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DETERMINING THE WEIGHTS OF COMMERCIAL CRITERIA FOR INVESTMENT PROJECT EVALUATION BASED ON THE IDOCRIW METHOD

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Abstract: Current approaches for the assessment of investment projects in the business world are mostly only limited to common financial analysis. Instead, the industry needs to increasingly emphasize the importance of commercial criteria for making investment decisions. The objective of this research is to propose a model for determining the weights of commercial criteria for evaluating investment projects. For that purpose, the modified IDOCRIW (Integrated Determination of Objective CRIteria Weights) method is applied to calculate weights for commercial criteria. The motivation for conducting this research is the fact that there are few papers in the literature dealing with the determination of weight vectors using the IDOCRIW method. The model is tested on real-life data from a large project-oriented manufacturing company, and the research results indicate improved accuracy in determining the weights of commercial criteria. This approach allows for a better understanding of the significance of each criterion and contributes to the enhancement of the decision-making process in the business environment.

Keywords: Investment projects, Assessment, Commercial criteria, IDOCRIW method

1 INTRODUCTION

Investment projects play a crucial role in the growth and sustainability of companies, providing the framework for achieving both long-term strategic goals and short-term operational improvements [1]. These projects, which often require significant capital outlay and resources, are vital for driving innovation, improving efficiency, expanding markets, and enhancing competitive positioning. Through these projects, companies pursue strategic initiatives such as new product development, market expansion, technological upgrades, or infrastructure improvements.

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Project management as well as strategic management of the companies spend a lot of time and effort trying to select the best project while respecting the general objectives defined in the strategic plan. For the process of evaluation and selection of investment projects, both, researchers and practitioners rely on various criteria. The list of criteria that can be considered when evaluating investment projects is extensive. While technical feasibility and alignment with the company's strategic goals are important, commercial criteria are often the decisive factor in determining whether a project should proceed. In practice, those criteria have different relative importance. So, determining the weights of commercial criteria can be based on non-numerical or numerical models as proposed in this research.

In the literature, there are numerous multi-attribute decision-making methods (MADM) used for determining attribute weights. The most widely applied methods are the Analytic Hierarchy Process (AHP) [2] and the Best Worst Method (BWM) [3], which belong to the group of subjective MADM methods. These methods are sensible to apply when the attributes used to evaluate alternatives have a complex hierarchical structure, even if it is not possible to establish a decision matrix. Otherwise, if the attribute values can be obtained through measurement, from records, or in some cases through decision-makers' assessments, many authors suggest using objective MADM methods. One of the MADM methods that belongs to the class of objective methods is the Integrated Determination of Objective CRIteria Weights (IDOCRIW) [4]. In this method, weights obtained by applying the entropy method and the Criterion Impact LOSs (CILOS) method are combined. These authors argue that the weight values derived through the IDOCRIW method will show the variation in criteria values (a characteristic of the entropy method), but the significance of the attributes will decrease if there are larger losses compared to other attributes.

The motivation for this paper stems from the fact that, in the literature, there are few papers where the weights vector is obtained through the application of the IDOCRIW method. The paper aims to construct a normalized decision matrix by applying an enhanced accuracy method [5], which represents the main difference between the proposed procedure and the conventional IDOCRIW method. The authors believe that applying this normalization procedure leads to greater accuracy in the normalized decision matrix, which subsequently propagates to higher accuracy in the result. The practical aim of the paper is reflected in the application of the proposed IDOCRIW method for determining the weights of commercial criteria used to evaluate investment projects in a company.

The paper is structured as follows. Section 2 briefly describes the commercial criteria used by both researchers and practitioners in the evaluation and selection of investment projects. Section 3 presents the modified IDOCRIW method. In Section 4, the proposed method is illustrated using real-life data from a large manufacturing company that is project-oriented. Section 5 provides concluding remarks.

