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Bayesian Expected Value for Perfect Information of Bori-Ogoni Multipurpose Multi-Objective Farmland Project

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ABSTRACT
Appropriate decision making in complex investment framework is hugely influenced by perfect information of the project structure. Uninformed investment decision making can grossly collapse a lucrative project or business structure immediately or in the future. This research is aimed at determining Bayesian expected value for perfect information (EVPI) of Bori-Ogoni multipurpose multi-objective farmland project. The specific objectives are to develop a payoff matrix of a multipurpose multi-objective farmland project, determine the Bayesian expected profit without perfect information ($EPPI_1$) of the project, Bayesian expected profit with perfect information ($EPPI_2$) and the EVPI of the farmland project. Game theory was used to develop the payoff matrix of the farmland project while Bayesian decision theory was used to determine the $EPPI_1$, $EPPI_2$ and EVPI of the project. Result showed that the $EPPI_1$, $EPPI_2$ and EVPI of the farmland project are 0.823, 4.400, and 3.577 billion naira respectively. Investors should allocate maximum EPVI of 3.577 billion naira for intensive research that would help improve performance of the workforce, acquire better technologies that will increase output of the system, and improve on entrepreneurship development of the project. The determined $EPPI_2$ of 4.4 billion naira can increase in the future if the EPVI is optimally allocated. The Bayesian expected value for perfect information provides adequate information that will enable Bori-Ogoni multipurpose multi-objective reclaimed diesel spill farm land project managers and investors take informed decision in investing resources for sustained productivity and development of the organization. It is recommended that federal ministry of Environment and Agriculture should subscribe to useful tools like EPVI in executing environmental and agricultural projects for sustainability and development of the Nation's GDP.

KEYWORD: Bayesian expected value, Perfect information, Multipurpose project, Multi-objective project, Reclaimed diesel-spill land, Farmland projects

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I. INTRODUCTION

Bori-Ogoni located in Niger Delta of Nigeria is the industrial hub of the Nigeria that generates the largest proportion of her GDP (Akpotor , 2019 and Oluwaniyi (2018). Oil spill in Bori-Ogoni has caused so much acute and chronic effects on aquatic lives, humans, plants, and animals (Amie-Ogan, Petaba, Leyira, Nwikina, Philip-Kpae, and Akpan, 2022, and Aniefiok, Thomas, Clement, Ekpedeme and Iniemem , 2018).The clean up implementation exercise of the UNEP report, 2016 in Bori- Ogoni impacted land is almost a failure due to inappropriate allocation of resources to the project. The impact of the spill is still posing more threat on environmental aspect (Amie-Ogan, Petaba, Leyira, Nwikina, Philip-Kpae, and Akpan,2022). There is need for proper properly plan the project as per clause 6 of environmental management system (ISO 14001:2015) to possible achieve goal 8 of sustainable millennium development goal. In view of this thought, reclaimed farmland multipurpose/multiobjective project was proposed to help generate profit maximization model for sustainability of oil spill reclamation projects in Bor-Ogoni, Rivers State Nigeria (Gbinu, Mahmud, Akpan, Badom, Nwiyor. and Letam, 2022). The works of Mahmud, Gbinu, Amie-Ogan, Ndam, Letam, and Akpan, (2022) discussed on cost minimization model that be used to reduce the investment cost of multipurpose / multi-objective reclaimed diesel spill farm land projects. The developed profit and cost optimization models yielded billions of naira per annum based on the works of Mahmud et al.,(2022) and Gbinu et al., (2022).

