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Capital Budgeting in the National Iranian Petrochemical Company Using the Markowitz Model

Hassan Heidari *[1], Azam Soleimani [2]

[1] Department of Financial Management, Science and Research Branch Islamic Azad University, Tehran, Iran
[2] Department of Accounting, Share Rey Branch Islamic Azad University, Tehran, Iran

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ABSTRACT

This paper addresses the capital budgeting efficiency in the National Iranian Petrochemical Company (NPC) from 2007 through to 2011. The proposed target function optimally minimizes the investment risk of the existing assets in portfolio, risk of project completion time, and risk of project non-execution, while it optimizes the allocated budge to each project and maximizes return on investment (ROI) of the present assets in portfolio. The model assumes that total share of the invested assets in the portfolio is always equal to 1, and the constraint $Xj \geq 0$ makes sure that share of each asset in portfolio is not negative which in our case it concerns the share of each project from the total budget, project completion time, etc. For prioritization of the goals in the target function, analytic hierarchy process (AHP) techniques are employed which involve economic, technical, and resource sustainability modeled as a linear programming problem. This problem is solved using the technique applied in the Markowitz model. The results indicate significant deviations (risks) of the actually allocated budgets from the optimum resource allocation level.

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1. Introduction

With tremendous technological advances in improvement of production methods, business units annually invest enormous sums on installations, machineries, equipment, environment protection, and other new assets. Unlike current assets, long-term assets which are referred to as capital assets are used for multiple periods in the physical production process of goods and services. "Capital Budgeting Process" is applied to get insight into the company actual resource allocation system compared to an optimum and efficient resource allocation model, and to show funds flow control and planning mechanisms. Capital budgeting is the company actual planning process of fixed assets investment and funding. That is to say, the decision making process adopted by a company for purchase of fixed assets such as building, machinery, and equipment. Capital investment, in addition, involves decision making on investment in other companies either by purchase of ordinary shares or investment in certain assets which entitle the company to exercise direct supervision on current activities of the investees (Vakili Fard, 2009: 328). These investments are of a nature that after effectuation may affect company profitability for several years. From the perspective of financial management, capital budgeting is the selection process of a set of long term investment projects the execution of which is expected to maximize shareholders' wealth.

Capital budgeting is generally a two-dimensional process which begins with project start-up cash expenditures and continues with company cash flows throughout the project lifetime. To achieve the highest possible return on investment, the projects with a real economic and financial justification are selected and executed.

In response to the growing dissatisfaction in academic and business circles with the current practices in capital budgeting and resource allocation, there has been a move toward trial of other approaches to this issue. This research by applying the Markowitz model to capital budgeting in one of the major state-owned enterprises (i.e. NPC) with a wide range of activities as a case study, while tries to promote the understanding round the issue of capital budgeting through comparison of the current state of capital budgeting in the mentioned organization with the optimum level, seeks for an efficient method of capital budgeting and resource allocation in this company which may serve similar purposes in other organizations.

2. Theoretical backgrounds

2.1 Capital budgeting

Capital budgeting is one of the most crucial decisions made by financial management in a company. Capital budgeting decision making seriously affects all the organizational units, including production, sales and marketing. Therefore, all managers regardless of their area of responsibility need to be informed about the made decisions on capital budgeting. Capital budgeting is the process of identification, evaluation, planning, and financial support of major investment projects in organizational units. Made decisions on capital budgeting to a great extent affect organization success in achieving the set goals. Hence, capital budgeting plays a major role in the long-term success of the units. Many studies on capital budgeting signify a gap between the theory and practice. The customary evaluation methods of investment projects such as net present value (NPV) and internal rate of return (IRR) methods do not allow for managerial flexibility when

