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Bayesian Optimization Modeling of Bori-Ogoni Multipurpose Multi-Objective Reclaimed Diesel Spill Farmland Project

Akpan Paul P. [1], Mahmud Hussaini [2], Abednego George G.T. [3], Akien Alli I. J. [4], Dickson Rachael[5], and Gbimadee NuBari B. P.[6]

(1,3, and 6) Department of Civil Engineering, Kenule Beeson Saro-Wiwa Polytechnic, Bori, Nigeria.
(2) Department of Civil Engineering, Federal Polytechnic Bali, Nigeria.
(4) Department of Industrial Safety and Environmental Engineering Technology, Kenule Beeson Saro-Wiwa Polytechnic, Bori, Nigeria.
(5) Department of Electrical/Electronic Engineering, Kenule Beeson Saro-Wiwa Polytechnic, Bori, Nigeria.

ABSTRACT
In other to optimize the expected value for perfect information (EVPI) and expected opportunity loss (EOL) for Bori-Ogoni farmland project, a posterior Bayesian analysis is required. This analysis gives a revised EOL which is expected to be lesser than the determined EOL based on prior analysis. The difference between the two should at least be equal to the cost of obtaining the additional information (EVPI). This research is aimed at developing Bayesian optimization model of Bori-Ogoni reclaimed diesel spill farmland project with specific objective of determining the prior and posterior EOL and EVPI of the farmland project. Bayesian decision theory was used for the optimization. Result showed the prior and posterior EOL and EVPI obtained from the farmland project are 2.09 , 0.33, and 1.67 billion naira respectively. The reduction of the EOL value from 2.09 to 0.33 billion naira means the farmland project is expected to optimally yield maximum profit. The obtained EVPI of 1.67 is the maximum amount the investor or manager can use for research, creative innovations, technological acquisition and development to improve the structure of the system, performance of the workforce, and returns of investment of the farmland project. Federal ministry of environment, agriculture and national oil spill detection regulation agency (NOSDRA) in alliance with the federal house of representative and national house of assembly of Nigeria should sponsor bill for the adoption and implementation of the developed Bayesian optimization model of Bori-Ogoni reclaimed diesel spilled farmland project since it will help increase the nations GDP and fulfill the requirements of ISO 14001:2015 standard.

KEYWORD: Bayesian optimization modeling, Bori-Ogoni Multipurpose project, Multi-objective farmland project, Diesel spill, Expected opportunity loss, Expected value for perfect information.

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I. INTRODUCTION

Bori- Ogoni an industrial hab of Nigeria (Akpotor , 2019), is located at Khana local government area with a residential and agricultural land mass of 7,507.3 and 10,159.6 hectares respectively (Barizaa and Weje, 2019). It is geographically located at latitude and longitude 400'34''N and 7021'54''E. Industrial activities in Bori-Ogoni have impacted so much on her environmental aspects (Kola-Olusanya and Mekuleyi, 2018; Collins, 2018 and Aniefiok, Thomas, Clement, Ekpedeme and Iniememc 2018). The environmental sensitive nature of Bori- Ogoni as declared by the UNEP report, 2016 made rural dwellers vulnerable to chronic mutagenic and carcinogenic effects as a result of oil spill pollution (Amie-Ogan, Petaba, Leyira, Nwikina, Philip-Kpae, and Akpan,2022; Otu and Oloidi, 2018; Oluwaniyi, 2018; Obire, and Nwaubeta, 2018, and Zock 2017). The UNEP report, 2016 recommended immediate reclamation of impacted environmental aspects. Implementation of UNEP reports has practically failed due to improper allocation of resources. A reclaimed farmland multipurpose/multi-objective project was proposed to help generate profit maximization model for sustainability of oil spill reclamation projects in Bor-Ogoni, Rivers State of Nigeria (Gbinu, Mahmud, Akpan, Badom, Nwiyor. and Letam, 2022).

