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Different criteria by Using Engineering Economy techniques For Best Project Selection in one of the sector of telecommunication in Iran

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Abstract— Selecting projects are an important problem, yet often difficult task. It is complicated because there is usually more than one dimension for measuring the impact of each project and especially when there is more than one decision maker. This paper considers a real application of project selection for Telecommunication projects with using the opinion of experts by one of the group decision making model, it is called TOPSIS method. There are four kinds of criteria that they are include qualitative, quantitative, negative and positive criteria have been considered and also one of them is engineering economy techniques that are included Net Present Value, Benefit-Cost Analysis, Rate of Return and Payback Period for selecting the best one amongst five projects and ranking them. By using AHP we found the weights of each engineering economy techniques out of 0.61 that we had defined before.[1, 6] We have also used from six expert's opinion in Cable Network in Iran. Finally the introduced method is used in a case study (Telecommunication sector of Iran) and extracted results from it are analyzed from different points of view. [1]

Index Terms— **project selection, Decision making, MCDM (Multi Criteria Decision Making), Group TOPSIS Method, Engineering Economy techniques, NPV (Net Present Value), B/C (Benefit-Cost Analysis), ROR (Rate of Return), PP (Payback Period).**

V. Introduction

A project is a temporary endeavor undertaken to create a unique product, service or result. Temporary means that every project has a definite end. The end is reached when the project's objectives has been achieved, or it becomes clear that the project objectives will not or cannot be met, or the need for the project no longer exists and the project is terminated. Temporary does not necessarily mean short in duration, many projects last for several years. In every case, however, the duration of a project is finite. Projects are not ongoing efforts. Selection of project among a set of possible alternatives is a difficult task that decision maker (DM) has to face.[2] Project selection and project evaluation involve decisions that are critical to the profitability, growth and survival of project management organizations in the increasingly competitive global scenario. Such decisions are often complex, because they require identification, consideration and analysis of many tangible and intangible factors.

Hwong & Yoon describe multiple decisions making as follows:

Multiple decisions making is applied to preferable decisions (such as assessment, making priority and choice) between available classified alternatives by multiple attribute (and usually opposite). [3] People generally use one of two following methods for making decision:

1- Trial & Error method and modeling method

2- Modeling method

In trial & error method decision maker face the reality so he chooses one of alternatives and witness the results. If decision errors are great and cause some problems, he changes the decision and selects other alternative.

In modeling method decision maker models the real problem and specifies elements and their effect on each other and get through model analysis and prediction of real problem [4].

Many mathematical programming models have been developed to address project-selection problems. However, in recent years, multi-criteria decision making (MCDM) methods have gained considerable acceptance for judging different proposals. The objective of Mohanty's study was to integrate the multidimensional issues in an MCDM framework that may help decision makers to develop insights and make decisions. [5] Another research used fuzzy AHP and TOPSIS technique (without qualitative criteria) to presented a method for project selection problem. The reviewed four common methods of comparing alternatives investment including net present value, rate of return, benefit cost analysis and payback period to use them as criteria in AHP. They computed weight of each criterion and then assessed the projects by doing TOPSIS algorithm. [6] The location selection maybe simply based on past experience, rudimentary, "gut-feeling", or a combination of them. Alternatively, it may involve scientific methods. They introduced both deterministic and dynamic approaches and present some of the basic quantitative methods, including data envelopment analysis model and binary integer linear program models, serving as a base for both academics and practitioners. [7] An application of the fuzzy ANP along with the fuzzy cost analysis in selecting R&D projects presented by another researcher. They used triangular fuzzy numbers are used for the preferences of one criterion over another then by using a pair wise comparison with the fuzzy set theory, in which weight of each criterion in the format of triangular fuzzy numbers is calculated. [8] A multi objective functions have been considered to maximize the summation of the absolute variation of allotted resource between each successive time periods. [9] Some researchers developed a multi objective model for the problem, which was formulated by goal programming. In that model, the selection of priorities and aspiration levels was performed by using Delphi method. They recommended employing multi objective approach to obtain non-dominated solutions of project selection problems firstly and applying subjective methods like Delphi method next in order to choose among non-dominated solutions. [10] Project selection problem was presented by using a methodology based on the AHP for quantitative and qualitative aspects of a problem, is proposed in another research to assist in measuring the initial viability of industrial projects. He believed that industrial investment company should concentrate its efforts on that development of pre-feasibility studies for a specific number of industrial projects which have a high likelihood of realization. [1], [11]

