APPLICATION OF QUANTITATIVE MODELS IN THE ORGANIZATION OF THE FINANCIAL FUNCTION OF AGRICULTURAL ENTERPRISES

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ABSTRACT

The role and content of the financial function can be seen through the identification of its tasks. They determine the volume and method of organization of the financial function in agricultural enterprises. Hierarchical priorities of tasks, their volume and complexity, the impact on business efficiency are just some aspects that affect its organization. Multi-criteria optimization methods can be used in choosing the organization and setting the model of job specialization within the organizational structure of the financial function of agricultural enterprises. By applying the individual methods that have been applied so far, not all requirements could be fully covered, so in this paper we applied a hybrid optimization model - DEMATEL-TOPSIS. The DEMATEL method was used for obtaining the weighting coefficients of the criteria on the basis of which the evaluation of alternatives was performed. The selection of criteria for evaluating the model was based on the analysis of the available literature. Evaluation and selection of models was performed using a multi-criteria method - TOPSIS. The paper presents the practical application and sensitivity analysis of the TOPSIS method.

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Introduction

The financial function is to some extent an independent whole in achieving its goals (Okunlola et al., 2019). However, it cannot be isolated and act separately because the execution of its tasks depends on cooperation with other business functions of the organization. The financial function in its tasks represents to a certain extent an independent whole, but it cannot exist independently and act separately, but the fulfillment of its tasks is conditioned by cooperation with other business functions of the organization (Vasilev et al, 2019). The execution of the tasks of the financial function of agricultural enterprises can be seen through primary and secondary tasks (Ilić, 2019; Rakić, & Adamović, 2019). The most common tasks are: obtaining and investing funds and matching them with the period of mobilization and availability of elections due to the specificity of agricultural production (Milašinović et al., 2019). These tasks are complemented by secondary tasks relating to: financial planning, maintaining financial records, liquidating documentation, financial control over the use of funds, depositing money, financial analysis and information, etc (Bolzem, 2015).

Agricultural enterprises seek to obtain rationally used funds, whereby the objective of the financial function is to shape: the purpose of the use of funds, the temporal dimension of use and the expected return on assets, taking into account the potential risk of investment in agricultural production (Zekić, 2015; Savić & Nešković, 2018). By establishing a functional link between the use and availability of funds, the task of the financial function is primarily reflected in their alignment to ensure the ongoing liquidity and solvency of the business (Ertz et al., 2019).

The establishment of equilibrium is reflected not only in the time availability of use, but also in the functional availability of the source of funds for agricultural production (Krstić et al., 2017; Jolović & Bobera, 2019; Grbić & Jovanović, 2020). In order to balance the availability of funds and their sources, a balance must be struck between short-term and long-term sources of funds (Akanbi et al., 2015).

The subject of this paper is precisely the possibility of optimizing the organization of the financial function of the agricultural enterprise using multi-criteria models (Ciutacu & Chivu, 2014). This aims at proposing a model that can be applied in organizations depending on the qualitative and qualitative characteristics of a particular agricultural enterprise.

Considering the secondary tasks of the financial function that are categorically more pronounced, compared to the primary tasks that are qualitatively more complex, some assumptions are made, which are the starting points of this research

The liquidation of financial documents is implemented before each payment due to the deposit of funds or settlement of liabilities (Vasić, 2015; Simić, Kosumi & Jialiang, 2019).. In addition, there is ongoing financial supervision over the use of funds, whether the funds are used in the intended volume and structure.

Both cash and non-cash records are required to carry out these tasks, which is certainly different from accounting records. The necessity of these records is reflected in the need to familiarize the management with the real state of deposit accounts (not accounting), the status of approved but unused loans, the balance of reserved and non-committed funds, etc (Chomanov et al., 2020).

With such internal data provided, the financial function also obtains external data to provide permanent financial planning which is reflected in the presentation of the required volume of funds, the required time of use of these funds, potential sources and the cost of obtaining funds (Shripathi, K.P. 2018).

Materials and methods

Within decision theory, there are a number of multi criteria decision making (MCDM) methods that support us in solving the problem of choosing the optimal organization. Each MCDM method is characterized by a specific mathematical apparatus, which is why different methods often result in different results (Bergman & Lundberg, 2013; Đurković, et al., 2019; Mimović & Krstić, 2016).