* Corresponding author.
Email address: hassan.heidari1981@gmail.com

it comes to adjust their decisions in accordance with market developments. The discounted cash flow (DCF) techniques assume once an investment project has been approved, it shall be preserved until the end of its useful life, ignoring the changing economic condition and the investment under uncertainty. In such condition, in the course of time, management expectations will undergo revision and upon entry of new information part of the initial uncertainty regarding the market condition will be removed. Therefore, to cope with the new condition, management tends to reconsider and modify its earlier decisions (Fadayeenejad, 2007: 27). Some other researchers in 1980s criticized the DCF techniques for ignoring the strategic condition. These methods are described by some authors as incorrect evaluation methods because they neglect managerial flexibility. Terry Jerjis and Misen (1987) proposed the Monte Carlo (simulation) Method and AHP technique as a solution, since these methods allowed for analysis of various decisions based on future events. The authors described managerial flexibility as the management ability to change their earlier decision in regard to an investment project. Managerial flexibility in the new capital budgeting literature is known as the real options for investment in capital assets. Kester and Myers (1984) suggest in order to fully capture the underlying capital asset value, capital budgeting should reckon with the investment options as part of the decision making process.

In sum, a multiplicity of solutions are proposed in capital budgeting, including the Game Theory, Simulation, Data Mining, and Analytic Hierarchy Process (AHP) of which AHP technique is treated in this study.

2.2 Analytic hierarchy process (AHP)

It has been now for several years that multi-factor decision making methods take a special place in the science of decision making in which choice of a solution from among a number of available solutions is the subject of analysis, and of these methods AHP has been the most frequently applied method in management science. AHP is a well known multipurpose technique which was first in 1970s invented by the Iraqi born Al Saati. AHP reflects human pattern of natural behavior and thought. This technique investigates complex problems based on their mutual effects and transforms them into simple forms and then solves them (Mehrgan, 2004: 176). This technique can be used where decision is to be made on several competing options and criteria. The criteria in question can be either quantitative or qualitative. This decision making technique is based on pairwise comparison. Decision maker begins his work with preparing the decision tree. The decision tree represents factors and competing options subject to comparison and evaluation. In fine, AHP logic combines the obtained matrices from pairwise comparisons in a way that the optimum decision is achieved. In other words, in evaluation of each subject, we need a measurement criterion or index. The choice of the right index allows us to correctly compare the alternatives. But when several or more criteria are designated for the measurement, the evaluation process becomes complicated and this complicacy escalates when the multiple criteria are of different types. In these cases, the evaluation process and comparison exceeds the simple analytical situation which our mind normally can manage so that a strongly practical analytic tool will be needed. One of the powerful tools for such situations is the AHP technique. This method is basically used for the purpose of grading and rating, but at times it is applied to social and economic issues as well. In this method, before anything, the data of each place have to be standardized (Ghodsipour, 2002: 6).

2.3 Portfolio Optimization Theory

The modern portfolio theory was proposed in 1990 by the famous economist of the Chicago School, Harry Markowitz, the Nobel Prize winner in Economics. In this theory, Harry Markowitz develops a method for choice of the best and the most efficient investment combination by the investor. His technique helps the investor at diverse investment prices to choose the combination or portfolio which involves the least risk relative to all the other portfolios with the same economic value, or gives the highest economic rate of return compared to all the other portfolios with the same risk. This theory which was first used in the share trading markets allowed the investor to obtain a diversified portfolio of shares with highest efficiency. The Portfolio Theory mathematically is expressed in the following relation:

$$E\left(r_p^t\right) = \frac{1}{v_0^t}\sum_{i=1}^{n} E\left(r_p^t\right) X_j^t P_i^t$$

Where, $E\left(r_p^t\right)$ is the portfolio total expected rate of return at time t (t = 1, 2… T), v_0^t is the portfolio total value at time t, X_i^t number of shares for asset *i (i = 1, 2… n)* at market price P_i^t, and $E\left(r_i^t\right)$ expected rate of return per asset.

