Economic Feasibility Study for Petroleum Projects (Practical Aspects)

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Abstract:

An increasing importance is given to the Economic Feasibility Study of Petroleum Projects. The reason behind that is the critical role played by the Petroleum Industry in Society, Economy and Foreign Trade. In general, Petroleum Industry is involved with the Exploitation of Oil and Gas Resources to satisfy the country's needs (households and industrial sectors) and to export these resources, in order to, gain foreign currencies which are necessary for funding the country's social and economic requirements. Petroleum Projects have diversity features in terms of location, size, capital, technology and risks. On the Other hand, because of the importance of the Petroleum Industry, high significance should be given to the Economic Feasibility Study, especially the necessary of good knowledge of the nature of Petroleum Activities, Projects and Contracts, as well as the fundamentals of Advanced Feasibility Study.

الخلاصة:

تزداد أهمية موضوع دراسة الجدوى الاقتصادية للمشروعات البترولية لأسباب عديدة في مقدمتها أهمية الصناعة البترولية للاقتصاد والمجتمع والعلاقات التجارية الدولية. الصناعة البترولية، عموماً، تختص باستغلال الموارد الهيدروكاربونية وسد حاجة البلد من المنتجات النفطية والغازية سواء للقطاع الأسري أو الصناعي أو في التجارة الخارجية لكسب عملات صعبة تكون ضرورية لتمويل متطلبات التنمية الاقتصادية والاجتماعية للبلد. مشروعات الصناعة البترولية لها خصائص متنوعة من حيث الموقع والحجم ورأس المال والتكنولوجيا والمخاطر. وفي الجانب الأخر ، وبسبب طبيعة الصناعة البترولية وأهميتها، يكتسب موضوع دراسة الجدوى الاقتصادية في المشروعات البترولية أهمية خاصة لاسيما مايتعلق منها بضرورة المعرفة الجيدة بطبيعة الأنشطة والمشروعات والتعاقدات الجديدة وأساسيات دراسات الجدوى ومضامينها والتقدم المتحقق في أساليب الدراسة الحديثة وتقنياتها .

Introduction:

The subject of an Economic Feasibility Study for Petroleum Projects has recently gained increasing importance. Petroleum projects specialize in the exploitation of oil and gas resources and their products which are used in most of our daily needs. These projects have specific features related to the nature of their activities, location, capital, technology, risks and uncertainty. Therefore, those features require specific considerations pertinent to practical experience whether the study for upstream or downstream projects. Advanced knowledge about the fundamentals and techniques of a modern economic feasibility study, as well as specific knowledge about the requirements of establishing and operating petroleum projects and their developments, all are necessary issues to conduct a systematic study that enables involved parties to make reasonable decisions about available investment opportunities in petroleum industry.

Focusing on the requirements and the implementation of a modern economic feasibility study for petroleum projects is the main purpose of this paper through six parts.

Part One

Economic Feasibility Study:

1: Definition

In general, an Economic Feasibility Study as a tool is a series of interrelated and subsequent studies, used by companies, banks, investors, promoters, individuals and government agencies, that to consider a new project as an investment opportunity among many opportunities by studying their future cost and future revenue to find out and adopt the best options. This tool involves different uses of data and information related to marketing, technical, economic, financial, environmental, social and legal areas (monetary, quantitive and qualitative expressions) to build specific projections about the establishment and operation of the project. The initial investment and operating costs are expressed in monetary terms. A monetary expression is necessary to calculate the expected revenues, net cash flows, and net benefits or profitability indicators, taking into account the time value of money, risk factors and changing conditions, to make an initial judgment on a project proposal.

2: Methodology:

An Economic feasibility study is a set of diversified processes, starting from a simple idea heading toward several directions, then ending to form a complex study or simple report (project proposal) at hand for decision-makers. The ideas are designed to produce new goods or services, (or modify, modernize or renew given goods and services, etc). Basically, these ideas require an examination of their market features. A market study includes all the available data and information about the markets of inputs and outputs and their components; location, site, size, specifications, linkages, rules and laws, projections, etc. If positive results have been obtained (from a market viewpoint) this will open a way to continue for studying the technical framework options of the project.

In principle, technical analysis is an essential step, maybe it is the Most important step. This analysis go deeply to study the project elements that are related to project shape, size, design, specifications, technology level, buildings, inputs, outputs, equipments, labor and services,…etc. All these elements are organized in the form of technical, monetary, and time schedules. Integrated technical analyses are often classified into investment costs and operating costs, which shall determine whether or not the project analysis needs to terminate, to modify or to continue to the next step. That is, the encouraging results will be the base for the financial analysis.

