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Economic and Feasibility Studies using Particle Swarm Optimization for Petroleum and Gas Projects

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Abstract-- *High financial returns may be realized from oil and gas projects as a result of the high degree of risk due to high investment levels over a long period of time and high-tech resources. The capital allocation process and related decisions have a critical impact in final performance. A feasibility study is a tool for investigating the viability of the prospective projects. It is conducted on the very first stages of project development; to reveal whether or not the project is viable from all aspects. In this paper a proposed model, to maximize the profit using the net present value method, based on particle swarm optimization (PSO) technique is built to assess the overall viability for the petroleum and gas projects. Where the overall viability for the petroleum and gas projects includes the operational,economic and financial feasibility studies.*

The proposed model is applied to a project being conducted by Egyptian Petroleum Research Institute (EPRI) and the Academy for Scientific Research & Technology (ASRT). The total project budget is 20 million L.E. The costs are shared equally by EPRI and ASRT. The project financier is ASRT. The results are shown that the proposed model gives optimal solutions, which can be added as an alternative approaches for solving petroleum and gas projects evaluation problem. Moreover, the results of the proposed model indicated that the proposed model is robustness and reliable for evaluating the project under investigation.

Keywords: *Economic, Feasibility Studies, Thermal Enhanced oil recovery, Semi-pilot, Steam flooding, Optimization Technique, PSO, Petroleum and Gas Projects.*

I. INTRODUCTION

Investments as one of the major economic issues raised and to create and sustain economic growth, capital formation in the country is very important [1]. The capital allocation process, and the quality of its associated decisions, remains a critical factor influencing overall performance. The most common economic objectives for process optimization are profit and cost. These criteria have been applied to various problems [2].

A feasibility study is a tool for investigating the viability of the prospective projects. It is conducted on the very first stages of project development, to reveal whether or not the project is viable from all aspects [3].

A well-designed feasibility study should provide a historical background of the business or project, a description of the product or service, details of the operations and management, marketing research and policies, financial data, legal requirements and tax obligations. Feasibility studies should address issues from which are: Analysis of the budget relative to client/stakeholder requirements, Assessment of any site information provided by the client/stakeholder including geotechnical studies, assessment of any contamination, availability of services, uses of adjoining land, and so on, Planning issues, environmental impact assessment, Legal approvals, Assessing operational and maintenance issues and Procurement options [4].The construction and operation of chemical plants require large amounts of capital. Corporations engaged in the production of chemicals must raise the finances to support such investments. Like taxation, corporate financing is a specialized subject with many intricacies that require expert knowledge. The design engineer needs a superficial awareness of this subject to carry out economic analysis and optimization of the design [5].

Financial feasibility is often a predominant factor in feasibility analysis, as most investments are not realized if they do not generate profit for the project owners [6]. Financial feasibility analysis requires detailed information regarding the project operations and financial requirements [7]. In order to evaluate the financial feasibility of an investment project, relevant measurements or criteria need to be specified. [8] categorized the evaluation methods into five basic types: Net present value (NPV) methods; Rate of return methods; Ratio methods; Payback methods and Accounting methods. The cash flow method is considered more appropriate for evaluating the financial feasibility of investment projects [9].

The economic feasibility study take place after technical feasibility study [10]. Economic feasibility amounts to analyzing the financial stability of the project, judging whether the projected benefits are worth the risk and finding the bottom line for the project i.e. what is the minimum benefit of the project under which it is not worth doing [11].

Petroleum projects as investment opportunities require huge funds and with a long time to construct and they are associated with a series of risks and uncertainties. Therefore, the economic evaluation can be a main tool and reasonable way to find out best petroleum investment opportunities in terms of cost, revenue and risks [12].

The rest of the paper is organized as follows: in section 2, we describe the feasibility study measures. In section 3, we present the thermal enhanced oil recovery. In section 4, we describe the characteristics of Issaran field. Section 5 we present the particle swarm optimization. section 6, we describe the project under investigation. section 7, we illustrate the proposed model. Section 8, we discuss the results. Finally, section 9, presents the conclusion of the work.