2 COMMERCIAL CRITERIA FOR EVALUATING INVESTMENT PROJECTS

This section presents a review of the literature that includes: (i) different models of resilience and performance evaluation systems, and (ii) the Delphi technique, which is extended with type 2 interval fuzzy numbers. The list of criteria that can be considered when evaluating investment projects is extensive. One of the most used sets of criteria is presented in [6]. These criteria generally reflect the financial and market-oriented aspects of a project, and their proper weighting and evaluation are crucial for making informed investment decisions. In this paper, only commercial criteria are considered. Commercial criteria refer to the set of financial and market-related metrics used to evaluate the viability and profitability of an investment project. These criteria help decision-makers assess whether a project will generate sufficient returns, how it compares to alternative investments, and whether it aligns with the company's financial strategy and risk tolerance.

Return on Investment (ROI) measures the profitability of an investment relative to its cost. It is a coefficient that compares the gain or loss from an investment relative to its cost [7]. The payback period represents the time it takes for an investment to generate cash inflows that cover the initial outlay, used to assess the profitability of an investment. Long-term market dominance refers to a company's sustained ability to maintain a dominant position in the market over an extended period. The initial cash outlay represents the upfront capital needed to fund the initial phase of the investment, including all expenditures necessary to launch and set up the project. The ability of an investment or project to generate future business or enter new markets is a crucial criterion that assesses how well the project can expand its market presence, create new revenue streams, and sustain growth over time.

3 THE PROPOSED MODEL

In this section, two objective MADM methods for determining the weights of commercial criteria for evaluating investment projects are presented. Conventional method have been modified in terms of using different normalization procedures. The algorithm of the IDOCRIW method can be divided into three parts. The first part presents the algorithm for the entropy method. The second part provides the algorithm for the CILOS method. The third part gives the formula used to determine the aggregated value of the weights.

3.1 Entropy method

The algorithm for implementing the entropy method is realized through the following steps:

Step 1. Set up the decision matrix:

$$[x_{ik}]_{IxI} \tag{1}$$

Step 2. Let us construct the normalized decision matrix:

$$[r_{ik}]_{IxI} \tag{2}$$

$$r_{ik} = \frac{x_{ik}}{\sum_{i=1,..,I} x_{ik}} \tag{3}$$

Step 3. Let us determine the entropy degree for each criterion $k, k = 1,..,K$:

$$E_k = -\frac{1}{\ln I} \cdot \sum_{i=1,..,I} r_{ik} \cdot \ln r_{ik} \tag{4}$$

Step 4. The entropy deviation degree is obtained according to the formula:

$$\vartheta_k = 1 - E_k \tag{5}$$

Step 5. Let us determine the normalized weight vector of the criteria by applying the linear normalization procedure [8]:

$$\boldsymbol{\Omega}_{\text{к}} = \frac{\boldsymbol{\vartheta_k}}{\sum_{\text{к}\boldsymbol{k=1,..,I}} \boldsymbol{\vartheta_k}} \tag{6}$$

3.2 The modified CILOS method

The algorithm for the modified CILOS method is implemented through the following steps:

Step 1. Set up the decision matrix:

$$[\boldsymbol{x_{ik}}]_{\boldsymbol{IxI}} \tag{7}$$

Step 2. Let us construct the normalized decision matrix using the enhanced accuracy method [5]:

$$[\boldsymbol{r_{ik}}]_{\boldsymbol{IxI}} \tag{8}$$

where:

а) benefit type

$$\boldsymbol{r_{ik} = 1 - \frac{x^{max} - x_{ik}}{\sum_{i=1}^{I}(x^{max} - x_{ik})}} \tag{9}$$

б) cost type

$$\boldsymbol{r_{ik} = 1 - \frac{x_{ik} - x^{min}}{\sum_{i=1}^{I}(x_{ik} - x^{min})}} \tag{10}$$

Step 3. Let us construct the square normalized matrix by applying the linear normalization procedure [8]:

$$[\boldsymbol{z_{ik}}]_{\boldsymbol{IxI}} \tag{11}$$

Step 4. Let us construct the matrix of relative impact loss:

$$[\boldsymbol{p_{ik}}]_{\boldsymbol{IxI}} \tag{12}$$

where:

$$\boldsymbol{p_{ik}} = \begin{cases} \boldsymbol{\max\limits_{i=1,\dots,I} z_{ik}} & \boldsymbol{i = k} \\ \boldsymbol{\dfrac{z_{ii} - z_{ik}}{z_{ii}}} & \boldsymbol{i \neq k} \end{cases} \tag{13}$$