Many factors are required to achieve an accurate financial analysis because the final judgments will ultimately depend on the future financial results of project. Financial analysis deals with the commercial viability over the lifetime of a project. Many issues should be covered in this step, including various factors that are firstly required during the investment phase; (e.g. funding sources, financing terms, and the amount of loans and interests), as well as all the issues related to future costs and revenues. Profitability indicators to evaluate and judge the project viability may be simple such as; (Net Profit, Average Profit, and Payback Period). Indicators may be complex as well, such as; (Internal Rate of Return, Net Present Value, Discounted Payback Period and Profitability Index.), Indicators may also be more extended to comprise diverse financial statements of the project such as statements of; (Net Income, Cash Flow, and Budget) with selected financial Ratios. These basic items are shown in **Table (1)**.

Table (1)

Basic Indicators of a Financial Evaluation

Undiscounted and Discounted Methods	**Rate of Return**
	Payback Period
	Net Present Value NPV
	Internal Rate of Return IRR
	Break-Even Point
	Capital Productivity Index
	Profitability Index
	NPV/MAX Exposure Point
	Others
Financial Statements	**Balance Sheet**
	Income Statement
	Cash Flow Statement
Financial Ratios	**Current Ratio**
	Profit Margin
	Return on Equity
	Return on Assets
	Interest Coverage
	Debt to Equity
	Debt to Total Capitalization
	Others

The economic and financial results of the project will determine, to a great extent, the importance of the project for decision makers. They will decide whether the project is a good investment opportunity or not, or if there is a need to make modifications about the basic assumptions and/or initial calculations related to issues such as project design, production profile, technology level, investment expenditures, operating costs, products prices, etc.

As a completed methodology, big projects require extensive analysis which should extend to cover environmental topics and a social profitability analysis. But in small projects these analyses are often neglected.

In short words, a feasibility study of a project comprises a market analysis, a technical analysis, and a financial analysis. The findings are the resulting study which is referred to as an (Economic Feasibility Study).

3- Practical Requirements:

In practice, there are varied requirements for the feasibility study process; First: a special team should be formed to undertake this task. The team mainly consists of specialists such as; (an experienced manager, engineers, economist, accountant, legal expert and a coordinator). Second: providing a technical background expressed as technical data and information of the project which is an essential source for computing the capital expenditures and operating costs. Third: legal frameworks and regulations that should be up to date, involving taxes, duties and any other financial obligations the project will be subjected to.

Fourth: gathering economic data about supply and demand, market prices, inflation rate, interest rate, etc. Fifth: use software programs which have been designed for economic and financial evaluation purposes. All of those requirements should be combined and integrated throughout the economic feasibility study.

Part Two

Petroleum Industry:

1: Definition

The Petroleum Industry is one of the most important industries in the world. This industry has special characteristics and requirements; a huge capital, advanced technology, senior specialists, high risks, specific skills and experience, long term projects and high sensitivity to political and economic events.

Generally, the petroleum industry has diverse activities related to the

exploitation of oil and gas resources under and above the ground, starting from the pre-exploration efforts, exploration, development and production, transportation, refining, gas processing, local distribution and external marketing (see **fig** 1).

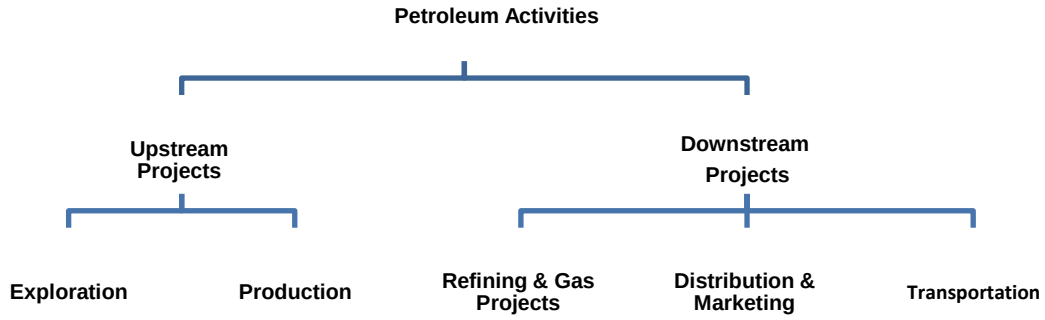

Fig. (1)

The Main Activities of the Petroleum Industry

In spite of the specific features, especially the issues that pertain to capital requirements and the number of employees, type of inputs and outputs, location, and level of risks, .etc, most of these issues are interrelated and integrated.