Methodologically, DEMATEL is a multicriteria technique (Alberti et al, 2011; Bobar, et. al., 2015; Durkalić, Furtula & Borisavljević, 2019; Tang et al., 2020) that is based on decomposing a complex problem into a hierarchy and will be used in this model to derive weighting coefficients on the basis of which the evaluation of alternatives was performed. The TOPSIS method (Yang, et. al., 2008; Tsai, et al., 2010) will be used to rank alternatives based on the criteria obtained, comparing alternatives' distances from ideal solutions. The goal is at the top of the hierarchy, while the criteria, sub-criteria and alternatives are at the lower levels. DEMATEL holds all parts of the hierarchy in the relationship, so it's easy to see how changing one factor affects the other factors

The process of selecting an adequate model of organization of the financial function of an agricultural enterprise starts from the view that there is no universal model of structure, but one must constantly take into account the state of the relevant factors of its configuration (Jing, 2020). Based on the research conducted by Janićijević et al (2019), the criteria for selecting the optimal organization model of Table 1 were selected.

Table 1. Respondents' ratings of QR code for honey

No	Criterion name and designation	Criterion description
1.	Technology (C_1)	Features that increase with the increasing complexity of technology include: the number of levels in the hierarchy, the ratio of the number of production and non-production workers, the number of managers to the total number of employees, the range of control of senior managers, etc.
2.	Personnel (C_2)	Provision and availability of qualified personnel for financial functions in the agricultural sector.
3.	The size of the organization (C_3)	The growth of the organizational structure equally captures the dimensions of the overall structure. Consequential changes include the degree of formalization and the degree of decentralization.

No	Criterion name and designation	Criterion description
4.	Life cycle stages (C_4)	It is not an independent variable, i.e. there is no automatism of the transition from phase to phase that compels certain behavior, but rather there is a certain behavior that can be identified as characteristic at some stage of the life cycle.
5.	The environment (C_5)	The characteristics of the environment that most affect the Organization are heterogeneity, variability-stability, interdependence. The variability of the environment puts further pressure on the decision-making capacity at the top.
6.	Funding (C_6)	Possibility of financing the financial function and providing the resources needed to carry out financing in agribusinesses.

Source: Janićijević et. Al, 2019

A total of five models of organization of the financial function of an agricultural enterprise were considered: A_1. centralization, A_2. division of labor or specialization, A_3. unit grouping or departmentalisation, A_4. distribution of authority or decentralization, A_5. network. Ten experts participated in the model testing process. Expert decisions were used to derive the criterion weights. Weight coefficients were obtained using the DEMATEL method.

Testing and model selection was conducted through two phases. In the first phase, the criterion was selected and the weights of the criteria were defined using the DEMATEL method. In the second phase, the TOPSIS method selected the optimal model(Falagario, 2012).

In the first step of the DEMATEL method, Saaty's scale was used to compare the criteria (Saaty, 1980). The scale shown was used to derive the offset matrices for the criteria $Z = \left[z_{ij} \right]$. Since ten experts participated in the study, a total of ten averaged criteria matrices were obtained after implementation. Aggregation of expert opinions was performed using the term $z_{ij} = \sqrt[k]{\prod_{i=1}^{k} z_{ij}^{e}}$ and is shown in Table 2.

Table 2. Aggregation of expert opinions

	C_1	C_2	C_3	C_4	C_5	C_6
C_1	1,00	0,56	2,28	3,11	0,38	7,44
C_2	2,09	1,00	3,51	3,03	3,00	5,01
C_3	0,44	0,32	1,00	1,25	3,14	2,20
C_4	0,32	0,33	0,80	1,00	3,09	1,25
C_5	2,61	0,49	0,33	0,29	1,00	1,37
C_6	0,13	0,18	0,43	0,82	0,73	1,00

Source: Authors' calculations

Table 2. is the starting point for obtaining the initial normalized direct link matrix

$$D = \begin{bmatrix} d_{11} \; d_{12} \; \dots \; d_{1n} \\ d_{21} \; d_{22} \; \dots \; d_{2n} \\ \dots \; \dots \; \dots \; \dots \\ d_{n1} \; d_{n2} \; \dots \; d_{nn} \end{bmatrix}$$

Based on expressions representing the elements of the matrix $d_{ij} = \frac{z_{ij}}{R}$ and $R = \max\left(\sum_{j=1}^{n} z_{ij}\right)$ we get the matrix, D (Pamučar et al., 2018), Table 3. After obtaining the Expert Opinion Aggregation Matrix (Table 2), the normalized direct link matrix is calculated using the above expressions D.