And variance of the asset portfolio is calculated as follows:

$$\sigma_p^2 = \frac{1}{v_0^t}\sum_{i=1}^{n}\sum_{j=1}^{n} X_j^t P_j^t \sigma_{ij}$$

Where, σ_{ij} indicates covariance of each pair of assets.

And optimization of the asset portfolio in the Markowitz model is formulated as follows:

$$Max.\left(\frac{1}{v_0^t}\sum_{i=1}^{n} E\left(r_p^t\right) X_j^t P_i^t\right)$$

$$St: \sum_{i=1}^{n} X_i^t P_i^t = v_0^t$$

or

$$Min\left[\frac{1}{v_0^t}\sum_{i=1}^{n} E\left(r_p^t\right) X_j^t P_i^t\right]$$

$$St: \frac{1}{v_0^t}\sum_{i=1}^{n} X_i^t P_i^t r_i^t \geq r$$

In which, r is the minimum expected rate of return.

Strategic investment decision makings for the most part involve risk and uncertainty while at the same time they create long-term liabilities for the investor. Therefore, the resolution and willingness of the company to take a decision with an appropriate risk level plays an essential role in the process of strategic investment decision.

3. Research background

Jafari Samimi and Dehghani (2007) using Markowitz optimization method and the Preference Theory addressed one of the most important challenges of the Ministry of Petroleum in recent years, that is optimum allocation of natural gas to various options including gas export, petrochemicals with natural gas feeding, and gas injection to oil fields. This was done based on technical and economic characteristics of each group of projects by calculation of its expected net present value and standard deviation as the risk indicator and finally by formation of efficient asset portfolios. On the other hand, the risk analysis for the investor (Ministry of Petroleum) in different scenarios gives different outcomes as the optimum combinations of natural gas allocation. The obtained results indicate that both in terms of mean expected present value and risk, the projects of gas export, gas injection, and petrochemical operation, respectively, are the best investment choices. In choice of the asset portfolios based on efficiency, if the lower risk is a decisive factor, the weighted ratio of the allocated gas to export is smaller than the case where higher risk together with higher return is the decision criterion, in which the weighted ratio of gas injection and petrochemicals simultaneously decreases with an increase in risk and expected value of the asset portfolio.

Emamifar (2006) investigates application extent of capital budgeting techniques and the barriers in the way of their application among financial managers and executives of electronic firms. The findings indicate low application level of capital budgeting techniques in the understudy companies, but Capital Cost Recovery method is widely used by them. The findings further indicate significant relationship of academic ranks of managers and investment value with application extent of these techniques. In addition, it is found that the more familiar the executives are with these techniques, the more likely they are to apply them. In general, it is concluded that technical, structural and environmental barriers, respectively, are the main reasons for the low application level of capital budgeting techniques in these companies.
Tom Adams and Jeff Lund (2000) in a research on the American oil companies demonstrated a change in the objectives of capital budgeting in these companies from cost control to investment diversification. Their findings suggest that use of capital management is an inevitable response to the risk diverse environment.

Walls (2004) by illustration of the asset portfolio management techniques and the preference theory argues that the mere reliance on these techniques does not provide an oil and gas company with adequate means for decision making when faced with new investment opportunities. In addition to knowledge of risk and economic value of investment opportunities, the company needs to know its domain-specific risk-taking scale. For this purpose, he introduces utility functions and the calculation way of domain-specific risk-taking scale.

The results of the study by Walls and Dayer (1996) on risk behavior of the American oil and gas companies indicated that these companies were highly risk averse and their financial risk-taking scale strongly affected their performance. In another study on 50 American oil and gas companies, including Exxon, Conoco, Philips, and Amoco, and their operation during 1981-2002, Walls (2005) measures their risk-taking scale and examines the relationship of the firm risk-taking scale with the firm size. The results of this study confirm the hypothesis suggesting a direct relationship between the firm size and its risk-taking scale.