II. Feasibility Studies Measures

In order to evaluate the different feasibilities of an investment project, relevant measurements or criteria need to be specified. The cash flow method considers the time value of money; cash flows are always calculated in several different ways, i.e. using different depreciation methods or inventory listings, which give different profit results. The cash flow method is considered more appropriate for evaluating the financial feasibility of investment projects [6]. There are several different cash flow based methods that can be used to measure the financial feasibility of investment projects, such as the NPV, Internal Rate of Return (IRR), Annual Equivalent Worth, Benefit-Cost Ratio and the Modified Internal Rate of Return. Investors use these quantitative measures to help them decide whether to undertake an investment or not, based on their return requirements [8]. The payback period (PBP) is another method that is sometimes used in financial feasibility analysis. The method determines when the project will break even, i.e. how long it takes for revenues to pay investment outlays [9].

In evaluating the expenses of a project two kinds of expenses are studied. The first expense is CAPEX (Capital Expenditure) which is used by a company to acquire or upgrade physical assets such as equipment, property, or industrial buildings. The second one is the cost of operations or maintenances of a plant known as OPEX (Operational Expenditures) Consisting of insurance expenses, plant repair, maintenance expenses, and other ongoing costs [13].

The NPV is one of the most important criteria for choosing among investment projects [14]. Since the NPV as the key factor for project investment is very sensitive value, it is very important to determine the most influential petroleum and gas parameters on the NPV. The selected parameters can make the best prediction of the NPV for the project investment. This technique is normally called variable decision, and it contrasts with uncovering a subset of the full set of recorded Variables that shows extra ordinary prescient capacities [15].

NPV is the difference between the present value of all cash inflows and cash outflows associated with an investment project. The NPV establishes whether or not the investment project is an acceptable investment, given the return the investor requires from the investment. [8] claim that maximizing or minimizing the NPV of a project, depending upon the situation, will provide the most efficiency, and as a result, the most profitability. In order to calculate the NPV, the interest rate used for discounting the cash flows needs to be determined.

It was shown recently that single objective optimization with proper economic objectives, like the NPV, produce specific process designs that represent good compromises between several objectives, like the economic, environmental and operational efficiencies. [16] concluded that the NPV has been widely used in several investment planning models. [17] enhanced the economic production quantity (EPQ) model by using Laplace transformation, analyzing cash flows from a NPV viewpoint and obtained an exact expression for the PV of the cash flows in the EPQ problem. [18] developed an alternative approach to conceptual design where a compound objective function based on the NPV and IRR aggregate performance metrics. This formulation models the integral value delivered by the candidate designs over their respective life-cycles by applying value-based NPV discounting to all objectives.[19] evaluated the application of the process schemes (lean vapour compression or LVC) and optimized based on maximizing the NPV of the process scheme savings (including capital investment), rather than minimizing energy demand in the form of equivalent work. Two scenarios have been analyzed. In the first scenario, the capture plant was fully adapted to the effect of LVC. In the second scenario, LVC is retrofitted to a basic capture plant design. For both scenarios the net present value of the process scheme over the whole plant life was calculated as a function of the LVC operating conditions.

[20] presented a framework for an energy supply decision support system for sustainable plant design and production. The mathematical model has been applied within an eco-industrial park setting and includes three steps, one step from them to express the economic analysis relies on a traditional cash flow analysis but also considers the current trends in power and fossil fuel prices in all revenues and costs, resulting in both revenue and cost adjustments during the medium-term investment. The two multi-objectives are to maximize the NPV and the human health impact reduction (HHIR) of the combined solutions.

[21] provided an overview of the influences that different economic objectives have on the efficiencies of those optimal process designs obtained by using single and multi-objective optimizations. Optimizations of monetary criteria, like the profit, lead to operationally and environmentally more efficient but economically less attractive designs than optimization of non-monetary economic objectives, like the internal rate of return. The NPV produced compromise designs with intermediate efficiencies and environmental impacts. These differences are significant only if the processes' mathematical models are sufficiently accurate for establishing appropriate trade-offs between investment and cash flow.

IRR is a concept based on the return on invested capital in terms of a project investment, or as Park [9] defines it: "IRR is the interest rate charged on the unrecovered project balance of the investment such that, when the project terminates, the unrecovered project balance will be zero". In other words, the investment has zero NPV at this rate of return, noted asi^*.

III. THERMAL ENHANCED OIL RECOVERY

Enhanced Oil Recovery (EOR) will have an important place in oil production in view of the escalating energy demand and tight supply. It is suggested that much research is needed to develop technologies for recovering over two-thirds of the unrecovered oil in reservoirs. Only a few recovery methods have been commercially successful. The choice of the method and the expected recovery depends on many considerations, economic as well as technological [22]. Issaran oilfield is one of the first fields in which steam EOR has been successfully implemented in a heavy oil carbonate reservoir [23].