2: Petroleum Projects:

A petroleum project as an investment opportunity may not considerably differ from projects in other industries. Simply, it is an allocation of a certain amount of capital to be spent on specific production factors which are required to establish a new project with commercial objectives in one or more activities .

As an integrated part, it is necessary to distinguish between the types of petroleum project evaluations; whether simple or complex, high cost or low cost, high risk or low risk, are for a company, investor, or government, all these factors will determine the directions and the implementation of an economic feasibility study.

Petroleum Projects involve various activities regarding inputs and outputs, markets, cash flows, locations and sites, etc. In this context, for any petroleum project, funds which are spent during the initial investment at an earlier period will be channeled into hundreds of directions; for instance, purchase equipments and materials from various sources, recruitment of expertise, contracting with a number of companies to undertake some designs or conduct certain works and services, etc. In contrast, expected revenues may be received after a relatively long time span, under uncertain conditions, and only from selling one or a few products.

Table (2) describes the main items of investment and operating costs and cash flows of the petroleum projects which consists of the categories of the basic cash flow for each type of petroleum projects.

Table (2)

Petroleum Projects: Main Items of Cash Flow

Exploration & Production Project

• **Cash Inflows**
  - **Revenue from selling produced volumes of oil and gas in Royalty/Tax fiscal systems**
  - **Cost Recovery and Profit Share in Production Sharing Contracts**
• **Cash Outflows**
  - **Capital Expenditures to explore and develop the field**
  - **Operating Costs to maintain equipment and transport production to market**
  - **Royalties, taxes and any other payments to government entities as defined by special Hydrocarbon Laws, negotiated contracts and tax legislation**

Gas Processing Plants

• **Cash Inflow**
  - **Revenue from selling plant products (e.g. ethane, propane)**
• **Cash Outflow**
  - **Capital Expenditures to build the plant**
  - **Operating Costs to operate the plant and to buy raw material and feedstock (e.g. Natural Gas)**
  - **Local and national fees and taxes as defined by contract or tax legislation**

Refining Projects

• **Cash Inflow**
  - **Revenue from selling refining products (e.g. Benzene, Gas oil)**
• **Cash Outflow**
  - **Capital Expenditures to build the Refinery**
  - **Operating Costs to operate the Refinery and to buy feedstock (Crude oil)…**
  - **Local and national fees and taxes as defined by contract or tax legislation**

Pipeline Projects

• **Cash Inflow**
  - **Revenue from tariffs charged to those transporting products in the pipeline**
• **Cash Outflow**
  - **Capital Expenditures to build the pipeline**
  - **Operating Costs to maintain the pipeline and its equipment**
  - **Local and national fees and taxes as defined by contract or tax legislation**

Source: IHS ENERGY, 2005.

Part Three

Risks and Uncertainty Analysis:

In a business life cycle, nothing is 100% in future events. An economic feasibility study, as a comprehensive picture of a proposed project, should involve future cash in and future cash out and must be coupled with reasonable assumptions. The reasons beyond that are many known and unknown affected factors over the life of project and the frame that deals with these factors called (risks and uncertainty analysis).

Petroleum projects are quite sensitive to changing circumstances, especially those related to the inside development of projects (markets, costs and revenues), as well as events related to inflation, exchange rates, etc. All Those have a significant effects on the total value of project. Therefore, the risks and uncertainty analysis forms a key part in any economic feasibility study of petroleum projects.

1: Definition:

Generally, risks and uncertainty have no specific definitions; also they are diferent from other industries and activities. Risks and uncertainty cover all the unusual and unknown, expected and unexpected conditions which affect over the life of project, whether that is attributed to technical factors, environmental factors, political and social factors, or financial and economic factors. The direct results of these factors, if they are considered in an economic feasibility study, will generate more than one expected value for the project. This case is a critical point for decision makers who aim to determine a specific value or at least very close values.

