water for drinking purpose in the lowest price than JICA and DCDA's proposals.

There is possibility to increase intake water capacity from 52.8 Million M3 to 70 Million m3 in Panjshir fan aquifer for 1.5 million residents' demand by 2025. Recycle water would be reused in industrials parks in the existing and new Kabul city. The remaining amount of recycle water could be supplied for recreational purpose.

References:

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