Recovery methods used in heavy oil reservoirs usually yield very low recovery factors (5-10%). However, thermal recovery methods can be applied in order to enhance the heavy oil recovery. Steam flooding is proven to be successful in light, heavy and extra heavy oil reservoirs. There are several mechanisms that govern the recovery of oil via steam flooding. Some of the main mechanisms are thermal expansion, viscosity reduction, wettability alternation, steam distillation and gas generation. The design parameters of steam injection are vital to produce an economical project [24].

Productive Viscosity Oil (VO) bearing NFCRs in the Middle East are characterized by low matrix permeability and high fracture permeability. Large-scale oil flux is obtained through the high permeability fracture system, whereas the matrix-fracture interaction mainly controls recovery efficiency and maintaining production levels. This is the type of production taking place from reservoirs in Oman, Iran, Iraq, Syria, Turkey and Egypt [25].It is critical to have large oil saturation in applying the thermal methods especially in the steam flooding process. This is because much of the produced oil will be used on the surface as the source of fuel to fire the steam generators [26].

IV. ISSARAN FIELD

The Issaran oilfield concession consists of 20,000 acres. It is located 290 km southeast of Cairo and 3 km inland from the western shore of the Gulf of Suez (Shaheen et al., 2012). The Issaran field, a heavy to extra-heavy oil reservoir with reserves of approximately 500 MM bbl of oil, was discovered in 1981. The field primarily consists of three oil-bearing reservoirs ranging in depth from 1,000 to 2,000 ft. In the field there are three formations: the Upper Dolomite, Lower Dolomite and Nukhul formations [27].

According to [24] the Issaran field consists of five formations: the Zeit formation which has a 12 ft. a pay zone; the Upper Dolomite formation which is characterized by a depleted fractured dolomite reservoir, has an average thickness of 400 ft, with the top of the formation located at 1,000 ft, an average pressure of 250 psia and cannot be produced naturally due to its low pressure; the Lower Dolomite formation located at 1,500 ft, has the same characteristics and average thickness as the Upper Dolomite formation; the Gahrandal formation consists of three types of limestone; and lastly the Nukhul formation. The major heavy oil accumulation occurs within shallow Miocene formations through the five reservoir layers [27]. Heavy oil contained in fractured reservoirs represents a large portion of the total oil in place [24].

Carbonate formations are complex with widely varying permeability and porosity within the same formation and they are often naturally fractured [23]. The reservoir characteristics of the Nukhul formation, which lies deeper than the Upper and Lower Dolomite formations, is quite different from the more shallow ones. It consists of a tight limestone matrix [28]. The oil consists of 10% H_2S, 10% CO_2 and asphalting content around 15%. Moreover, the pressure of all zones is very low and considered to be below the normal gradient [24].
The porosity of the productive Nukhul reservoir is vugular because of the dissolution of the bioclastic particles. These large pores, or vugs, have extremely high permeabilities. The Nukhul reservoir accounts for 15% of the reserves for the Issaran field [28].

The average reservoir temperature is ranges from 85° to 100°F, the bottomhole pressure is approximately650 to 700 psi and the API gravities are 9.2° and 12.1° for the crudes with corresponding densities of 0.964 and 0.988 g/cm^3 and viscosities of approximately3,000 and 5,000 cp. Porosity and permeability measurements made on several porosities ranged from 23% to 33%, and permeability ranged from 1.3 to 104 mD. The matrix permeability for the Nukhul formation is estimated to be very low, but the fracture permeabilities exceed several darcies [28]. One of the biggest challenges with this field is that it consists of several zones and each zone has its own unique properties and characteristics. The general properties that these zones share are oil type, content and pressure. The average gravity of oil existing in all zones is between 10°-12°API with a viscosity of up to 4000 cp at standard conditions [24].