1.1 Bayesian posterior probability and analysis

Bayesian decision theory can be used to take optimal market decision that can optimally yield much more profits to further develop and sustain the farmland project (Rigoli , Mathys , Friston and Dolan, 2019; Stengård and van den Berg, 2019, and Ramalakshmi and Sharathchandra, 2015). According to Gupta,2014) in preceding analysis of decision making under risk, the probability used in the expected value criteria are usually obtained from past historical data. These probabilities are called prior probabilities and the analysis that uses them to find expected payoffs is known as prior analysis (Martel-Escobar, Vázquez-Polo and Hernández-Bastida (2018); David, Fabrizio, and Refik (2019), and Mihali, Van Opheusden , and Ma, 2017). If the prior analysis result has high expected opportunity (EOL) or EVPI, it may be desirable to obtain additional information through sampling or experimentation or test research. In the view of Angelini, (2019) prior probabilities may be revised in the light of this additional information by using Bayes theorem to yield posterior probabilities or Bayes probabilities.

Acceding to the thoughts of Taha, (2013) the posterior analysis or Bayesian analysis is a revised analysis of system problem using probabilities. This analysis gives a posterior value of EMV which is expected to be better than the EMV based on prior analysis. The expected profit with perfect information ($EPPI_2$) is equivalent to the expected monetary value (EMV). Sometimes the EPVI can be too high to be reallocated for research, In other to reduce the expected value of perfect information, a posterior Bayesian analysis is required. The difference between the posterior and prior EVM is equal to the cost of obtaining the additional information known expected value for perfect information (EVPI). If EVPI is equal to zero, then it may not be worth to carry out posterior analysis (Valdés , Cheng ,Comendador and Nieto, 2018).

The views of scholars reviewed in this article are very useful in optimization. However, they did not apply their thoughts in optimizing farmland projects. Hence the research gap this article intend to bridge. This research is aimed at developing Bayesian optimization model of Bori-Ogoni multipurpose multi-objective farmland project. The specific objectives are to determine the prior and posterior EOL and EPVI of the farmland project.

II. MATERIALS AND METHODS

The materials used in this research are based on the thoughts Amie-Ogan et al., (2022); Petaba, Badom, Pepple, Amie-Ogan, Nwikina, and Akpan (2022); Gbinu et al., (2022); Mahmud, Gbinu, Amie-Ogan, Ndam, Letam., and Akpan.(2022); Gupta and Hira (2014), and Taha,(2013).

Game theory was used to develop a payoff matrix of accrued benefit from Bori-Ogoni multipurpose multi-objective reclaimed diesel spill farmland project base on prior information with probability as shown in table. 2.1 (Amie-Ogan et al., 2022 and Mahmud et al., 2022) The developed payoff matrix was used to develop a EOL tables showing the conditions for probability and state of nature

Table 2.1. Payoff of accrued benefit from the multipurpose multi objective project based on prior information with prior probability

LAND	Prior Probability	Profit (Billion Naira)				
		Maize	Cassava	Yam	Oil Palm	Fishery
Hectare A	0.10	0.44	0.02	0.05	0.05	0.11
Hectare B	0.32	0.04	1.32	0.16	0.16	0.07
Hectare C	0.10	0.01	0.02	0.44	0.05	0.05
Hectare D	0.23	0.03	0.05	0.11	0.88	0.11
Hectare E	0.25	0.01	0.02	0.05	0.05	0.44

Expected Opportunity Loss (EOL) of the farmland project was analyzed as shown in table 2.2

Table.2.2. Expected opportunity loss from the multipurpose multi objective project based on prior information with prior probability

LAND	Prior Probability	Profit (Billion Naira)				
		Maize	Cassava	Yam	Oil Palm	Fishery
Hectare A	0.10	0.00	0.42	0.39	0.39	0.33
Hectare B	0.32	1.28	0.00	1.16	1.16	1.25
Hectare C	0.10	0.43	0.42	0.00	0.39	0.39
Hectare D	0.23	0.85	0.83	0.77	0.00	0.77
Hectare E	0.25	0.43	0.42	0.39	0.39	0.00
EOL		2.99	**2.09**	2.71	2.33	2.74

The EOL is the strategy with the least prior probability of 2.09 billion naira. Now performing a posterior analysis of the research strategy from table 2.2, conditional and joint probability analysis was done as shown in table 2.3.