The knowledge and practice of past and current events, and the ability to project certain future conditions that could cause a large loss, or even affect achieving the objectives of a project is called (Risk Analysis). But the absence or a little practice about past conditions and the inability to project some affected conditions and

their type, is called (Uncertainty Analysis). In realty, there is no quite Separation between risks and uncertainly

2: Techniques:

In order to study the impact of potential factors (Risks and Uncertainty Analysis) the factors should be treated and determined at quantity levels, then in monetary expression. This step is so necessary in an economic feasibility study that deals and aims to reach the specific monetary values of a project. Entering risks and uncertainty analysis into the calculations of a feasibility study, a number of results will be produced. This means there is more than one value of a project to be achieved, up and down the level of base value.

Different techniques are used with this analysis, ranging from simple methods to the complex, but the nature of project and the details that are required will determine which techniques should be used. For instance, some commonly used techniques (with simple and complex projects) are as follows:

1. Sensitivity Analysis
2. Probability Analysis
3. Monte Carlo Simulation
4. Methods of High Discount Rate, Maximizing Payback Period

3: Risks and Uncertainty in Petroleum Industry:

Concerning the petroleum industry, for example in case of Upstream Projects, in addition to economic and financial risks, there are numerous geological risks. Decisions to drill almost invariably have to be made on the basis of insufficient information. There are uncertainties about the porosity and permeability of reservoir rocks, hydrocarbon reserves in the reservoir, etc. Also, there are technical and non-technical risks associated with the successful drilling and completion of the wells, etc. (*Krishan A. Malik*).

On the other hand, Downstream projects may face different unusual

events; many changing circumstances are associated with production operations such as crude oil prices, product prices, maintenance costs, sudden shutdowns, marketing problems….and so on. Gas plants also face circumstances that may be expected but some are not, for example feed gas price, long term contracts, or geo-political events. Treatment of these events is different from case to case, depending on the nature of the project and the goals of feasibility team.

Part Four

Software Programs:

In practice, an economic feasibility study of a petroleum project is a complex process and includes Intensive efforts, whether that is linked to collect and organize data, or this data is treated to obtain accurate results. The process contains many factors and relations, and requires notably understanding not only what is related to the nature of project, but also all the steps and the phases of the path of the feasibility study. Using the advanced technology of the computer had created a number of software programs which are used in broad areas and have the ability to perform many tasks especially for the petroleum project evaluations.

1: Definition:

Software programs are a set of systems, based on mathematical and statistical logic that have been developed by specialists to achieve a variety of tasks related to all areas of sciences. The most important advantages of these programs are their capabilities to store, organize and analyze huge data and information, in an easy and quick way. Additionally, these programs draw the (Project) in a very detailed picture, covering all data as inputs and all results as outputs, involving tables, diagrams and figures, as well as different systems of equations and formulas.

2: Types of Petroleum Programs:

Practically, the analysis of various activities requires different software programs, and then a variety of structures and applications. Today, there are many types of software programs, depending on their purposes. Simple programs are often used for small projects, but complex and expensive ones are used for large projects. Simple programs are often free and they include a limited number of factors regarding some technical information and fundamentals of cash flows as well as main evaluation indicators. Complex programs extend to the more details to cover as much technical, financial, and economic data as possible. For petroleum projects, complex programs are commonly used in areas of (Upstream Projects) and (Downstream Projects). The design and the components of software programs involve many fields in addition to financial, economic, and accounting concepts, many details related to technical analysis are included and many techniques cover risks and uncertainty analysis.

Since there are many petroleum activities, a number of software programs such as exploration, development and production programs, and some other programs concerning refining projects and pipeline programs have been produced and developed to meet many purposes within an economic feasibility study.

The work with software programs requires, first of all, a wide awareness and good experience concerning the nature of the proposal project, specific skills for using computers, good knowledge of an economic evaluation, and some principles about mathematical and statistical tools. Because the complex software programs are very expensive and are often restricted in use with limited time, using these programs needs a high degree of efficiency to perform these tasks.

Part Five

Petroleum Contracts:

High attention is given to oil and gas resources because their inputs are valuable and interrelated with most of our life needs. Petroleum contracts are the basic tools of oil and gas exploitation in the world, which cover the activities of exploration, development and production. Exploitation efforts of oil and gas resources require huge capital, advanced technology and high experience; therefore, only experienced companies can have those capabilities to be involved. The essential point in this context is that petroleum contracts are concluded between Host Governments and Oil Companies. Each party has a different philosophy and objectives as shown in Table 3.