Table 3. Aggregation of expert opinions

	C_1	C_2	C_3	C_4	C_5	C_6
C_1	0,06	0,03	0,13	0,18	0,02	0,42
C_2	0,12	0,06	0,20	0,17	0,17	0,28
C_3	0,02	0,02	0,06	0,07	0,18	0,12
C_4	0,02	0,02	0,05	0,06	0,18	0,07
C_5	0,15	0,03	0,02	0,02	0,06	0,08
C_6	0,01	0,01	0,02	0,05	0,04	0,06

Source: Authors' calculations

Based on the elements of the matrix D and by applying the

expression $T = \lim_{m\to\infty}(D + D^2 + \dots + D^m) = \sum_{m=1}^{\infty} D^i$ where is

$$\begin{aligned}\sum_{m=1}^{\infty} D^i &= D + D^2 + \dots + D^m = \\ &= D(I + D^1 + D^2 + \dots + D^{m-1}) \\ &= D(I - D)^{-1}(I - D)(I + D^1 + D^2 + \dots + D^{m-1}) \\ &= D(I - D)^{-1}(I - D^m) \\ &= D(I - D)^{-1}\end{aligned}$$

the elements of the matrix of total impact T are determined. The total relation matrix is shown in Table 4.

Table 4. Total relation matrix

	C_1	C_2	C_3	C_4	C_5	C_6
C_1	0,1105	0,0561	0,1952	0,2708	0,1473	0,5705
C_2	0,2125	0,0995	0,2971	0,2961	0,3387	0,5112
C_3	0,0732	0,0385	0,0984	0,1195	0,2509	0,2146
C_4	0,0703	0,0369	0,0848	0,1038	0,2424	0,1561
C_5	0,1894	0,0471	0,0689	0,0847	0,1147	0,2086
C_6	0,0274	0,0171	0,0360	0,0709	0,0708	0,0971

Source: Authors' calculations

To make a diagram of the cause-and-effect relationships, using the expression $D_i = \sum_{i=1}^{n} t_{ij,}\ i = 1, 2, ..., n$ and $R_i = \sum_{j=1}^{m} t_{ij,}\ j = 1, 2, ..., m$ we determined the sum of the direct and indirect interactions of the factors (Pamučar et al., 2018) (Table 5).

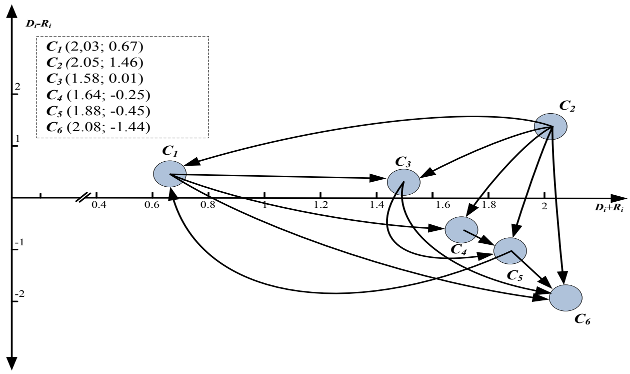
Table 5. Sum of direct (D) and indirect (R) effects of factors

	D	R
C_1	1,35	0,68
C_2	1,76	0,30
C_3	0,80	0,78
C_4	0,69	0,95
C_5	0,71	1,16
C_6	0,32	1,76

Source: Authors' calculations

Based on the limit value (α) $\alpha = \frac{\sum_{i=1}^{n} \sum_{j=1}^{n} \left[t_{ij} \right]}{N}$ (Pamučar et al., 2018)the average of the elements of the matrix T is calculated and a diagram of cause and effect relationships is drawn up in order to visually represent the complex relationships, Figure 1.

Figure 1. Diagram of causal relationships



Source: Authors' calculations

The presented diagram gives us information about the importance of factors on the system and the interaction of the presented factors. Factors of the matrix of the total relation whose value is greater than the limit value ($\alpha = 0.16$)are chosen for the purpose of showing cause and effect relationships.

After determining the relationship between criteria (factors) by applying the expression $W_i = \sqrt{(G_i + R_i)^2 + (G_i - R_i)^2}$ and $w_i = \frac{W_i}{\sum_{i=1}^{n} W_i}$ criteria weights are determined, Table 6.