NET PRESENT VALUE (NPV)

Present Worth is the value found by discounting future cash flows to the present or base time. In a Present Worth comparison of projects, the cost associated with each project investment are transformed to a present sum of money, and the best project has the least of these values. Each cash flows in future must be converted to the present. The process of finding present value (P) is called Discounting and the interest rate used to compute present values is called the Discount Rate (i).

$$P=F\,(1+i)^{-n}$$

It is considered the time value of money, multi-rates of discount and also easy to calculate are some advantages of it. In this method, It is assumed the discount rate will be constant in future, and also can be predict future discount rates are disadvantages of this.

BENEFIT-COST ANALYSIS (B/C)

It is one technique of analyzing proposed or previously enacted projects to determine whether doing them is in the public interest, or to choose between two or more mutually exclusive projects. There are several variations of the B/C ratio, however, the fundamental approach is the same. All cost and benefit estimates must be converted to a common equivalent monetary unit (PW-Present Worth, AW-Annual Worth, FW-Future Worth) at the discount rate (interest rate).

$$B/C = \frac{PW\ of\ benefits}{PW\ of\ costs} = \frac{AW\ of\ benefits}{AW\ of\ costs} = \frac{AF\ of\ benefits}{AF\ of\ costs}$$

The sign convention for B/C analysis is posotive signs.

Benefit-Cost Analysis assigns a monetary value to each input into and each output resulting from a project. The value of the inputs and outputs are then compared. In the most basic sense, if the value of the benefits is greater than the value of the costs, the project is deemed worthwhile and should be executed.

If B/C≥1.0, accept the project as economically acceptable for the estimates and discount rate applied.

If B/C <1.0, the project is not economically acceptable.

If the B/C value is exactly or very near 1.0, noneconomic factors will help make the decision for the **best** alternative. Disbenefits are considered in different ways depending upon the model used. Most commonly, disbenefits are subtracted from benefits and placed in the numerator.

The conventional B/C ratio, probably the most widely used, is calculated as follows:

$$B/C = \frac{benefits - disbenefits}{costs} = \frac{B-D}{C}$$

Benefit-Cost Analysis proceeds in four essential steps:

a) Identification of relevant costs and benefits.

b) Measurement of costs and benefits.

c) Comparison of cost and benefit streams accruing during the lifetime of a project.

d) Project selection. [12, 16]

RATE OF RETURN (ROR):

The internal rate of return (ROR) method of analyzing a major purchase or project allows you to consider the time value of money. Rate of return is the interest rate earned on uncovered project balances such that an investment's cash receipts make the terminal project balance equal to zero. The rate of return is an intuitively familiar and understandable measure of project profitability that many managers prefer to other equivalence measures. Mathematically, we can determine the rate of return for a given project cash flow series by locating an interest rate that equates the net present worth of the project's cash flows to zero. This break-even interest rate is denoted by the symbol i*. To apply rate of return analysis correctly, we need to classify an investment as either simple or non-simple. A simple investment is defined as an investment in which the initial cash flows are negative and only one sign change in the net cash flow occurs, whereas a non-simple investment is an investment for which more than one sign change in the cash flow series occurs. Multiple i*'s occur only in non-simple investments. However, not all non-simple investments will have multiple I*'s. In this regard, The possible presence of multiple i*'s (rate of return) can be predicted by:

- The net cash flow sign test.
- The accumulated cash flow sign test.

For a pure investment, i* is the rate of return that is internal to the project. For a mixed investment, the IRR analysis yields results consistent with other equivalence methods. MARR is often used to describe the interest rate for discounting purposes, because it is the minimum rate of growth that a company will accept from its invested projects. So the decision rule is as follows:

If IRR>MARR, accept the project.

If IRR=MARR, remain indifferent.

If IRR<MARR, reject the project.

In properly selecting among alternative projects by IRR analysis, incremental investment must be used. In creating an incremental investment, we always subtract the lower cost investment from the higher cost one. Basically, you want to know that the extra investment required can be justified on the basis of the extra benefits generated in the future. Unfortunately it has two limitations as follow:

1. It does not help much in ranking projects of differing

sizes or levels of investments.