The study of Marcel and Rodriguez (2005) on application of asset portfolio management in oil and gas companies and its eventual consequences indicate that some of the oil industry requirements especially under the sates governance may render this application inefficient. To minimize the probability of such inefficiency in practice, the quantified objectives need to be derived from the context of the oil industry macro planning strategy and any possible conflict between the quantified objectives ought to be identified. Hence, it is argued that efficiency of asset portfolio management does not necessarily imply introduction of one optimum asset portfolio. Therefore, in such condition, it is suggested in place of looking for one optimum asset portfolio, it should be looked for an optimum outlook which may contain several optimum asset portfolios.

Stephan (2003) gives a full detail of capital budgeting of the public companies in Sweden. In this study, the required information was gathered from a questionnaire sent to 528 companies majority of which were the stock exchange listed companies. Of the communicated companies, 24.4% filled and returned the questionnaire. The obtained information from the questionnaire revealed that the beneficiaries in the public sector mostly prefer use of discounted cash flow methods, and the capital cost recovery method was used in all industries of this sector. Lately, there was a growing interest in the firm present value calculation methods. In addition, the management value-based models were introduced for the listed firms. The findings also signified high importance of the tradition and old financial customs in choice of budgeting methods. Use of discounted rate of cash inflows by manufacturing firms was by far more common than other companies. It seemed the companies were not much concerned about tax effect on capital budgeting decisions.

4. Research questions

1. Considering the varying investment situations in different projects with the assigned budget, what is the optimum investment combination?
2. How much are the deviations (risks) from the estimated project completion time and how much budget the projects get allocated?
3. How much shall the firm nominal production capacity increase or decrease relative to its real production capacity?
4. How much are the deviations from the firm estimated sales, cost price, and operating profit?

5. Methodology

Statistical population and sample

Statistical population of the present research includes all the subsidiary companies of the NPC with an operation record in the period 2007 – 2011. Considering that each subsidiary has its own projects and products, the range of products and projects differs from one company to another, hence from among the subsidiary companies the data of "Mobin Petrochemical Company" for the respective 5-year period is considered as the statistical sample. The rationale behind this choice was the availability of the actual information on the company capital budget allocation and production volumes.

Type of research

Since this research is focused on one subsidiary of the NPC, it is best characterized as a case study. Case study as one of the research strategies, in social sciences, especially in researches at small scales is rapidly gaining popularity. The purpose of case study is bridging the gap between theoretical laws and principles and knowledge of real life in order that scientific theories are not held behind the university walls (Russell, 1996: 30).

Tools and methods

In this study, at the hand of the Markowitz model we try to answer the research questions. Since in this model the efficient asset portfolio is obtained by combination of diverse assets with different risks, both quantitative and qualitative measures are required for which analytic hierarchy process is utilized. In addition, following our meeting with the Budget Planning Management of the NPC, the environmental, production and economic issues were found to have the strongest effect on the amount and mode of budget allocation to various projects. The decision making indicators (criteria) based on which different options are compared with each other are technology, value added, nominal production and profit of the projects. Diagram 1 presents decision hierarchy in regard to capital budgeting. In the following tables, evaluation of indicators relative to each other, pair wise comparison matrix of indicators (criteria), and their relative weights are briefly presented.