Table (3)

Objectives of Host Government and Oil Company

Parties	Main Objectives
Government	• **Maintaining control over resources** • **Attracting risk investments** • **Meeting domestic consumption requirements** • **Maximizing national revenues from petroleum** • **Developing indigenous technology and expertise** • **Promoting national economic growth through petroleum development by foreign companies.**
Company	• **Seeking Oil & Gas discoveries** • **Obtaining a reasonable rate of return** • **Securing crude oil supply** • **Ensuring sufficient security on investment** • **Retaining as much flexibility and control of the operation as possible.**

1: Definition:

Simply, the petroleum contract consists of specific arrangements, mainly; legal, technical, financial and environmental provisions. However, the basic concerns among involved parties are the economic and financial issues (Rights & Obligations). These issues arise from the economic feasibility study which is prepared separately by each party. In this area, contracts focus on special requirements such as the amount of capital and pricing mechanisms, work programs, and the value of outputs and risks; therefore, the feasibility study is different comparing with studies in other industries. Furthermore, as the petroleum contracts focus, among other things, on accurate rights and obligations, so this work is not smooth and needs a long time and different experiences. Feasibility studies are often complex and expensive; therefore, centering on the net ultimate values of Host Government and Oil Company is the basic goal of a feasibility study.

2: Techniques:

Conducting feasibility studies in this industry depend on a good understanding and awareness of the conceptual framework of a petroleum contract, as well as economic and financial issues related to techniques and mechanisms for computing costs and revenues and splitting the shares among involved parties (Host Government and Oil Company) such as taxes, royalties, bonuses, Profit Oil and Cost Oil, R-factor, price cap, etc., see Table (4).

3: Types of Contracts:

In general, petroleum contracts are divided into three main categories; Concession Contracts, Production Sharing Contracts, and Service Contracts, see Figure (2).

Table (4)

Selected Financial & Economic Items of Petroleum Contracts

Some Fiscal Terms in Petroleum Contract	Techniques	Some Terms Subject to Sliding Scale
Bonuses Royalty Cost Oil Cost Recovery Profit Oil Taxes Gov. Participation Commerciality Domestic Obligations Ring Fencing Gov. Take Co. Take	Sliding Scale R – Factor Rate of Return Price Cap Net Back Value	Profit Oil Split Royalty Bonuses Cost Recovery Limits Tax Rates Uplifts

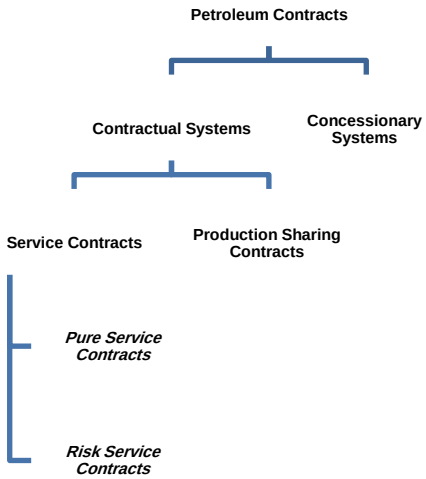

Fig (2)

Main Types of Petroleum Contracts

Historically, concessions are the oldest type; tax and royalty are main elements of the relationship between the Host Government and the Oil Company. Production sharing contracts began in the sixties and they involve more complex mechanisms in computing costs and profits.

There are a number of service contracts types and there is no one standard model, but this type of contract has a basic point called a service fee which shall be covered by petroleum costs and a certain return for the Oil Company. In general, many considerations may determine the trends of a relationship between involved parties, mainly; ownership, payments, profit split, working program, and risk level.

Part Six

Case Studies

1. General Comments:

It goes without saying that diversity of petroleum projects makes their economic and financial features different. A general framework of costs and revenues and profitability indicators in any given project's feasibility study hides many complex details, including all items throughout the earlier steps until the final study. Typically, the main focus is not only on the final result itself, but significant attention is also given to the original sources of costs and revenues and the unusual circumstances associated with the performance of the project.

It is useful in this area, and as an integral chain, to take some examples (just for illustrating the main parts of cash flow) of selected petroleum projects, particularly cases include general inputs and the main results of cash flows derived from long and complex stages related to market, technical, and financial studies reaching the following briefs.

2 .Upstream Projects:

In general, feasibility studies of upstream projects are more complex and often take a long time and require high experience. The main emphasis is on the quantities and qualities of oil and gas reserves,

extracting abilities, potential production rates, time scheduling, investments requirements, and operating costs. More attention is also given to the future values of oil and gas reserves and profitability indicators. Any expected risks associated over the life of project are considered with a high degree of accuracy. Table (5) shows an example of a production sharing contract (from Oil Company's viewpoint).