Step 5. Construct the weight system matrix:

$$[\boldsymbol{f_{ik}}]_{\boldsymbol{IxI}} \tag{14}$$

where:

$$\boldsymbol{f_{ik}} = \begin{cases} \boldsymbol{-\sum\limits_{i=1,\dots,I} p_{ik}} & \boldsymbol{i = k} \\ \boldsymbol{z_{ik}} & \boldsymbol{i \neq k} \end{cases} \tag{15}$$

Step 6. Set up the system of equations.

$$[\boldsymbol{f}_{ik}]_{IxI} \cdot [\boldsymbol{q}_k]^T_{Ix1} \qquad (16)$$

$$\sum_{k=1,..,I} q_k = 1 \qquad (17)$$

Step 7. The weight vector, $[\boldsymbol{q}_k]_{Kx1}$ is obtained by solving the set of equations.

The aggregated weight values, $\boldsymbol{\omega}_k$ (the third part), are obtained according to the procedure defined in the IDOCRIW method.

$$\omega_k = \frac{\Omega_k \cdot q_k}{\sum_{k=1,..,I} \Omega_k \cdot q_k} \qquad (18)$$

4 THE ILLUSTRATIVE EXAMPLE

In this section, the modified IDOCRIW method is demonstrated using data obtained from a project-oriented company operating in the mechanical engineering sector. The investment projects may be presented by the set of indices $\{\boldsymbol{1},\dots,\boldsymbol{i},..,\boldsymbol{I}\}$ where $\boldsymbol{I}$ present the total number of investment projects, and the index of each investment project is denoted as $\boldsymbol{i}, \boldsymbol{i} = \boldsymbol{1},..,\boldsymbol{I}$. The total number of investment projects which are considering is 5.

The value of each commercial criteria should be assessed at the level of each investment project. The commercial criteria can be presented by the set of indices $\{\boldsymbol{1},\dots,\boldsymbol{k},..,\boldsymbol{K}\}$ where K presents the total number of criteria, and the $\boldsymbol{k}, \boldsymbol{k} = \boldsymbol{1},..,\boldsymbol{K}$ is the index of commercial criteria. The commercial criteria are defined according to the referent literature [LIT]: Return on investment (ROI), $\boldsymbol{k} = \boldsymbol{1}$, The payback period, $\boldsymbol{k} = \boldsymbol{2}$, Long-term market dominance $\boldsymbol{k} = \boldsymbol{3}$, The initial cash outlay $\boldsymbol{k} = \boldsymbol{4}$, and The ability of an investment or project to generate future business or enter new markets $\boldsymbol{k} = \boldsymbol{5}$.

The values of the mentioned criteria for each investment project are shown in Table 1. The commercial criteria $\boldsymbol{k} = \boldsymbol{1}$, $\boldsymbol{k} = \boldsymbol{2}$, and $\boldsymbol{k} = \boldsymbol{4}$, can be determined by appropriate calculations, while criteria $\boldsymbol{k} = \boldsymbol{3}$ and $\boldsymbol{k} = \boldsymbol{5}$, are quantified by the members of the committee for making a decision on the selection of an investment project. The committee is composed of three members, the project manager, the financial controlling manager, and the strategic procurement manager.

The weight vector of commercial criteria for evaluating investment projects is determined by applying the entropy method. The decision matrix is presented in Table 1.

Table 1. *The decision matrix*

	$k=1$	$k=2$	$k=3$	$k=4$	$k=5$
$i=1$	2,03	2,92	8,00	0,95	9,00
$i=2$	1,14	13,11	5,00	1,70	8,00
$i=3$	0,43	4,46	3,00	0,75	6,00
$i=4$	1,34	7,48	6,00	0,69	7,00
$i=5$	1,10	9,09	7,00	0,80	9,00
criterion type	max	min	max	min	max

By applying the simple normalization procedure, the normalized decision matrix is obtained and presented in Table 2.