V. PARTICLE SWARM OPTIMIZATION

The original PSO algorithm is discovered by Kennedy and Eberhart in 1995 [29]. It is related to the bird flocking, fishing schooling, and swarm theory. PSO was first designed to simulate birds seeking food which is defined as a "cornfield vector." The bird would find food through social cooperation with other birds within its neighborhood:

$$\left.\begin{aligned} v_{id} &= v_{id} + c_1 rand()(p_{id} - x_{id}) + c_2 Rand()(p_{gd} - x_{id}) \\ x_{id} &= x_{id} + v_{id}, i = 1, \dots, D. \end{aligned}\right\} \quad (1)$$

where c_1 and c_2 are positive constants, and rand() and Rand() are two random functions in the range $[0,1]$; $x_i = (x_{i1}, x_{i2}, \dots, x_{iD})$ represents the i^{th} particle; $p_i = (p_{i1}, p_{i2}, \dots, p_{iD})$ represents the best previous position (the position giving the best fitness value) of the i^{th} particle; the symbol g represents the index of the best particle among all the particles in the population; $\boldsymbol{v}_i = (v_{i1}, v_{i2}, \dots, v_{iD})$represents the rate of the position change (velocity) for particle i. Equation (1) is describing the trajectory of the population of particles and describes how the velocity is dynamically updated and the bottom line of the position update of the"flying" particles. The first part is the momentum part. The velocity cannot be changed abruptly. The second part is the "cognitive" part which represents private thinking of its learning from flying experience. The third part is the "social" part which represents the collaboration among particles - learning from group flying experience.

The introduction of the first new parameter added into the original PSO algorithm is the inertia weight [30]. The dynamic equation of PSO with inertia weight is modified to be:

$$\left.\begin{aligned} v_{id} &= wv_{id} + c_1 rand()(p_{id} - x_{id}) + c_2 Rand()(p_{gd} - x_{id}) \\ x_{id} &= x_{id} + v_{id}, i = 1, \dots, D \end{aligned}\right\} \quad (2)$$

and the references cited therein [31]. Another parameter called constriction coefficient is introduced with the hope that it can insure a PSO to converge. A simplified method of incorporating it appears in Equation (2), where k is a function of c_1 and c_2 as seen in Equation (3).

$$\left.\begin{aligned} v_{id} &= k[v_{id} + c_1 rand()(p_{id} - x_{id}) + c_2 Rand()(p_{gd} - x_{id})] \\ x_{id} &= x_{id} + v_{id}, i = 1, \dots, D. \end{aligned}\right\} \quad (3)$$

with

$$k = \frac{2}{\left|2 - \varphi - \sqrt{\varphi^2 - 4\varphi}\right|}. \quad (4)$$

where$\varphi = c_1 + c_2, \varphi > 4$ Mathematically, Equations (3) and (4) are equivalent by setting inertia weight w to be k, and c_1 and c_2 meet the condition $\varphi = c_1 + c_2, \varphi > 4$. The PSO algorithm with the constriction factor can be considered as a special case of the PSO algorithm with inertia weight while the three parameters are connected through Equation (4).

PSO is a powerful technique since it is simple and easy to implement. PSO has many advantages such as converging fast to the global minimum, handling and finding good solutions for nonlinear and non-differentiable optimization problems. When comparing PSO with other techniques like GA and TS, it is found that PSO finds better solutions with less number of iterations. Some researchers claimed that the performance of PSO is parameter dependent [32-37].

VI. The Proposed Model

A mixed integer nonlinear programming model is proposed for feasibility studies of petroleum and gas projects. The objective function is presented in Equation (5) which maximizes the profit using the net present value method.

$$\max NPV = \sum_t \frac{TCF_t\_X2}{(1-i)^{t-1}} \quad (5)$$

where$i$ is the interest rate, total cash flow is in each period (TCF_t_X2) is the outcome of subtracting the total depreciable capital ($FraTDC_t\_X5$) from net earnings$NetE_t_X4$ by considering the salvage value (sv)of capital in the last period, as it is presented in following.

$$TCF_t\_X2 = NetE_t\_X4 - FraTDC_t\_X5, \quad t = 1, 2, \dots, T-1 \quad (6.a)$$

$$TCF_t\_X2 = NetE_t\_X4 - FraTDC_t\_X5 + (sv).TFCI\_X6, \quad t = T \quad (6.b)$$

Net earnings ($NetE_t\_X4$) in each period is determined by calculating the differences between total variable costs (TVC_t_X8) and sales revenue ($SaleRev_t\_X7$) by considering tax rate (α) and capital invested depreciation (Dep_t_X9) as stated in Equation (7).

$$\text{NetE}_t\_X4 = (1-\alpha).(\text{SaleRev}_t\_X7 - \text{TVC}_t\_X8) + \alpha.\text{Dep}_t\_X9 \quad \forall t \qquad (7)$$

Where the values of SaleRev_t_X7 *and* TVC_t_X8 depend on the problem under investigation.

