MEDIUM - SCALE PROJECTS SELECTION USING MULTI-OBJECTIVE DECISION MATRIX IN NORTH EASTERN NIGERIA

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ABSTRACT

Multi-Objective Decision Matrix was applied to rural water supply and sanitation (RWSS), small scale irrigation(SSI) and flood/erosion/geotechnical (FEG) in Adamawa State and North- eastern Nigeria (Adamawa, Gombe, Taraba, and Bauchi States). Sixty (60) questionnaires were administered to experienced technically oriented personnel in the study area for evaluating objective weights attached to various projects. Forty-five responded and their values of objective weights attached to project cost, environmental effects, reliability, implementability and sustainable energy source were used to evaluate objective weights for the study area. The objective weights were applied to various project alternatives in the study area. In Adamawa state, rural water supply and sanitation (RWSS) gave the highest objective index of 552552. In the North east, small scale irrigation projects gave the highest objective index of 6401271. Rural water supply and sanitation and small scale irrigation are the most preferred projects in the study area based on the cost data available.

Introduction

In profitability estimates, safety and convenience play a significant role in taking engineering decisions especially during design, construction and operation stages. For projects in developing countries, other objectives may be necessary especially when such projects are funded by Non-Governmental Organisations (NGO) as observed by Little and Mirrless [1]. Among competing demands, alternative analysis indicators may be required to determine the viability and acceptability of such projects by the beneficiaries. There are project evaluations methods like cost-benefit ratio [2, 3] but require a lot of data apart from being rigorous. Cost benefit ratio may require project cost (cost of land and compensations, cost of benefit and investment, etc). Multi-Objective Decision Matrix approach is simple and do not require much much data [4]. Some of the projects that could empower the rural dwellers economically may include; rural water supply and sanitation (RWSSS), small scale irrigation (SSI) using hydraulic structures (Micro-earth dams), flood/erosion and geotechnical (FEG), rural roads (RR), rural housing schemes (RHS), etc.

The variables to be considered for analysis may include those suggested by Goodman [4] such as the effect of the Project cost on the beneficiaries, Environmental implication of the project, the Project reliability, and the implement-ability of the

project and Sustainable energy requirement.

This paper presented an approach using Multi-Objective Decision Matrix for project selection to satisfy some conditions as stated above.

Theory and Analysis

The Multi-Objective Decision Matrix approach suggested by Goodman [4] utilizes the overall aim of a project to evaluate an Index (I) by combining the monetary value of the project (V_i) and the objective weights (W_i) attached to the project by the benefiting communities. The vertical sum of the product value (V_i) and the weight apportioned to an objective cost, environment, reliability, implementability and energy source of the project by the community (W_i) gives the overall index (I_i) for each project alternatives.

$$I = \sum_{i=1}^{n} W_i V_{ij} \quad (1)$$

Where W_i = Weight of importance placed on an objective i, V_{ij} = Relative value of an alternative, i in fulfilling an objective, j and m, n = Number of objectives and alternatives

Equation (1) was modified to suit the study as:

$$I = \sum_{i=1}^{n} W_{ij} V_j \quad (2)$$

Where i = 1 ..... 5, represent objectives and j alternative

The weights (W_i) rated in percentage are shown in Table 1 for the various projects.

Table 1: Weights attached to each project objective by the community

Objective	RWSS	SSI	FEC	....	RR
Cost	W_{11}	W_{12}	W_{13}	....	W_{1n}
Environment	W_{21}	W_{22}	W_{23}	....	W_{2n}
Reliability	W_{31}	W_{32}	W_{33}	....	W_{3n}
Implementability	W_{41}	W_{42}	W_{43}	....	W_{4n}
Energy source	W_{51}	W_{52}	W_{53}	....	W_{5n}

Source: Philip [5]

Table 2 shows products of the weights (W_{ij}) and the monetary value of each project alternative (V_j)

Table 2: Multi-Objective Decision Matrix for Final Index (I)

	Project Alternatives						
Objective	RWSS	SSI	FCG		RR	....	HP
Project cost	$W_{11} V_1$	$W_{12} V_2$	$W_{13} V_3$	....	$W_{14} V_4$	....	$W_{1n} V_n$
Environment	$W_{21} V_1$	$W_{22} V_2$	$W_{23} V_3$	....	$W_{24} V_4$	....	$W_{2n} V_n$
Reliability	$W_{31} V_1$	$W_{32} V_2$	$W_{33} V_3$	....	$W_{34} V_4$	....	$W_{3n} V_n$
Implementability	$W_{41} V_1$	$W_{42} V_2$	$W_{43} V_3$	....	$W_{44} V_4$	....	$W_{4n} V_n$
Energy source	$W_5 V_1$	$W_{52} V_2$	$W_{53} V_3$	....	$W_{54} V_4$	....	$W_{5n} V_n$
TOTAL	I_1	I_2	I_3	....	I_4	....	I_n

Source: Philip [5]

Methods and Materials

Questionnaires were administered in the

study area to evaluate objective weights attached to a particular project alternative by the host community in fulfilling the objectives of costs, environmental effects, reliability, implementability and sustainable energy source. The questionnaire ranked the weights according to preference on how the above objectives compared to each other from 1% to 30% as suggested by Philips [5]. The respondents were expected to select the objective weights from the bounds of the rankings based on the short and long term effects of the project in fulfilling each objective. The results of the questionnaire were analysed using statistical average mean of all values turned in by each respondent on each objective. The various project's average cost [6] in Table 3a were used as data for Adamawa State.