Table 2. *The normalized decision matrix*

	$k = 1$	$k = 2$	$k = 3$	$k = 4$	$k = 5$
$i = 1$	0,166	0,079	0,276	0,194	0,231
$i = 2$	0,093	0,354	0,172	0,348	0,205
$i = 3$	0,035	0,120	0,103	0,153	0,154
$i = 4$	0,109	0,202	0,207	0,141	0,179
$i = 5$	0,089	0,245	0,241	0,164	0,231

The entropy degrees, $\boldsymbol{E_k}$ and the entropy deviation degrees, $\boldsymbol{\vartheta_k}$ of the considered criteria have been calculated and presented in Table 3.

Table 3. *The entropy degrees and the entropy deviation degrees*

	E_k	ϑ_k
$k = 1$	0,6793	0,3207
$k = 2$	0,8623	0,1377
$k = 3$	0,9357	0,0640
$k = 4$	0,9603	0,039
$k = 5$	0,9928	0,0072

The weight vector of commercial criteria obtained using the entropy method is:

$$\boldsymbol{\Omega} = [\mathbf{0,56 \quad 0,24 \quad 0,11 \quad 0,07 \quad 0,01}]$$

Let us determine the weights vector of commercial criteria using the CILOS method. The normalized decision matrix is obtained by applying: (1) an enhanced accuracy method [5] which is shown in Table 4, and (2) a linear normalization procedure [8] presented in Table 5.

Table 4. *The normalized decision matrix given by the enhanced accuracy method [5]*

	$k = 1$	$k = 2$	$k = 3$	$k = 4$	$k = 5$
$i = 1$	1	1	1	0,819	1
$i = 2$	0,723	0,546	0,727	0,299	0,833
$i = 3$	0,611	0,931	0,545	0,958	0,500
$i = 4$	0,832	0,797	0,818	1	0,667
$i = 5$	0,774	0,725	0,909	0,924	1

Table 5. *The normalized decision matrix given by linear normalization*

	$k = 1$	$k = 2$	$k = 3$	$k = 4$	$k = 5$
$i = 1$	0,254	0,250	0,250	0,205	0,250
$i = 2$	0,184	0,137	0,182	0,075	0,208
$i = 3$	0,155	0,233	0,136	0,239	0,125
$i = 4$	0,211	0,199	0,205	0,250	0,167
$i = 5$	0,196	0,181	0,227	0,231	0,250

The procedure for calculating the element values of the matrix of relative impact loss is further shown. The maximum value of each column is:

$\boldsymbol{p_{11} = 0,254}$, $\boldsymbol{p_{22} = 0,250}$, $\boldsymbol{p_{33} = 0,250}$, $\boldsymbol{p_{44} = 0,250}$ and $\boldsymbol{p_{55} = 0,250}$

The matrix of relative impact loss is presented in Table 6.

Table 6. *The matrix of relative impact loss*

	$k=1$	$k=2$	$k=3$	$k=4$	$k=5$
$i=1$	0	0,204	0,189	0	0
$i=2$	0	0	0	0	0
$i=3$	0,276	0,452	0	0,7	0,168
$i=4$	0,389	0,068	0,456	0	0,5
$i=5$	0,169	0,204	0,189	0	0

The weight system matrix is constructed and presented in Table 7.

Table 7. *The weight system matrix*

	$k=1$	$k=2$	$k=3$	$k=4$	$k=5$
$i=1$	-0,834	0,204	0,189	0	0
$i=2$	0	-0,928	0	0	0
$i=3$	0,276	0,452	-0,825	0,7	0,168
$i=4$	0,389	0,068	0,456	-0,7	0,5
$i=5$	0,169	0,204	0,180	0	-0,668