Table (5)

Production Sharing Contract: Simple Example

	2011	2012	2013	2014	2015	2016	Total
INPUT ($MM)							
Oil Production (MMBbl)			10	10	10	10	40
Oil Price ($/Bbl)			30	30	30	30	
Revenue			300	300	300	300	1200
Operating Cost -			10	10	10	10	40
Exploration Capital -	50						50
Development Capital -		250					250
Calculations ($MM)							
Royalty			30	30	30	30	120
Eligible Cost Recovery			310	10	10	10	
CR Carry foreword Used				70			
Adjusted Cost Recovery			310	80	10	10	
Cost Recovery Ceiling			240	240	240	240	
CR Carry Foreword			70				
Cost Recovery Taken +			240	80	10	10	340
Profit Oil to be Shared			30	190	260	260	740
Profit Oil +			18	114	156	156	444
Net Cash Flow	-50	-250	248	184	156	156	444

Source: IHS, ENERGY.

Note: Under assumptions of 60% Profit Share, 80% Cost Recovery Ceiling, and 10% Royalty.

3. Gas Projects:

The logic of the work in gas processing plants is almost the same as the work in refining projects, but the main focus is given to the feed gas of the plant, products of processed gas, buyers' obligations, and some other related issues.

4. Pipeline Projects:

The main elements for the pipeline projects that are considered within the economic feasibility study are; the investment needs to establish the pipeline, operating costs, and the sources of revenue such as tariffs or any form of returns related to the running of oil, gas and products pipelines.

5. Refining Projects:

Concerning refining projects is different in terms of operations, area and technology, their plants and activities that related to the refining of crude oil are on the ground. The main focus in this context is on the investments, projections of crude oil and product prices, operating costs and product markets and technological developments. Parts of Table (6) give some details about some items in an economic feasibility study of a particular refinery project (in US 2002

Table (6)

Selected Calculations from Refinery Project

A: Capital Costs

Engineering $	5,266,800
Site Facilities	21,824,000
Process Units:	
Crude Unit	6,482,000
Naphtha HDS	5,100,000
Reformer	14,700,000
Unicracker	13,800,000
Sour Gas/Sulfur Treating	1,700,000
Other Infrastructure	1,603,000
Contingency	10,571,370
Total Fixed Capital Cost	81,047,170
Working Capital	5,662,333
Total Project Capital $	86,709,503

B: Crude Oil Price

Base Crude $/bbl	26.33
Competitive $/bbl	-
Crude Cost $/bbl 26.33 - 32.81	26.33
Cost per Day $/d	158

C: Daily Operating Costs

Natural Gas $	12,254
Electricity	2,179
Water	170
Chemicals	7,144
Royalties	375
Labor	7,870
Maintenance Supplies	800
Total $	30,792

D: Value of Products $/day

	Bbl/dy	Gal/dy	$/Gal	$/dy
Gasoline	3600	151200	1.03	156,184
Kerosene	470	19740	1.08	21,384
Diesel	1900	79800	0.95	75,633
Oil	12	493.5	0.71	351
Total $				253,552

E: Main Results

Capital Investment	**86,709,503**
Value of Products	**87,475,343**
Cost of Crude Oil Feed	**(54,493,440)**
Operating Expense	**(10,623,391)**
Depreciation	**(5,065,448)**
Net Profit	**17,293,064**
Return on Investment	**20%**

Source: John D., & P.E.

Conclusions:

1-Developments in the world economy and business life have made petroleum projects more complex and very sensitive to changing conditions, especially to the markets, prices, and advanced technologies.

2-Many developments should be considered for any modern economic feasibility study, and to make that possible, many issues are required; new mathematical and statistical and financial skills, modern software programs, experience in preparing detailed feasibility studies,

experience in legal issues, as well as capabilities in the forecasting of future technical and non-technical developments in the petroleum industry.

3-Gathering theoretical considera-tions, practical experience, and technological developments is the cornerstone in conducting a complete economic feasibility study of petroleum projects.

4-Increasing the details of feasibility topics such as (financing, contracting, negotiating, procure-ments, supply multiline, environm-ental issues….) made the process of feasibility study more difficult and complex, so it needs more time and more fund, as well as the international consultants/offices advices to achieve a completed study especially for the large and extensive petroleum projects.

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