The straight-line method is applied to obtain the capital invested depreciation (Dep_t_X9) as stated in Equation (8).

$$\text{Dep}_t\_X9 = \frac{(1-sv).TFCI\_X6}{T} \quad \forall t \qquad (8)$$

Equation (9) is shown the total fixed capital investment comes from fixed cost investment (FCI_t_X3) summation of all periods by considering interest rate i.

$$TFCI\_X6 = \sum_t \frac{\text{FCI}_t\_X3}{(1+i)^{t-1}} \quad (9)$$

The value of FCI_t_X3 depends on the problem under investigation.

The summation of total fixed capital investment ($TFCI\_X6$) by considering interest rate i, forms fraction of the total depreciable capital (FraTDC_t_X5) as follow:

$$\text{FraTDC}_{tX5} = (TFCI_{X6}).\left[\frac{i.(1+i)^t}{(1+i)^t - 1}\right] \quad \forall t \qquad (10)$$

VII. Applying the Proposed Model to the EPRI Project

The project title is "Constructing of semi-pilot plants for enhanced oil recovery by unconventional methods". The project is ongoing. The total project budget is 20 million LE. The costs are shared equally by EPRI and the Academy for Scientific Research & Technology (ASRT). The ASRT is the project financier. The project aims to link between industry and scientific research through the application of enhanced oil recovery technology by unconventional methods to recover oil at Egyptian oil fields. This goal requires the construction of a semi-pilot plant for enhanced oil recovery to test the suitability of these unconventional methods then pre-field applications and training of oil company engineers. The project will be investigated according to the laboratory scenario. This piece of research will apply the project to the Nukhul formation of the Issaran field for field scenario. Table 1 shows the economic bases for the project.

Table 1: Economic Bases for the Project.

	Value
Semi pilot life	15 years
Depreciation	15 years (straight line)
Construction period	2 years
Work days/year	320 days
the salvage value (sv)	.002 from FCI
Maintenance	300,000 L.E. / year
Discount rate	10%
Changing rate from US$ to L.E.	16.5
Prices [38]:	
Supper heated steam price	$18/ m^3
Oil price	$80/bbl
Utility Prices [8]:	
Water	0.34 $/m^3
Electricity	0.08 $/kWh
Budget for construction phase:	
Equipment's and supplies & materials	17,000,000 L.E.
Incentives	2,000,000 L.E.
Transportations, accommodation and training	500,000 L.E.
Other Accessories	500,000 L.E.

where

- Steam injected rate: As the steam injection rate increases, the cumulative oil production from the field increases slightly. There are several criteria for determination of the best injection rate, including economic factors, steam production cost, steam generator capacity, cost and oil price, among many others [39].

Project Decision Variables:

NPV	Net present variable
TCF_t_X2	Total cash flow in each period
FCI_t_X3	Fixed cost investment in period *t*
$NetE_t$_X4	Net earnings in period *t*
$FraTDC_t$_X5	The fraction of total depreciable capital in period *t*
TFCI_X6	Total fixed cost investment
$SaleRev_t$_X7	Sale revenues in period *t*
TVC_t_X8	Total variable cost in period *t*
Dep_t_X9	Depreciation of the capital invested in period *t*

The proposed model will be as above in addition to Equation (7) will multiplying by the EPRI Credit percentage for the net profit.

$$\mathrm{NetE}_{t_{X4}} = [(1-\alpha).\ (\mathrm{SaleRev}_t\_X7 - \mathrm{TVC}_t\_X8) + \alpha.\mathrm{Dep}_t\_X9\ \ ] * 0.75\ \ (\text{EPRI Credit})\ \forall t \qquad (11)$$

Thevalues of $\mathrm{SaleRev}_t\_X7$ *and* TVC_t_X8 will be as stated in Equations (12),(13) for laboratory scenario.