Table 6. Criteria weight coefficients (*w*)

	D+R	D-R	*W*	*w*
C_1	2,03	0,67	2,14	0,173
C_2	2,05	1,46	2,52	0,204
C_3	1,58	0,01	1,58	0,128
C_4	1,64	-0,25	1,66	0,134
C_5	1,88	-0,45	1,93	0,156
C_6	2,08	-1,44	2,53	0,205

Source: Authors' calculations

Weighting coefficients of criteria, pores of initial decision matrix

$$R = \begin{matrix} A_1 \\ A_2 \\ . \\ A_3 \end{matrix} \begin{bmatrix} r_{11} & r_{12} & \dots & r_{1m} \\ r_{21} & r_{22} & \dots & r_{2m} \\ \dots & \dots & & \dots \\ r_{n1} & r_{n2} & \dots & r_{nm} \end{bmatrix},$$

represent the input parameters for the implementation of the TOPSIS method, Table 7

Table 7. Initial decision matrix

	C_1	C_2	C_3	C_4	C_5	C_6
A_1	2,11	3,03	0,42	0,22	0,20	1,05
A_2	1,83	2,87	0,33	0,28	0,16	1,20
A_3	2,60	4,11	0,51	0,15	0,08	0,92
A_4	1,68	2,43	0,23	0,30	0,22	1,53
A_5	2,23	2,75	0,47	0,17	0,11	1,13
w_i	0,173	0,204	0,128	0,134	0,156	0,205

Source: Authors' calculations

After calculating the criterion weights (w_i)After the calculation of the weights, the conditions for evaluation and selection of the optimal alternative using the TOPSIS method were met. By applying the expression of the criteria criters $x_{ij} = \frac{r_{ij}}{\sqrt{\sum_{i=1}^{n} r_{ij}^2}}$ the elements of the initial decision matrix are normalized (Pamučar et al., 2018). By multiplying the normalized elements of the matrix $X = \begin{matrix} A_1 \\ A_2 \\ . \\ A_3 \end{matrix} \begin{bmatrix} x_{11} & x_{12} & \dots & x_{1m} \\ x_{21} & x_{22} & \dots & x_{2m} \\ \dots & \dots & & \dots \\ x_{n1} & x_{n2} & \dots & x_{nm} \end{bmatrix}$ with weight coefficients (w_i)we get an aggravated noramlized matrix

$$V = \begin{matrix} A_1 \\ A_2 \\ . \\ A_3 \end{matrix} \begin{bmatrix} v_{11} & v_{12} & \dots & v_{1m} \\ v_{21} & v_{22} & \dots & v_{2m} \\ \dots & \dots & & \dots \\ v_{n1} & v_{n2} & \dots & v_{nm} \end{bmatrix} = \begin{matrix} A_1 \\ A_2 \\ . \\ A_3 \end{matrix} \begin{bmatrix} w_1 x_{11} & w_2 x_{12} & \dots & w_m x_{1m} \\ w_1 x_{21} & w_2 x_{22} & \dots & w_m x_{2m} \\ \dots & \dots & & \dots \\ w_1 x_{n1} & w_2 x_{n2} & \dots & w_m x_{nm} \end{bmatrix}$$

, table 8

Table 8. Difficult normalized matrix

	C_1	C_2	C_3	C_4	C_5	C_6
A_1	0,077	0,089	0,059	0,057	0,086	0,081
A_2	0,067	0,085	0,047	0,073	0,069	0,093
A_3	0,095	0,121	0,072	0,039	0,034	0,071
A_4	0,062	0,072	0,032	0,078	0,095	0,118
A_5	0,082	0,081	0,066	0,044	0,047	0,087

Source: Authors' calculations

By defining ideal solutions and separating alternatives from ideal solutions by expression $S_i^* = \sqrt{\sum_{j=1}^{m}(v_{ij} - v_j^*)^2}, i = 1,...,n$ and $S_i^- = \sqrt{\sum_{j=1}^{m}(v_{ij} - v_j^-)^2}, i = 1,...,n$ we obtain the final ranking of alternatives, which is shown in Table 9.