2. Non-conventional cash flows will produce multiple RORs. [13]

PAYBACK PERIOD (PP)

The Payback method screens projects on the basis of how long it takes for net receipts to equal investment outlays. This calculation can take one of two forms: either ignore time-value-of money considerations or include them. The former case is usually designated the conventional payback method, the latter case the discounted payback method.[14] Probably the simplest measure of the risk involved in a project, and one that is quite popular in industry, is the Payback Period. Mathematically, it is the first period in which the cumulative inflows from a project exceed the cumulative outflows. The term of "payback period" is used because it identifies the first period in which you recover the outflows that generally occur at the beginning of an investment. Managers may often ask, "How long will it take for us to get our money back?"The manager is referring to the payback period, since most investments are characterized by cash outflows near time zero, followed by positive net cash flows for the duration of the project. We can also alleviate one of our concerns about the payback period by including interest in our calculation such that the time value of money is considered. As long as our interest rate is positive and we make an investment at time zero, the payback period with interest will always be greater than or equal to the traditional payback period without interest. [15]

In a general form it has some limitation as follow:

1. It ignores the time value of money,
2. Does not consider all of the project's cash flows, and
3. The accept/reject criterion is arbitrary.

VI. METHODOLOGY

When the contractors want to choose the best project amongst all proposed projects, they need to choose some criteria that they can help to find the best one. Based on proposed methodology, we collected these criteria from 6 expert's opinion like as follow:

1. Resection in degree of contractor (c_1): Each project after completion would be mentioned in the dossier of the contractor. Therefore resection has got a direct relation with the number and size of contract.

2. Contract Period (c_2): It is the maximum time of project should be completed. This period begins from the time of the project hand over to the contractor and continues until the end of project and handing it over the employer. It is negative and quantitative.

3. Project risks (c_3): They are unidentified but probable event which would show off in the form of negative side effects that will affect on the aims of project.

Benefit: Money provided by the government or others to people who are contractors and can perform projects.In this paper, we can compute benefits by four techniques that each of them condiders as a criterion.

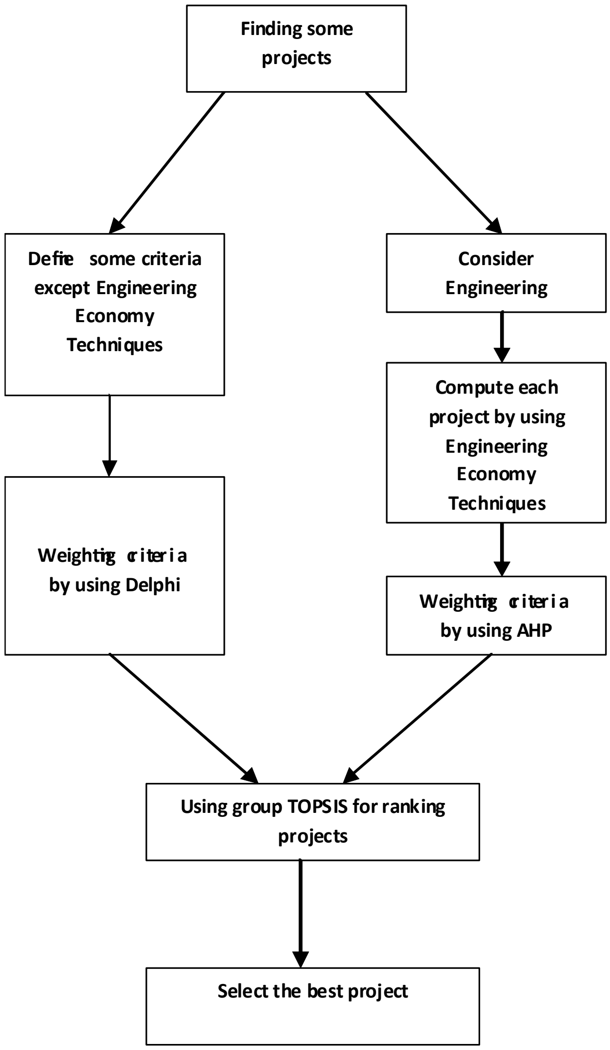
***4. NPV (c_4)*:** Net Present Value.