Diagram 1. AHP tree diagram

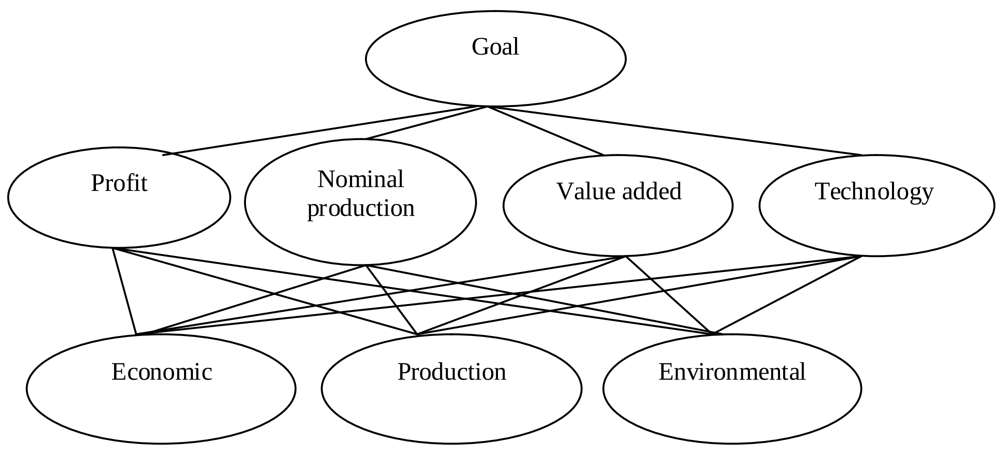

Table 1. Evaluation of indicators (criteria) relative to each other

Preferential value	Indicator *i* relative to indicator *j*	Description
1	equally important	Options *i* and *j* are equally important or have no advantage over each other
3	relatively more important	Option *i* has a slight advantage over option *j*
5	more important	Option *i* has advantage over option *j*
7	much more important	Option *i* has a significant advantage over option *j*
9	absolutely important	Option *i* has an absolute advantage over option *j*
2, 4, 6 and 8		Indicate intermediary values. For instance, 8 is more important than 7 and less important than 9

Table 2. Pairwise Comparison Matrix and relative weight of criteria

	Technology	Value added	Nominal production	Profit	Weight
Technology	1	3	2	2	0.398
Value added	1.3	1	1.4	1.4	0.085
Nominal production	1.2	4	1	1.2	0.218
Profit	1.2	4	2	1	0.299

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Table 3. Pairwise Comparison Matrix and relative weight of options relative to nominal production

	Environmental	Economic	Production	Weight
Environmental	1	2	8	0.593
Economic	1.2	1	6	0.341
Production	1.8	1.6	1	0.066

Table 4. Pairwise Comparison Matrix and relative weight of options to technology

	Environmental	Economic	Production	Weight
Environmental	1	1.3	1.4	0.123
Economic	3	1	1.2	0.320
Production	4	2	1	0.557

Table 5. Pairwise Comparison Matrix and relative weight of options to value added

	Environmental	Economic	Production	Weight
Environmental	1	1.4	1.6	0.087
Economic	4	1	1.3	0.274
Production	6	3	1	0.639

Table 6. Pairwise Comparison Matrix and relative weight of options to profit

	Environmental	Economic	Production	Weight
Environmental	1	4	4	.265
Economic	3	1	7	.655
Production	1.4	1.7	1	.080

Table 7. Final prioritization of options

option	Preference	Weight	Calculations
Economic	1	.421	.398*.320+.085*.274+.218*.341+.299*.655=.421
Production	2	.314	.398*0.557+.085*.639+.218*.066+.299*.080=.314
Environmental	3	.265	.398*.123+.085*.087+.218*.593+.299*.265=.265

6. Modeling and its results

In the following, we solve the target function of Mobin Petrochemical Company, given the potential production and investment projects (see table 8). First, the following points have been observed in the process of the model development and solution:

A. As was seen, from among the three economic, production and environmental options, economic option was of higher importance for the company finance and budgeting management. According to Pareto Principle, economic and production issues account for 80 percent of the importance and priority attached to a subject of budgeting. In this study too, economic and production issues are the first and second priorities, respectively.