Table 9. Final ranking of alternatives

	S_i^+	S_i^-	Q_i	ranking
A_1	0,0581	0,0661	0,5321	2
A_2	0,0642	0,0564	0,4679	3
A_3	0,0858	0,0717	0,4555	4
A_4	0,0717	0,0858	0,5445	1
A_5	0,0784	0,0458	0,3686	5

Source: Authors' calculations

Applying the hybrid model, or a combination of DEMATEL and TOPSIS method, we get the solution to be the most optimal model, under number 4, which has the highest ranking among all alternatives. However, it should be emphasized that in this way the result obtained is only a possible variant, since the application of multicriteria optimization does not mean a rigorous solution, but an opportunity that can only be verified by the comparison of several different methods and scales of estimation.

The advantage of using multi-criteria optimization models is the possibility of software support in the specific example of using Visula Basic for Applications program, where after determining the weight of the criteria and inserting data, it is relatively easy to check the ranking alternatives with graphical representation.

Table 10. Calculating the rank of the proposed models in the software

Alternatives	Criteria (criterion weights)					
	K1	K2	K3	K4	K5	K6
	0.173	0.204	0.128	0.134	0.156	0.205
model 1	2.11	3.03	0.42	0.22	0.20	1.05
model 2	1.83	2.87	0.33	0.28	0.16	1.20
model 3	2.60	4.11	0.51	0.15	0.08	0.92
model 4	1.68	2.43	0.23	0.30	0.22	1.53
model 5	2.23	2.75	0.47	0.17	0.11	1.13

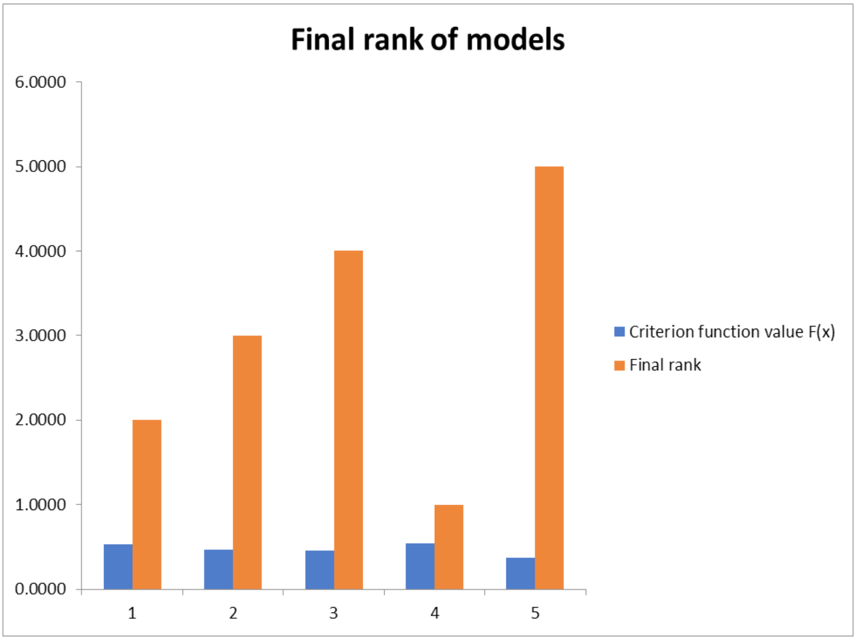
Source: Authors' calculations

Table 11. The final rank of the alternatives

Criterion function value *F(x)*	Final rank
0.5321	2
0.4679	3
0.4555	4
0.5445	1
0.3686	5

Source: Authors' calculations

Figure 3. Final ranking diagram of alternatives



Source: Authors' calculations

When applying the MCDM ranking, the alternative changes with the change in the weight coefficients of the criteria, that is, the relative importance we attribute to the particular criteria (Mongollon et al., 2020). Therefore, it is necessary to perform a sensitivity analysis of the solution.