5. B/C (c_5): Benefit-Cost Analysis.

6.ROR (c_6): Rate Of Return.

7.PP (c_7):Payback Period.

After using Delphi Method, the weights of four criteria will be found. One of criteria (Benefit) is classified to four kinds of criteria as NPV, B/C, ROR and PP. By using AHP we find the weights of them out of 0.61 that we had defined before.[1] Six experts help us about specifying the weights of criteria respect to projects separately. The relative importance values are determined with a scale of 1 to 9, where a score of 1 represents very low between the two elements and a score of 9 indicates the extreme of one element from another. And in the final step the best projects were selected by Topsis Group method. And you can see algorithm of project selection in below figure.



VII. CASE STUDY

This study is illustrated the expansion of optical fiber for Telecommun-ication sector in one part of IRAN. There are five projects with five different routes including the amounts of Soil, Asphalt and Rock excavation and also restoration of excavation path after implementation are as data.

Decision Matrix

	C_1	C_2	C_3	C_4	C_5	C_6	C_7
Project 1	5	7	9	13	1.4	27	2

Project 2	3	8	7	11	1.2	22	2
Project 3	5	10	5	12	1.3	25	3
Project 4	1	8	1	9	1.1	23	5
Project 5	3	6	7	10	1.1	21	4

Now we construct normalized decision matrix:

0.6019	0.3957	0.6286	0.5242	0.5109	0.4808	0.2626
0.3612	0.4522	0.4889	0.4436	0.4379	0.4231	0.2626
0.6019	0.5652	0.3492	0.4839	0.4744	0.4808	0.3939
0.1204	0.4522	0.0698	0.3629	0.4014	0.4423	0.6565
0.3612	0.3391	0.4889	0.4032	0.4014	0.4038	0.5252

By using Delphi method, W_1=0.13, W_2=0.18, W_3=0.08 and W_E=0.61 that the last one has been included:

$$W_E=W_4+W_5+W_6+W_7$$

W_E is the weight of economy techniques so W_4, W_5, W_6 and W_7 are weights of NPW, B/C, RoR and PP techniques respectively. With the same techniques they are found easily as follow:

	ROR	PB	NPV	BC	Weights
ROR	1.00	2.00	1.00	1.00	0.29
PB	0.50	1.00	0.50	0.75	0.16
NPV	1.00	2.00	1.00	2.00	0.34
BC	1.00	1.33	0.50	1.00	0.22
TOTAL	3.50	6.33	3.00	4.75	

Then these weights are computed out of 0.61 that we had found before.[1]

W_4=0.2068, W_5=0.1331, W_6=0.1747, W_7=0.0954

We construct the weighted normalized decision matrix.

By using this table compute amounts of ideal and negative ideal solution:

A* = {.07825, .06105, .00559, 0.10841, 0.06801, 0.08399, 0.06262}

A' = {.01565, .10174, .05029, 0.07505, 0.05344, 0.07055, 0.02505}

The separation measures from the ideal and negative ideal alternative:

S^* = {0.05927, 0.06636, 0.05363, 0.07552, 0.05726}

S^- = {0.07972, 0.04280, 0.07400, 0.06220, 0.05880}

Calculate the relative closeness to the ideal solution C_i^* and Select the option with C_i^* closest to 1.

Score of Each Project

Project 1	0.57358
Project 2	0.39209
Project 3	0.57980
Project 4	0.45164
Project 5	0.50662

Project3>>Project1>>Project5>>Project4>>Project2

VIII. CONCLUSION

In view of the fact that selecting projects is an important problem, yet often difficult task. It is complicated because there is usually more than one dimension for measuring the impact of each project and especially when there is more than one decision maker. There are four kinds of criteria that they are include qualitative, quantitative, negative and positive criteria have been considered and also one of them is engineering economy techniques that are included Net Present Value, Benefit-Cost Analysis, Rate of Return and Payback Period for selecting the best one amongst five projects and ranking them. In this paper the amount of benefit has been computed in four methods by using Engineering Economy Techniques. Finally the best project will be number 3 and it was followed by 1, 5, 4, 2. When these results are compared with another paper that I have pointed in this reference [1] we will find that benefit should be compute by scientific methods like Engineering Economy Techniques not experimental and stochastic methods.

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