$$\begin{aligned}\mathrm{SaleRev}_t\_X7 = {} & Training\ (\ No.of\ trainer\ per\ year * \$\ Price\ per\ trainer * changing\ rate) \\ & + Studies\ (\text{Thermal EOR: \$Price} * changing\ rate * \text{expected number of studies per year} \\ & + \text{Chemical EOR: \ \$Price} * changing\ rate * \ \text{expected number of studies per year} \\ & + \text{Miscible EOR: \ \$} * changing\ rate * \text{expected number of studies per year})(12)\end{aligned}$$

$$\begin{aligned}\mathrm{TVC}_t\_X8 = {} & [320\ days * (Steam\ injected\ rate) * \$Steam\ price * changing\ rate + P2 * Incentives\_X30 + P3 \\ & * SupMat\_X31 + P4 * SparePart\_X32 + P5 * Others\_X33 * +300{,}000 * Maint\_X34 + P6 \\ & * Materials\_X35 + \$Price * changing\ rate * Q * Water\_X36 + \$Price * changing\ rate * Q \\ & * Elec\_X37] + \ Training\ costs \\ & * TRNG\_X29 \qquad (13)\end{aligned}$$

Where $P2, P3, P4, P5, P6$ are the incentives -operation cost for mangers and assistance team, the supplies & materials-operation cost, spare parts -operation cost, *others* -operation cost and materials -operation cost respectively, Q is the consumption quantities, and Steam injected rate is50 m^3/d.

The value of FCI_t_X3will be as stated in Equations (14).

$$\mathrm{FCI}_t\_X3 = \ \ EQP1\_X28 * EQP\ Price \qquad (14)$$

where

$TRNG_{X29}, Incentives_{X30}, SupMat_{X31}, SpareParts_{X32}, Maint_{X34}, Materials_{X35}, Water_{X36}$, $Elec\_X37, EQP1\_X28$ are binary variables.

$\mathrm{TCF_t_X2}, \mathrm{FCI}_t_X3, \mathrm{NetE_t_X4}, \mathrm{FraTDC_t_X5}, \mathrm{TFCI_X6}, \mathrm{SaleRev_t_X7}, \mathrm{TVC_t_X8}, \mathrm{Dep_t_X9}_t$are nonnegative variables.

VIII. RESULTS AND DISCUSSION

The proposed modelis used to solve the problem under discussion (EPRI project), where the parameters of the PSO is setting to $C_1 = C_2 = 2, \omega_{max} = 0.5, \omega_{min} = 0.0, cf = 0.732$, Pop. Size = 40 and max no. of iterations = 10,000 .We tried different values to PSO parameters and noticed the solutions until we reached to the best valued for the PSO parameters which gave us the optimal solution for the EPRI Project. All implementation made on a PC computer with a processor intel CORE i7, and matlab program version 2015a.

Table (2) summarizes the results of the feasibility studies for EPRI Project. The results of this study show that the project will be successful and has a great performance from all aspects. It is obvious from Table (2) that the financial feasibility measures are reflecting perfect performance for the project. The optimal investment levels increase from the optimum NPV. The profitability index and IRR are dependent on the quality of computing the NPV. ROI is a simple measure of economic performance based on cash flow, not profit and does not include a depreciation charge.

***Table 2: Results for the EPRI Project(*Laboratory Scenario).**

Operational Feasibility	**Value(*Million L.E.)***	***Measures***	***Financial Feasibility***
Capital Costs at $t = 0$	17.00	Total Investment(M L.E.)	1,886.5
Operating Costs at $t = 0$	3.00	NPV (M L.E.)	2.720.2
Operating Revenues at $t = 0$	0.00	IRR (%)	29.32
TotalOperating Costs	424.48	Profitability Index	136.01
		Pay Back Period (Years)	7
		Net Profit(M L.E.)	1,462.02
		ROI (%)	4.3

IX. CONCLUSION

Investments as one of the major economic issues raised and to create the economic growth, capital formation in the country is very important. The capital allocation process, and the quality of its associated decisions, remains a critical factor influencing overall performance. The net present value establishes suitable measure between the profitability and the long-term sustainable cash flow generation, it could be concluded that this criterion would be the most appropriate economic objective for performing different feasibility studies. After investigating the EPRI Project for viability, we found that the operational, economic and financial feasibilities achieve the desires and the goals of the decision maker. We concluded that it is very important to have a vision about the return of investments at the beginning of the project. For the future work, we recommend using the multi-objective optimizations of monetary criteria for investigating the viability of the projects for performing different feasibility studies.

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