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Provide A Model for Project Selection Using Principal Component Analysis (PCA) and Benefit-Cost Ratio (B/C)

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Abstract: *One of the most problematic issues in organizations and large and small companies that face a large number of projects is the selection of projects among the most feasible and economically viable projects. Therefore, evaluation and selection of the project are very important issues that play a significant role in the success and failure of the project. In this paper, a model is presented in which a systematic methodology for evaluating and selecting a project is described, taking into account a series of criteria, as well as specific attention to the economic criterion. The proposed model in this research consists of three parts: 1. Identification of alternatives and criteria. 2. Economic appraisal of projects using the benefit -to-cost ratio (B/C) 3. Selecting the best project using the Principal Component Analysis (PCA).*

Keywords: *Project Selection, Economic Benchmark, Benefit/Cost Ratio Technique (B/C), Principal Component Analysis (PCA)*

INTRODUCTION

Selecting a project means identifying some options to maximize the organization's benefits and allocating limited resources to the organization only within the same projects. Today senior executives around the world are faced with such issues as selecting the most suitable project among the projects under consideration, and how to use the available science and knowledge to predict the failure or failure of the underlying projects, or in other words better projects How to choose how to choose to avoid resource constraints.

The categorization of project selection methods is as follows: 1. Financial methods, such as current value and investment returns, 2. Business-based strategies, 3. Babylon diagrams, with portfolio maps, 4. Different models of five-model scoring, such as multi-criteria models, and two The criterion is based on financial criteria ... He believes that financial methods are more popular among organizations and this popularity is reduced from top to bottom.

Basic Component Analysis (PCA) is a statistical method for defining new variables based on the linear combination of primary variables that can be used to select a project.

In 2017, LaraHawchar and Charbel-PierreElSoueidy and FranckSchoefs have used PCA and extended polynomial chaos for probabilistic scheduling problems. (LaraHawchar et al., 2017)

In 2017, MohammadRafi Malik and BenjaminJ. Isaac and AxelCoussement and PhilipJ. Smith and AlessandroParente used the Principal Component Analysis (PCA) technique with nonlinear regression for chemical reduction. (MohammadRafi Malik et al., 2017)

The project's economic analysis involves comparative and decision-making techniques, and choices among solutions based on favorable monetary or economic conditions. As economic technology grows, economic decision making becomes more difficult and more sensitive. In general, the use of economic assessment techniques is essential, the profit or loss from the quality of the chosen solution depends on the proper use of these techniques. (Osko Nezhad, 2005)

In 2017, Delfina G. Ramos, Pedro M. Arezes, and Paulo Afonso have used the profit-to-profit ratio technique to analyze the effectiveness of preventive measures in musculoskeletal disorders in a hospital. (Delfina et al., 2017)

The main objective of this paper is to provide a systematic evaluation model for selecting the most suitable project in terms of the criteria under assessment. The project selection consists of two parts: 1. Evaluating the projects using the benefit -to-cost ratio (B/C). 2. Selecting the best project using the Principal Components Component Analysis (PCA).

Methods

Ratio of profit to expense method

One of the techniques of the economics of engineering is to compare the economics of projects in terms of the ratio of benefits to expenditures or profits to costs. In addition to conducting an economic review of private investment projects, this methodology is a well-known and well-known method for assessing government projects.

The general formula for the ratio of benefits to expenditures is as follows:

$$B/C = \frac{PW_B}{PW_C} \qquad (1)$$

$$B/C = \frac{EUAB}{EUAC}$$

And if so:

$$B/C \geq 1 \qquad (2)$$

The project is economical if:

$$B/C < 1 \qquad (3)$$

The project or project is uneconomic. (Osko Nezhad, 2005)

Principal Component Analysis (PCA)

Main Component Analysis (PCA) is a statistical method for defining new variables in terms of linear composition of primary variables. New variables are independent of each other and their variance has a downward trend.