Table 3a Fadama II Projects average costs and locations in Adamawa State

Project Description	Average Costs	Location in Adamawa
1. Rural water supply & sanitation	x 552000	BA, DM, ML and LL
2. Flood/Erosion/Geotechnical	x 550000	Lower Luggere
3. Small scale irrigation	x 500000	Lake-Geriyo

Source: Fadama II World Bank Assisted Project [6]

In the North East Sub-Region projects average cost data (Table 3b) from Adamawa (Central, South), Gombe (Central, North and South), Bauchi (South,), and Taraba (Central North and South were used.

Table 3 b: Projects average costs and locations in North Eastern Nigeria.

Project Description	Average Costs	Location
1. Rural Water Supply & Sanitation	x 2336321.40	AD, BA, GB and TB
2. Small Scale Irrigation	x 6401282.47	AD, BA, GB and TB
3. Food/Erosion/Geotechnical	x 975553.05	AD, BA, GB and TB

Source: Federal Ministry of Water Resources [7]

Results and Discussion

The objective weights attached to rural water supply and sanitation (RWSS), small scale irrigation (SSI) and flood/erosion and geotechnical (FEG) for forty-five (45) respondents in the study area are shown in Table 4. The standard deviation (σ), variance (σ^2) and standard error of mean $(\sigma/(n)^5$ are also shown in same table.

Table 4: Objective weights attached to project alternatives in the study area

Variables	Weight (W_i)	S/D (σ)	Variance (σ^2)	SEM ($\sigma/(n)^{0.5}$)
1. Rural water supply and sanitation				
Cost afforded by community	0.1630	0.0570	0.0032	0.0095
Project environment effects	0.2350	0.1380	0.0014	0.0063
Project reliability	0.2300	0.0680	0.0046	0.0115
Project implementability	0.2030	0.0312	0.0010	0.0051
Sustainbale energy source	0.1700	0.0415	0.0017	0.0070
2. Small scale irrigation				
Cost afforded by community	0.2082	0.0763	0.0058	0.0130
Project environmental effects	0.1962	0.0493	0.0024	0.0080
Project reliability	0.2162	0.0496	0.0025	0.0090
Project implementability	0.2262	0.0414	0.0017	0.0070
Sustainable energy source	0.1532	0.0394	0.0016	0.0007
3. Food/Erosion and Geotechnical Control				
Cost afforded by community	0.1472	0.0686	0.0047	0.0120
Project environmental effects	0.2462	0.0395	0.0016	0.0080
Project reliability	0.2552	0.0524	0.0027	0.0100
Project implementability	0.1972	0.0384	0.0015	0.0080
Sustainable energy source	0.1542	0.0419	0.0018	0.0070

n = no. of variables, SD = standard deviation, SEM = standard error of mean,

The objective weights in Table 4 were applied to project monetary values in Tables 3a and 3b for Adamawa State and North Eastern, Nigeria respectively. The overall objectives indices (I) for Adamawa State and North Eastern Nigeria are shown in Tabls 5a and 5b respectively.

Table 5a: Multi-Objective Decision Matrix for Final Index (I) in Adamawa State

Variables		Projects Alternatives	
	RWSS	SSI	FEG
1. Cost afforded by community	89976	104100	80960
2. Project environmental effects	129720	98100	135410
3. Project reliability	126960	108100	140360
4. Project implementability	112056	113100	08460
5. Sustainable energy source	93840	76600	84810
TOTAL	552552	43160	550000

RWSS - Rural water supply and sanitation, SSI - Small scale irrigation, and FEG-Flood/Erosion and Geotechnical Control Project

Table 5b: Multi-Objective Decision Matrix for Final Index (I) in North Eastern Nigeria

Variables	Projects Alternatives		
	RWSS	SSI	FEG
1. Cost afforded by community	380821	1332740	143602
2. Project environmental effects	549036	1255932	240181
3. Project reliability	537354	1383957	248961
4. Project implementability	474273	1447970	192379
5. Sustainable energy source	397175	980677	150430
TOTAL(I)	2338659	6401271	975553

RWSS - Rural water supply and sanitation, SSI - Small scale irrigation, FEG-Flood/Erosion and Geotechnical Control

Table 5a suggests that in Adamawa State, rural water supply and sanitation projects are the most preferred projects by the majority of the population. This is because the multi-objective model gave the highest objective index (I) of 552552. This was followed by flood/erosion and geotechnical projects with an objective index of 550000. Considering the whole North East Sub-Region projects, the multi-objective model showed people's interest to shift from rural water supply and sanitation to small scale irrigation projects which gave the highest objective index (I) of 64012271. This was followed by rural water supply and sanitation with an objective index of 2338659.

Conclusion

The study showed that in Adamawa State, water supply and sanitation projects are most preferred followed by flood/erosion and geotechnical projects with objective indices of 552552 and 550000 respectively. In the North East sub-region, the model showed that small scale irrigation projects with an overall objective index of 6401271 are most preferable. This was followed by water supply and sanitation projects with objective index of 2338659.

Recommendation

From the results of this study, it is recommended that the Government of Adamawa State to start implementing rural water supply and sanitation projects. However, for North Eastern Nigeria (Adamawa Taraba, Gombe and Bauchi States) it is preferable to embark on small scale irrigation projects followed by rural water supply and sanitation projects for gainful impact on the lives of their citizens.

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