To sustain this project, Bayesian decision theory for certainty and uncertainty need to be factored into the multipurpose/ multi-objective farmland project. Several scholars have implemented Bayesian decision theory to solve complex system problems. Angelini, (2019) showed how Bayesian prior analysis, preposterous analysis, posterior analysis provides managers and investors the best framework or models to take informed decision. Yamazaki and Motomura, (2019) demonstrated how Bayesian models can be used to detect hidden cause of losses in complex multipurpose/ multi-objective farmland project to minimize unexpected futuristic losses. The thoughts of Martel-Escobar, Vázquez-Polo and Hernández-Bastida (2018); David, Fabrizio, and Refik (2019), and Mihali, Van Opheusden , and Ma (2017) showed how Bayesian inference is used to audit prior information using complex entropy priors. This makes it possible to audit errors in complex multipurpose/multi-objective farmland project structures proposed by Gbinu et al., (2022) and Amie-Ogan et al.,(2022). Bayesian decision theory can be used to take optimal market decision that can optimally yield much more profit to further develop and sustain the farmland project (Ramalakshmi and Sharathchandra,2015). The thought Valdés , Cheng ,Comendador and Nieto (2018) combined Bayesian Network and information theory to forecast mid air accident reoccurrence in aviation industry. Schneps, Overill, and Lagnado ,(2018) revealed that Bayesian decision models can be used to rank the impact of multipurpose/multi-objective farmland project structure to suggest possible future modifications of the system for improvement and sustainability. Xiang and Landschoot, (2019) developed a modal-based Bayesian interference to accomplish estimation of the directions of arrivals (DoAs) of sound sources. In the view of Stengård and van den Berg (2019); Rigoli , Mathys , Friston and Dolan (2019); Wei (2019); Lee,Wang, Vlahov , Brar and Theodorou (2018),and Shen and Ma (2016), Bayesian decision theory is useful in scaling workers performances based on perceptual decision-making task and to suggest how incentive value of an option is affected by other options available during choice and by options presented in the past. This will help increase returns of investment of the project and the model can be replicated in other multipurpose multi-objective projects (Hardwicke, Tessler, Peloquin, and Frank ,2018; Cook and Puri, 2017 and Davis ,Kisiel and Duckstein, 2018)

Scholars have not explored the Bayesian expected value for perfect information in multipurpose/multi-objective projects. The identified research gap will help investors and manager to trace present and future constrains that can cause losses or eventual collapse of the project. This research is aimed at determining the Bayesian expected value for perfect information on the farmland project. In the views of Taha (2013), decision making under uncertainty, as under risk, involves alternative actions whose payoffs depend on the (random) states of nature. Many managerial decisions, however, are made with some uncertainty. Managers, authorise substantial financial investments with less than complete information about product demand. As the decisions taken by a manager govern the fortunes of business , right decisions will have a salutary effect while the wrong ones may prove to be disastrous, it is extremely important to choose the appropriate decision. Decision theory provides a rational approach to the managers in dealing with problems confronted with partial, imperfect or uncertain future conditions (Taha, 2013).

Gupta(2014) considered a scenario where the occurrence of state of nature was associated with probability. Complete and accurate information about the future demand, referred to as perfect information, would remove all uncertainty from the project’s lifespan. The EVPI enables investor’s to know in advance how the demand for goods or services would be daily, weekly, monthly and yearly. In such circumstance investors would make appropriate preparations to satisfy the needs of his customers daily, weekly, monthly and yearly to obtain the conditional profit values in condition of perfect information. The maximum amount of money needed for investment to increase investors expected daily profit can be determined. The EPVI is also equal to the minimum EOL. EPVI is an important concept in decision analysis, for a given problem , EVPI represent the maximum amount a person should pay to get additional information on which may be based on the decision alternative. It is also the difference between the expected profit with perfect information and the expected profit without perfect information (Gupta,2014).

II. MATERIALS AND METHODS

The materials used in this research include secondary data obtained from the ministry of agriculture and environment. Game theory was used to develop a payoff matrix. The developed payoff matrix was used to develop the EPVI tables showing the conditions for probability and state of nature

2.1 Model assumption for development of payoff matrix

i. The game has a mixed strategies. (Player A and Player B)

ii. Player A is a minimizer with an objective function of minimizing the cost of cultivating and rearing maize, yam, cassava, palm fruit and fish.

iii. Player B is a Miximizer with an objective function of maximizing profit from the five hectres of reclaimed diesel spilled land in Bori.

iv. The payoff matrix is obtained from the accrued benefit of cultivating maize, cassava, yam oil palm and rearing fishes on five hectares of reclaimed diesel spilled land in Bori.

v. Diesel spill occurred on 10%, 32%, 10%, 23% and 25% of land in Hectares A,B,C,D,E and F of Bori respectively.