In PCA, the goal is to obtain a new axis (a linear combination of variables) that contains the maximum variance of the total data (Max SSt). (Subhash Sharma, 1996)

The relationships that are used in this way are as follows:

$$x^* = x_1 \cos\theta + x_2 \sin\theta \qquad (4)$$

$$pc_1 = x_1 \cos\theta + x_2 \sin\theta \qquad (5)$$

$$pc_2 = x_1 \sin\theta + x_2 \cos\theta \qquad (6)$$

$$ss = \sum_{i=1}^{n} (X_i - \bar{X})^2 \times (n-1) \quad (7)$$

Suggested model

The proposed model for this project is the benefit / cost ratio (B/C) and principal components analysis (PCA), which has three main stages. The first step is to identify the alternatives and criteria for selecting a project: at this stage, alternatives and criteria are determined. The second stage of the economic evaluation of projects using the benefit -to-cost ratio (B/C) method: at this stage, economic factors such as income and expenses, etc., are determined and using the benefit / cost ratio (B/C), the present value of the revenues and expenses is calculated separately for each alternative. Then, for each project, the benefit / cost ratio (B/C) is calculated, and any project that is not an economy is removed from the survey. The third step is to select the best project using the Principal Component Analysis (PCA) method: at this stage, the options are evaluated by this method and then the most appropriate project is determined.
The schematic of the model is also visible in Fig. 1.

Case study (Iran's Selected Company)

Choosing the right project among the alternatives and in line with the criteria that would increase the company's production in a competitive market and result in the development of production is crucial for any manufacturing company, including the selected company. This research tries to use the proposed model to select appropriate projects that fit the criteria considered by the alternatives.

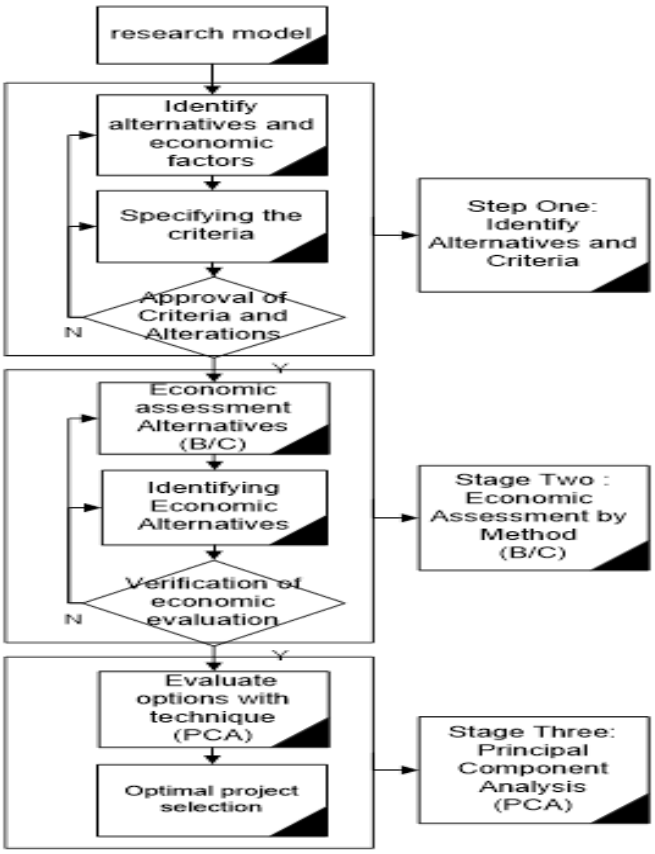

Figure 1. Research model

Economic evaluation of alternatives using net present value

In this case, the life of the projects or alternatives is 5 years and the minimum absorption rate is 10%. According to table (1), the alternatives (7 and 1) have a net negative net value, so these projects are not suitable for the company and are excluded from the next calculation.

Identify the criteria for selecting a project

Two criteria have been chosen for project evaluation, the first criterion is the ability to respond quickly to changes required by the customer and the second criterion of the quality of performance.