B. In the target function, risk (deviation) minimization is considered for the rial amount of the allocated budget.
C. In regard to project completion time, only minimization of positive deviations is provided for.
D. For the deviations from nominal production capacity, production volumes below nominal capacity are considered.
E. For the deviations from the cost price, positive deviations (i.e. the cost prices higher than the estimated ones) are taken into account.
The target function is formulated as follows:

$$Min \sum_{i=1}^{5} W_i(d_i^+ + d_i^-) + \sum_{j=6}^{9} W_j(d_j^-) + \sum_{k=9}^{9} W_k(d_k^-) + \sum_{l=10}^{10} W_l(d_l^+) + \sum_{n=11}^{11} W_n(d_n^-) + \sum_{m=12}^{16} W_m(d_m^-)$$

$$Min\ d_1^+ + d_1^- + d_2^+ + d_2^- + d_3^+ + d_3^- + d_4^+ + d^-_4 + d_5^+ + d_5^- + d^-_6 + d_7^- + d^-_8 + d_9^- + d_{10}^- + d^-_{11} + d_{12}^+ + d^+_{13} + d_{14}^+ + d^+_{15} + d_{16}^+$$

Table 8. Decision variables, deviations (risk), and constraints

Description		Variable	Positive deviations	Negative deviations	Measurement unit	Constraint
Development of the Air Isolation Unit and compressed air production		X_1	d_1^+	d_1^-	Million rial	$X_1 - d_1^+ + d_1^- = 1500000$
Purchase of two sets of GTG turbines – Power and Steam Expansion project		X_2	d_2^+	d_2^-	Million rial	$X_2 – d_2^+ + d_2^- = 1600000$
Setting up two DCSs of 132KW		X_3	d_3^+	d_3^-	Million rial	$X_3 – d_3^+ + d_3^- = 350000$
Execution of Waste Water Refinery and Waste Furnace Unit		X_4	d_4^+	d_4^-	Million rial	$X_4 – d_4^+ + d_4^- = 20000$
Construction of administration building		X_5	d_5^+	d_5^-	Million rial	$X_5 – d_5^+ + d_5^- = 40000$
Oxygen production		X_6	d_6^+	d_6^-	Million m^3	$X_6 - d_6^+ + d_6^- = 1240$
Steam production		X_7	d_7^+	d_7^-	Million ton	$X_7 - d_7^+ + d_7^- = 9$
Sweet water production		X_8	d_8^+	d_8^-	Million m^3	$X_8 - d_8^+ + d_8^- = 3$
Sales of products	Oxygen	X_9	d_9^+	d_9^-	Million rial	$X_9 + X_{10} + X_{11} + d_9^- - d_9^+ = 1390300$ X9 = 640 * X 6 X10 = 58300 * X 7 X11 = 16100 * X 8
	Steam	X_{10}	d_9^+	d_9^-	Million rial	
	sweet water	X_{11}	d_9^+	d_9^-	Million rial	
Cost price	Oxygen	X_{12}	d_{10}^+	d_{10}^-	Million rial	$X_{12} + X_{13} + X_{14} + d_{10}^- - d_{10}^+ = 1320800$ $X_{12} = 580 * X_6$ $X_{13} = 58120 * X_7$ $X_{14} = 13840 * X_8$
	Steam	X_{13}	d_{10}^+	d_{10}^-	Million rial	
	sweet water	X_{14}	d_{10}^+	d_{10}^-	Million rial	
Operating profit	Oxygen	X_{15}	d_{11}^+	d_{11}^-	Million rial	$X_{15} + X_{16} + X_{17} + d_{11}^- - d_{11}^+ = 69500$
	Steam	X_{16}	d_{11}^+	d_{11}^-	Million rial	
	sweet water	X_{17}	d_{11}^+	d_{11}^-	Million rial	
Project 1 completion time		X_{18}	d_{12}^+	d_{12}^-	Months	$X_{15} + X_{16} + X_{17} + d_{11}$
Project 2 completion time		X_{19}	d_{13}^+	d_{13}^-	Months	$X_{15} + X_{16} + X_{17} + d_{11}$
Project 3 completion time		X_{20}	d_{14}^+	d_{14}^-	Months	$X_{15} + X_{16} + X_{17} + d_{11}$
Project 4 completion time		X_{21}	d_{15}^+	d_{15}^-	Months	$X_{21} – d_{15}^+ + d_{15}^- = 18$
Project 5 completion time		X_{22}	d_{16}^+	d_{16}^-	Months	$X_{22} – d_{16}^+ + d_{16}^- = 64$