Table 2.1. Payoff matrix of accrued benefit from farm produce on five hectares of reclaimed diesel spill farmland in Bori

Player A

Player B		Maize	Cassava	Yam	Oil Palm	Fishery
	Hectare A	149550	229550	526550	529100	4401000
	Hectare B	149550	229550	526550	529100	4401000
	Hectare C	149550	229550	526550	529100	4401000
	Hectare D	149550	229550	526550	529100	4401000
	Hectare E	149550	229550	526550	529100	4401000

Table 2.2. Payoff matrix of accrued benefit from farm produce on five hectares of reclaimed diesel spill farmland in Bori per hectare in billion naira

Player A

Player B		Maize	Cassava	Yam	Oil Palm	Fishery
	Hectare A	0.1	0.2	0.5	0.5	4.4
	Hectare B	0.1	0.2	0.5	0.5	4.4
	Hectare C	0.1	0.2	0.5	0.5	4.4
	Hectare D	0.1	0.2	0.5	0.5	4.4
	Hectare E	0.1	0.2	0.5	0.5	4.4

Since diesel spill occurred on 10%, 32%, 10%, 23% and 25% of land in Hectre A,B,C,D,E and F of Bori respectively. The new payoff matrix becomes.

Table 2.3. Payoff matrix of diesel spill on 10%, 32%, 10%, 23% and 25% of land in Hectares A,B,C,D,E and F of Bori respectively.

		Player A				
		Maize	Cassava	Yam	Oil Palm	Fishery
	Hectare A 10%	0.01	0.02	0.05	0.05	0.44
	Hectare B 32%	0.04	0.07	0.16	0.16	1.32
Player B	Hectare C 10%	0.01	0.02	0.05	0.05	0.44
	Hectare D 23%	0.03	0.05	0.11	0.11	0.88
	Hectares E 25%	0.01	0.02	0.05	0.05	0.44

The new payoff matrix would be used to develop EPVI tables for Bayesian analysis

III. ANALYSIS OF EXPECTED VALUE OF PERFECT INFORMATION

Complete and accurate information about the future demand, referred to as perfect information, would remove all uncertainty from the problem of occurrence of state of nature with probabilities. The payoff matrix is used to produce a conditional table under uncertainty as shown in table 3.1

Table 3.1Conditional table under certainty (billion naira)

State of nature (Lands)	Probability	Expected profits from different Farm types (billion naira)				
		Maize	Cassava	Yam	Oil Palm	Fishery
Hectare A	-	-	-	-	-	0.440
Hectares B	-	-	-	-	-	1.320
Hectare C	-	-	-	-	-	0.440
Hectares D	-	-	-	-	-	0.880
Hectare E	-	-	-	-	-	0.440

The conditional table under uncertainty is used to produce the expected profit table with perfect information as shown in table 3.2. and table 3.3. The expected profit with perfect information is obtained by multiplying the conditional profit under uncertainty with the probability of occurrence as shown in table 3.2.

Table 3.2 Expected profit table without perfect information (billion naira)

State of nature (Lands)	Conditional profit under certainty(billion naira)	Probability	Expected profit with perfect information (billion naira)
Hectare A	0.440	0.10	0.044
Hectare B	1.320	0.32	0.422
Hectare C	0.440	0.10	0.044
Hectre D	0.880	0.23	0.202
Hectare E	0.440	0.25	0.110
Expected Profit Without Perfect Information (EPPI)			**0.823**

Table 3.3. Expected Monetary Value Table (billion naira)

State of nature (Lands)	Probability	Expected profits from different Farm types (billion naira) Maize	Cassava	Yam	Oil Palm	Fishery
Hectare A	0.10	0.010	0.020	0.050	0.050	0.440
Hectare B	0.32	0.032	0.064	0.160	0.160	1.408
Hectare C	0.10	0.010	0.020	0.050	0.050	0.440
Hectare D	0.23	0.023	0.046	0.115	0.115	1.012
Hectare E	0.25	0.025	0.050	0.125	0.125	1.100
Total expected profit		0.100	0.200	0.500	0.500	**4.400**

The expected value for perfect information is obtained by subtracting the expected profit without perfect information from the expected profit with perfect information as shown bellow.