Table 2.3. Conditional and joint probability analysis

LAND	Prior Probability	Conditional Probabilities					Joint Probability				
		Maize	Cassava	Yam	Oil Palm	Fishery	Maize	Cassava	Yam	Oil Palm	Fishery
Hectare A	0.10	0.01	0.02	0.05	0.05	0.44	0.001	0.002	0.005	0.005	0.044
Hectare B	0.32	0.04	0.07	0.16	0.16	1.32	0.013	0.022	0.051	0.051	0.422
Hectare C	0.10	0.01	0.02	0.05	0.05	0.44	0.001	0.002	0.005	0.005	0.044
Hectare D	0.23	0.03	0.05	0.11	0.11	0.88	0.007	0.012	0.025	0.025	0.202
Hectare E	0.25	0.01	0.02	0.05	0.05	0.44	0.003	0.005	0.013	0.013	0.110
Marginal Probabilities							0.024	0.043	0.099	0.099	0.823

Analyzing the conditional and joint probability payoff by calculating the ratio of the Joint probability to the marginal probability, a posterior probability payoff was obtained as shown in table 2.4 .

Table 2.4. Posterior probability analysis

LAND	Prior Probability	Posterior Probabilities				
		Maize	Cassava	Yam	Oil Palm	Fishery
Hectare A	0.10	0.041	0.047	0.051	0.051	0.053
Hectare B	0.32	0.529	0.522	0.517	0.517	0.513
Hectare C	0.10	0.041	0.047	0.051	0.051	0.053
Hectare D	0.23	0.285	0.268	0.256	0.256	0.246
Hectare E	0.25	0.103	0.117	0.126	0.126	0.134

Using the posterior probability analysis payoff, the EOL for each of the farm type was calculated to obtain the minimum EOL as shown in table 2.5, 2.6, 2.7, 2.8 and 2.9.

Table 2.5. Expected opportunity loss based on posterior probability for maize

LAND	Posterior Probability	Profit (Billion Naira)				
		Maize	Cassava	Yam	Oil Palm	Fishery
Hectare A	0.041	0.000	0.420	0.390	0.390	0.330
Hectare B	0.529	0.030	0.000	1.160	1.160	1.250
Hectare C	0.041	0.430	0.420	0.000	0.390	0.390

Hectare D	0.285	0.850	0.830	0.770	0.000	0.770
Hectare E	0.103	0.430	0.420	0.390	0.390	0.000
EOL		0.320	**0.315**	0.890	0.686	0.910

Table 2.6. Expected opportunity loss based on posterior probability for cassava

LAND	**Posterior**	**Profit (Billion Naira)**				
	Probability	Maize	Cassava	Yam	Oil Palm	Fishery
Hectare A	0.047	0.0000	0.4200	0.3900	0.3900	0.3300
Hectare B	0.522	0.0300	0.0000	1.1600	1.1600	1.2500
Hectare C	0.047	0.4300	0.4200	0.0000	0.3900	0.3900
Hectare D	0.268	0.8500	0.8300	0.7700	0.0000	0.7700
Hectare E	0.117	0.4300	0.4200	0.3900	0.3900	0.0000
EOL		0.314	**0.311**	0.876	0.688	0.893

Table 2.7. Expected opportunity loss based on posterior probability for yam

LAND	**Posterior Probability**	**Profit (Billion Naira)**				
		Maize	Cassava	Yam	Oil Palm	Fishery
Hectare A	0.051	0.0000	0.4200	0.3900	0.3900	0.3300
Hectare B	0.517	0.0300	0.0000	1.1600	1.1600	1.2500
Hectare C	0.051	0.4300	0.4200	0.0000	0.3900	0.3900
Hectare D	0.256	0.8500	0.8300	0.7700	0.0000	0.7700
Hectare E	0.126	0.4300	0.4200	0.3900	0.3900	0.0000
EOL		0.309	**0.308**	0.866	0.689	0.880

Table 2.8. Expected opportunity loss based on posterior probability for oil palm

LAND	**Posterior Probability**	**Profit (Billion Naira)**				
		Maize	Cassava	Yam	Oil Palm	Fishery
Hectare A	0.051	0.0000	0.4200	0.3900	0.3900	0.3300
Hectare B	0.517	0.0300	0.0000	1.1600	1.1600	1.2500
Hectare C	0.051	0.4300	0.4200	0.0000	0.3900	0.3900
Hectare D	0.256	0.8500	0.8300	0.7700	0.0000	0.7700
Hectare E	0.126	0.4300	0.4200	0.3900	0.3900	0.0000
EOL		0.309	**0.308**	0.866	0.689	0.880