Model assumptions

- An identical weight is considered for all deviations;
- The allocated budget is determined beforehand, and the company has to assign it to some project the execution of which at times due to prolongation of the project time may have no economic justification;
- The risk which exists in these projects is the very deviation from their estimated completion time which in some cases multiplies execution cost of each project.

LINGO outputs of the model solution are provided in table 9. In this table, the proposed optimum model is proposed in a way that the deviations (risks) are minimized. For example, to reduce the deviations, completion time of projects 1 to 5 needs to be reduced according to column 3 of this table. Thus, the lengthy completion time of the projects casts doubt on optimality of the current course of capital budgeting in this company.

Table 9. An overview of the obtained results from the model solution

Optimum amount	Actual amount	Constraint
1587500	1500000	Budget of project 1 (million rial)
1720000	1600000	Budget of project 2 (million rial)
362150	35000	Budget of project 3 (million rial)
20780	20000	Budget of project 4 (million rial)
41900	40000	Budget of project 5 (million rial)
1320	1240	Oxygen production (million m^3)
9.6	9	Steam production (million ton)
3.3	3	Sweet water production (million m^3)
1603100	1390300	Sales of products (million rial)
1480800	1320800	Cost price (million rial)
80400	69500	Operating profit (million rial)
26	30	Project 1 completion time (months)
39	42	Project 2 completion time (months)
58	58	Project 3 completion time (months)
17	18	Project 4 completion time (months)
64	64	Project 5 completion time (months)

7. Conclusion

A variety of factors contributes to formation and revision of capital budgeting of a business unit, including its organizational structure, attitude, the extent to which principles of organization is applied by the firm, firm size, nature of its operation, and characteristics of all the individual projects. An investment plan gives the best results only when the most efficient set of projects are chosen from among the potential projects at hand after having been thoroughly evaluated by right methods and rational procedures. In this study, capital budgeting by no means guarantees commitment of the allocated funds to the intended projects, instead, it serves to combine all projects as an integrated whole which will be considered and assessed next and in relation to each other. Thus, annual budget of capital expenditures should correspond with the firm long term investment and operational objectives and plans. In the NPC, there is an increase in the annual budget allocated to each company relative to the year before, for this increase, such factors as the company growth and expansion of profitable projects are taken into account. However, in practice, deviations from budget are not calculated, and in many cases, it is seen that the budget of one project is replaced to another project. As a result, execution of a project which is expected to be accomplished within a limited and specified timeframe lasts for several financial periods and due to such inordinate length of time and increase of execution costs the project practically loses its economic justification.

In this study, for choice of the projects and the right way of their execution, estimation of their costs and duration and reduction of the associated risks to project execution cost and duration, the Markowitz model which gives efficient set of projects with minimum risk (deviation) was used. The obtained results from this model indicated significant deviations (risks) from optimum method of resource allocation. The model outcomes for the projects of the sample company (Mobin Petrochemical Company) are summarized and interpreted as follows:

1. *Amount of allocated budget to projects*: all the deviations (risks) associated to the constraints (the first five constraints of the solved model) are positive so the company requires allocating more funds to these projects in order to achieve its objectives. Among the causes of deviations, it can be referred to failed financing efforts especially in receiving bank credits which further amplifies the fluctuations in this respect.
2. *Company products*: Mobin Petrochemical Company as a powerful economic producer needs to increase its products up to the nominal capacity. Also the optimum model suggests an increase in nominal capacity of the company. In doing so, higher revenues and operating profit can be realized.
3. *Sales, Cost and profit of products*: considering the relation of production, sales and profit, in the current state of budgeting, the company does not produce at its nominal capacity and shows significant deviations in its production lines and for this reason, deviation is seen in its sales, cost price and operating profit constraints.
4. *Project expiration and completion time*: one of the striking results of this study is the significant positive deviations beyond the project scheduled timeframe. By not timely finishing the projects and prolongation of their execution which at times may last for several financial periods, the company incurs heavy and economically unjustifiable costs.