Table 1. Economic evaluation of alternatives using the profit-to-cost ratio(B/C)

Project Code	p_1	p_2	p_3	p_4	p_5	p_6	p_7	p_8	p_9	p_{10}
Initial cost	1000	1500	3000	2500	1260	3250	2000	1200	1600	1750
Annual income	100	1150	1300	2000	1750	3000	500	1200	1500	1000
PW_B	379.08	4359.42	4928.04	7581.6	6633.9	11372.4	1895.4	4548.96	5686.2	3790.8
PW_C	1000	1500	3000	2500	1260	3250	2000	1200	1600	1750
B/C	0.37908	2.90628	1.64268	3.03264	5.265	3.4992	0.9477	3.7908	3.553875	2.166171

Evaluation of options and project selection with (PCA)

After the economic evaluation stages of the alternatives, the benefit-cost ratio (B/C) is selected using the Principal Component Analysis (PCA) analysis method and the most appropriate project.

In Table 2, two criteria are given in two columns for all alternatives, and for each of the two alternatives, a numerical value is given between 0 and 1 in each of the two dimensions, and in the subsequent columns the calculation table is performed on the PCA method. Finally, the angle 22 degrees is selected with the highest as the best angle. After calculating the Z value for all projects, the project 5 with Z equals 0.300124 and is ranked first and is selected as the optimal project.

Table 2: Valuation of Options Using Main Component Analysis (PCA)

	First criterion	The second criterion	z						
Project Code	x_1	x_2	0	10	20	22	30	40	50
p_2	0.196	0.184	0.196	0.224974	0.247111	0.250656	0.261741	0.268418	0.266939
p_3	0.227	0.163	0.227	0.251856	0.26906	0.271532	0.278088	0.278666	0.270778
p_4	0.138	0.196	0.138	0.169939	0.196714	0.201374	0.217512	0.231701	0.238849
p_5	0.234	0.222	0.234	0.268995	0.295817	0.300124	0.31365	0.321953	0.320474
p_6	0.079	0.142	0.079	0.102458	0.122803	0.126442	0.139416	0.151793	0.159559
p_8	0.15	0.126	0.15	0.169601	0.184048	0.186278	0.192904	0.195898	0.19294
p_9	0.2	0.17	0.2	0.226482	0.246082	0.24912	0.258205	0.262483	0.258785
p_{10}	0.177	0.192	0.177	0.207651	0.231993	0.236036	0.249286	0.259005	0.260854
Average	0.175125	0.174375	0.175125	0.202744	0.224203	0.227695	0.23885	0.24624	0.246147
Variance	0.002638	0.000954	0.002638	0.002874	0.002979	0.002983	0.002942	0.002767	0.002474
SS_T	0.018465	0.006676	0.018465	0.020115	0.020855	0.020884	0.020596	0.019368	0.017321

$$\theta = 22, Z_{P_2} = 0.196\cos(22) + 0.184\sin(22) = 0.250656$$

Sample of calculations:

$$SS_T(x_1) = var(x_1) \times (n-1) = var(x_1) \times 7 = 0.018465$$

Conclusion

Considering what was presented in this article, project selection is an important and influential issue and can play a significant role in the success and failure or progress and failure of companies and organizations in competitive market conditions. In this type of problem, several alternatives based on a series of criteria, as

well as the involvement of the economic criterion in the criteria examined, and special attention to it, are based on the techniques that have been evaluated and compared, and the most appropriate project is selected. In this paper, a model is presented in which a systematic method for evaluating and selecting a project is described, taking into account a number of criteria, as well as specific attention to the economic criterion. The proposed model in this research consists of three parts: 1. Identification of alternatives and criteria. 2. Economic evaluation of projects using the benefit-cost ratio (B/C) method. 3. Selection of the best project using the Principal Component Analysis (PCA).

In the following, the proposed model was used to select the project of the selected company and the angle of 22 degrees with the highest as the best angle is selected. After calculating the Z value for all projects, the project 5 with Z is equal to 0.300124 and is selected as the optimal project.

The proposed model of this research, as well as other engineering or mathematical models and techniques, can be combined to improve the model. As well as the variables and parameters of this research are definite and investigated in a definite environment, this research can be used in a non-deterministic environment using fuzzy and Has made possible a better match with the actual results to provide better results for the choice of project in manufacturing companies and organizations and similar decision-making issues. This can be useful for future research.

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