Expected profit with perfect information= 4.4 billion naira
Expected profit without perfect information= 0.823 billion naira
Expected value of perfect information = 3.577 billion naira.

IV. RESULTS AND DISCUSSION

Table 4.1. Payoff matrix of accrued benefit from farm produce on five hectares of reclaimed diesel spill land in Bori per billion naira

		Player A: Maize	Cassava	Yam	Oil Palm	Fishery
	Hectare A 10%	0.01	0.02	0.05	0.05	0.44
	Hectare B 32%	0.04	0.07	0.16	0.16	1.32
Player B	Hectare C 10%	0.01	0.02	0.05	0.05	0.44
	Hectare D 23%	0.03	0.05	0.11	0.11	0.88
	Hectare E 25%	0.01	0.02	0.05	0.05	0.44

Discussion of the result in table 4.1

i. Table 4.1 showed the payoff matrix of diesel spill that affected 10%, 32%, 10%, 23% and 25% of land in Hectre A,B,C,D,E and F of Bori respectively.
ii. Player A plays his strategy to minimize cost of cultivating maize, cassava, yam oil palm and fishery while player B plays his strategy to maximize profit on hectare A,B,C,D and E
iii. The value in the payoff matrix is the accrued benefit per million of a multipurpose multi objective project.

Table 4. 2 Results of expected profit table with perfect information (billion naira)

State of nature (Lands)	Conditional profit under certainty (Billion Naira)	Probability	Expected profit with perfect information (Billion Naira)
Hectre A	0.440	0.10	0.044
Hectre B	1.320	0.32	0.422
Hectre C	0.440	0.10	0.044
Hectre D	0.880	0.23	0.202
Hectre E	0.440	0.25	0.110
Expected Profit Without Perfect Information (EPPI)			**0.823**

Discussion of the result in table 4.2

i. The expected profit with perfect information is 4.4 billion naira from table 3.3
ii. The expected profit without perfect information is 0.823 billion naira from table 4.2
iii. The expected value of perfect information (EVPI) is 3.577 billion naira.
iv. The EVPI is the maximum amount of money that should be allocated for research that will optimally improve the GDP, performance and

sustainability of the multipurpose multi objective projects.

V. CONCLUSION

The value in the payoff matrix used in this research is the accrued benefit per billion naira of a multipurpose multi objective farmland project. From the payoff matrix, the expected profit without perfect information is 0.823 billion naira (table 4.2). The expected monetary value of the project is same as the expected profit with perfect information which is 4.4 billion naira (table 3.3).The expected value of perfect information (EVPI) of the project is analysed to be 3.577 billion naira. Investors should allocate a maximum of 3.577 billion naira for research, creative innovations and technological development that will optimally improve the returns of investment, performance of project, and sustainability of the multipurpose multi objective farmland projects. Investors should not exceed the EVPI when reinvesting in research for the optimal growth of the organization. Future failure and eventual collapse of the farmland project is anticipated if EVPI is not invested in research, training of workforce, purchase of new supplicated equipment, entrepreneurship development etc. The EPVI should not also be exceeded to prevent collapse of the farmland project.

VI. RECOMMENDATION

Federal ministry of environment, agriculture and national oil spill detection regulation agency (NOSDRA) in alliance with the legislative arm of government should sponsor bill for the adoption and implementation of the developed EPVI optimization model of reclaimed diesel spill farmland project since it will help fulfill ISO 14001:2015 requirements.

VII. CONTRIBUTION TO KNOWLEDGE

The Bayesian expected opportunity loss model developed will help manager of multipurpose/multi-objective reclaimed oil spill farmland projects and other lucrative projects to take informed decision in investment that will optimally develop and sustain the projects.

This research work implements Bayesian expected value for perfect information model in solving the oil spill challenge in Bori-Ogloni farmland and agrees with ISO 14001:2015 requirements.

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