8. Suggestions

Suggestions derived from the research findings

1. To reduce project completion time, close supervision, both financially and in terms of time, is required. For this purpose, completion stages should be subjected to monthly or quarterly control and inspection, while it is made sure that budget of one project is not replaced to and used for another project.
2. Before any budget allocation, the necessary overall feasibility studies are required. And before execution of projects, in choice and prioritization of potential projects, the criteria and options discussed earlier in this study can be of great service.

Suggestions for future research works

1. Study of qualitative and credit risk in the petrochemical industry in view of the Markowitz Model: how different risks such as qualitative risk and credit risk can be approached to by the Markowitz model?
2. Study of economic stability at macro level and financial rating of the petrochemical industry for receiving international credit in view of Markowitz model: How such issues as macro-level economic stability and financial rating for receiving international credits can be incorporated into the Markowitz model?
3. Considering that in this model profit is considered as one of the key constraints and a critical indicator, in study of capital budgeting in the NPC using Markowitz model, it is suggested export of petrochemical products and its associated constraints to be addressed in the model.

References

[1] Amiri, Maghsoud (2010), “Share Portfolio Optimization using Anti Ideal Compromise Programming”, Research and Scientific Quarterly of Industrial Management Studies, year 6, No.15, Winter 2010, pp. 143-165
[2] Fadaeenejad, Mohammad Esmaeel (2007), “Principles of Capital Budgeting”, SAMT Publications
[3] Hampton, John et al (2010), “Financial Management”, Vol. 1, Translation by Hamidreza Vakili Fard and Masoud Vakili Fard, Tehran, Jangal and Foaj Scientific Publications
[4] Jahankhani, Ali and Parsaeeiyan, Ali (2005), “Financial Management”, Vol. 2, 9th edition, SAMT Publications
[5] Mehrgan, Mohammad Reza (2004), “Advanced Operational Research”, Academic Book Bublications
[6] Mehrgan, Mohammad Reza, (2007), “Mathematical Modeling”, Faculty of Management, Tehran University
[7] Planning and Development Management of the National Petrochemical Company (2006), Report of the World Petrochemical Industries
[8] Raee, Reza and Ahmad, Talangi (2010), “Advanced Investment Management”, SAMT Publications

[9] Sadeghiyan, Salehi, Jamshidi, Amiri, Maghsoud, Taghavifar, Mohammad Taghi and Razavi, Seiyed Hossein (2008), “Combined Data Envelopment Analysis (DEA) and Analytic Hierarchy Process (AHP) Approach to Ranking of Efficient Units in Provincial Commercial Organizations”, Quarterly of Management Science, Tehran University, Period 21, No. 81, pp.75-90
[10] Saeedi, Parviz (2005), “Budget and Budgeting”, 1st edition, Negah-e-Danesh Publications
[11] Samimi, Jafari and Ahmad, Dehghani Touraj (2007), “Application of Dynamic Model to Income Optimization of Iran’s Gas Reserves”, Quarterly Journal of Iranian Economy, year 9, No.30, pp. 189-190
[12] Seddighi, Amir Abbas and Gomar, Pouran (1997), “Energy Planning in Developing Countries”, SAMR Publication Center
[13] Tehrani, Reza and Sirie, Alireza (2009), “Application of Efficient Investment Model using Mean – Half Variance Analysis (Markowitz Model)”, Quarterly Journal of the Stock Exchange, year 2, No.6, pp.137-155