The weight of commercial criteria using the CILOS method is obtained by solving the system of equations:

$$-0{,}834 \cdot q_1 + 0{,}204 \cdot q_2 + 0{,}189 \cdot q_3 = 0$$
$$-0{,}928 \cdot q_2 = 0$$
$$0{,}276 \cdot q_1 + 0{,}452 \cdot q_2 - 0{,}825 \cdot q_3 + 0{,}7 \cdot q_4 + 0{,}168 \cdot q_5 = 0$$
$$0{,}389 \cdot q_1 + 0{,}068 \cdot q_2 + 0{,}456 \cdot q_3 - 0{,}7 \cdot q_4 + 0{,}5 \cdot q_5 = 0$$
$$0{,}169 \cdot q_1 + 0{,}204 \cdot q_2 + 0{,}18 \cdot q_3 - 0{,}668 \cdot q_5 = 0$$
$$q_1 + q_2 + q_3 + q_4 + q_5 = 1$$

Let us:

$$q_2 = 1 - q_1 - q_3 - q_4 - q_5$$

so the system of equations is transformed into the following system of equations:

$$1{,}626 \cdot q_2 + 1{,}362 \cdot q_3 + 0{,}861 \cdot q_4 = 0{,}861$$
$$-2{,}367 \cdot q_2 + 0{,}256 \cdot q_4 = 0$$
$$0{,}455 \cdot q_2 - 1{,}384 \cdot q_3 + 0{,}150 \cdot q_4 = -0{,}382$$
$$0{,}286 \cdot q_2 + 0{,}022 \cdot q_3 - 1{,}267 \cdot q_4 = -0{,}479$$

Solving the above system of equations the weights of the commercial criteria are obtained.

The weight vector of commercial criteria obtained by the entropy method is:

$$[0{,}08 \quad 0{,}01 \quad 0{,}40 \quad 0{,}39 \quad 0{,}12]$$

Aggregated weight values of commercial criteria are:

$$[0{,}37 \quad 0{,}02 \quad 0{,}37 \quad 0{,}23 \quad 0{,}01]$$

According to the obtained results, the criteria Return on investment (ROI), $\boldsymbol{k} = \mathbf{1}$, Long-term market dominance, $\boldsymbol{k} = \mathbf{3}$, and then the criterion The initial cash outlay, $\boldsymbol{k} = \mathbf{4}$, have the highest weight value. The lowest weight value has the criteria The payback period, $\boldsymbol{k} = \mathbf{2}$, followed by the criteria The ability of an investment or project to generate future business or enter new markets, $\boldsymbol{k} = \mathbf{5}$. For the analyzed project-oriented company and its investment projects that are considered for implementation, criteria Return on investment (ROI) and Long-term market dominance have the greatest importance. When company management selects investment projects, those with the highest ROI and the potential for long-term market dominance should be prioritized. This approach allows the company not only to maximize profitability but also to secure sustainable competitive positioning in the market, creating conditions for long-term growth and stability.

5 CONCLUSION

The proposed modified IDOCRIW method provides a robust and accurate approach for determining the weights of commercial criteria when evaluating investment projects. By applying an enhanced normalization procedure, the model improves the precision of the decision matrix, which translates to more reliable results in investment decision-making processes. The proposed methodology supports more strategic and informed decision-making, ensuring that resources are allocated to projects with the greatest potential for long-term growth and market leadership.

The main contribution of this paper lies in the development and application of a modified IDOCRIW method for determining the weights of commercial criteria in the evaluation of investment projects. The main limitation of this paper is that it focuses exclusively on commercial criteria, without considering non-commercial factors like environmental impact, social responsibility, or technological risks, which may also be critical in certain investment decisions. Additionally, the model requires accurate input data and subjective assessments, which could introduce biases in criteria like long-term market dominance or future business generation. The main advantage of the paper is the enhanced accuracy of the modified IDOCRIW method, particularly in determining the weights of commercial criteria. The proposed method can be applied to investment projects of companies in all business areas.

One area for further research is the integration of non-commercial criteria, such as environmental sustainability, social impact, and technological risks, into the modified IDOCRIW method. This would provide a more holistic evaluation framework, particularly for companies aiming to balance profitability with broader corporate social responsibility goals. Additionally, future research could apply the proposed method across different industries and sectors to test its adaptability and robustness in various project-oriented environments.

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