Table 2.9. Expected opportunity loss based on posterior probability for fishery

LAND	**Posterior Probability**	**Profit (Billion Naira)**				
		Maize	Cassava	Yam	Oil Palm	Fishery
Hectare A	0.053	0.0000	0.4200	0.3900	0.3900	0.3300
Hectare B	0.513	0.0300	0.0000	1.1600	1.1600	1.2500
Hectare C	0.053	0.4300	0.4200	0.0000	0.3900	0.3900
Hectare D	0.246	0.8500	0.8300	0.7700	0.0000	0.7700
Hectare E	0.134	0.4300	0.4200	0.3900	0.3900	0.0000
EOL		**0.305**	**0.305**	0.858	0.689	0.870

The minimum EOL based on the posterior probability for each of the farm type were obtained and presented in table 3.1. The sum of the Expected EOL was equally obtained by summing all the minimum EOL obtained from table 2.5, 2.6, 2.7, 2.8 and 2.9.above.

III. RESULTS AND DISCUSSION

Table 3.1. Results of posterior probability of expected opportunity loss for all farm types

MP	OEOL	AEOL
0.024	0.315	0.008
0.043	0.311	0.013
0.099	0.308	0.030
0.099	0.308	0.030
0.823	0.305	0.251
Posterior EOL		**0.333**

Discussion of the result in table 3.1

i. The acronyms OEOL, AEOL, and MP represents optimal expected opportunity loss, anticipated expected opportunity loss and marginal probability respectively.
ii. The minimum EOL based on the posterior probability for each of the farm type were obtained and presented in table 3.1. The sum of the Expected EOL was equally obtained by summing all the minimum EOL obtained from table 2.5, 2.6, 2.7, 2.8 and 2.9 above
iii. The posterior EOL is 0.33 Billion.

The net gain or profit obtained for embarking on further research to optimally increase the profit of the multipurpose multi objective projects was calculated and presented in table 3.2

Table 3.2. Results of posterior probability expected opportunity loss

Prior EOL	2.09
Posterior EOL	0.33
Net Gain	**1.76**

Discussion of the result in table 3.2

i. The profit obtained embarking on further research improved optimum strategies of the system (multipurpose multi-objective farmland project) is 1.76 billion.
ii. Having obtained the best payoff based on informed decision. It is necessary to look in dept to the strategies for more information that will help to optimally increase return of investment of the farmland project. The informed based strategy or payoff is considered to be a state of nature where the framework or structure of the projects will optimally operated to yield maximum profit.

IV. CONCLUSION

The prior and posterior EOL of the Bori-Ogoni multipurpose multi-objective reclaimed diesel spill farmland project are 2.09 and 0.33 billion nairas respectively. Increase in EOL of project payoff will result in a simultaneous decrease in the returns of investment of the projects (Profit). Therefore, the posterior EOL of 0.22 billion naira means the organization will optimally earn maximum profit based on the Bayesian optimization model developed

Result also showed that the net profit (EPVI) obtained embarking on further research to optimally improve the systems strategies (multipurpose multi-objective farmland project) is 1.76 billion. Having obtained the best payoff based on informed decision. It is necessary to look in dept to the strategies for more information that will help to optimally increase return of investment of the farmland project. The informed based strategy or payoff is considered to be a state of nature where the framework or structure of the farmland projects will be optimally operated to yield maximum profit.

V. RECOMMENDATION

Federal ministry of environment, agriculture and national oil spill detection regulation agency (NOSDRA) in alliance with the federal house of representative and assembly should sponsor bill for the adoption and implementation of the developed Bayesian optimization model of Bori-Ogoni reclaimed diesel spilled farmland project since it will help fulfill the requirements of ISO 14001:2015 standards.

VI. CONTRIBUTION TO KNOWLEDGE

This research work applies Bayesian optimization model in generating more returns of investment to recover the cost of carrying out diesel spill farmland reclamation works at Bori-Ogoni and it agrees with Environmental management system requirement as per ISO 14001:2015.

The research educates investors to take informed decision in allocating resources to projects for optimal profit maximization, development and sustainability.

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