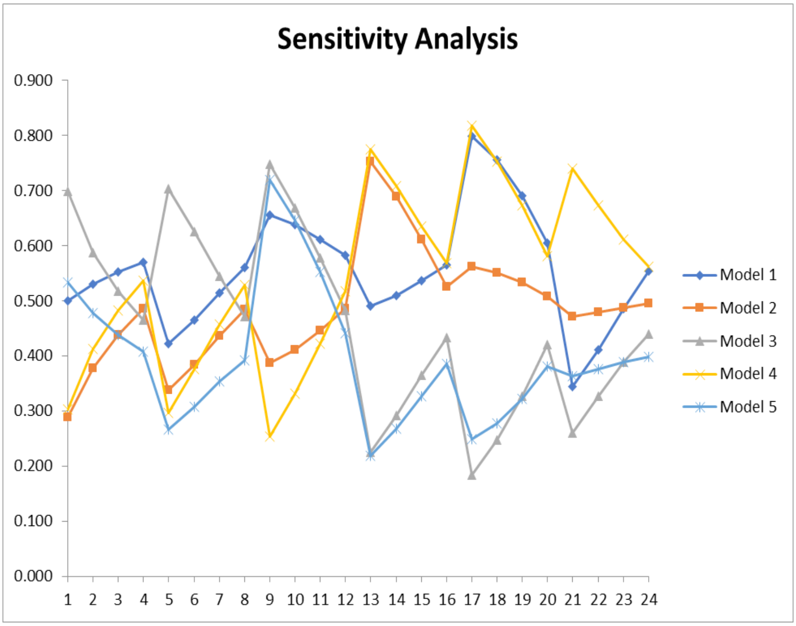
Table 12. Sensitivity analysis

	Criterion weight coefficient						Criterion function value				
	K1	**K2**	**K3**	**K4**	**K5**	**K6**	**M 1**	**M 2**	**M 3**	**M 4**	**M 5**
Variant 1	***0.50***	0.10	0.10	0.10	0.10	0.10	**0.500**	**0.288**	**0.698**	**0.302**	**0.534**
Variant 2	***0.40***	0.12	0.12	0.12	0.12	0.12	**0.531**	**0.377**	**0.587**	**0.413**	**0.477**
Variant 3	***0.30***	0.14	0.14	0.14	0.14	0.14	**0.553**	**0.437**	**0.518**	**0.482**	**0.438**
Variant 4	***0.20***	0.16	0.16	0.16	0.16	0.16	**0.569**	**0.486**	**0.464**	**0.536**	**0.408**
Variant 5	***0.10***	0.50	0.10	0.10	0.10	0.10	**0.423**	**0.337**	**0.704**	**0.296**	**0.266**
Variant 6	***0.12***	0.40	0.12	0.12	0.12	0.12	**0.465.**	**0.383**	**0.625**	**0.375**	**0.308**
Variant 7	***0.14***	0.30	0.14	0.14	0.14	0.14	**0.515**	**0.436**	**0.544**	**0.456**	**0.353**
Variant 8	0.16	***0.20***	0.16	0.16	0.16	0.16	**0.561**	**0.485**	**0.471**	**0.529**	**0.392**
Variant 9	0.10	***0.10***	0.50	0.10	0.10	0.10	**0.656**	**0.386**	**0.747**	**0.253**	**0.720**
Variant 10	0.12	***0.12***	0.40	0.12	0.12	0.12	**0.638**	**0.411**	**0.669**	**0.331**	**0.646**
Variant 11	0.14	***0.14***	0.30	0.14	0.14	0.14	**0.612**	**0.446**	**0.578**	**0.422**	**0.553**
Variant 12	0.16	***0.16***	0.20	0.16	0.16	0.16	**0.582**	**0.486**	**0.482**	**0.518**	**0.441**
Variant 13	0.10	***0.10***	0.10	0.50	0.10	0.10	**0.491**	**0.753**	**0.225**	**0.776**	**0.219.**
Variant 14	0.12	***0.12***	0.12	0.40	0.12	0.12	**0.510**	**0.690**	**0.292**	**0.708**	**0.268**
Variant 15	0.14	0.14	***0.14***	0.30	0.14	0.14	**0.536**	**0.612**	**0.364**	**0.636**	**0.327**
Variant 16	0.16	0.16	***0.16***	0.20	0.16	0.16	**0.565.**	**0.525**	**0.432**	**0.568**	**0.385**
Variant 17	0.10	0.10	***0.10***	0.10	0.50	0.10	**0.799**	**0.561**	**0.183**	**0.817**	**0.248**
Variant 18	0.12	0.12	***0.12***	0.12	0.40	0.12	**0.755**	**0.551**	**0.248**	**0.753**	**0.278**
Variant 19	0.14	0.14	***0.14***	0.14	0.30	0.14	**0.691**	**0.533**	**0.327**	**0.673**	**0.322**
Variant 20	0.16	0.16	***0.16***	0.16	0.20	0.16	**0.605**	**0.507**	**0.420**	**0.580**	**0.381**
Variant 21	0.10	0.10	***0.10***	0.10	0.10	0.50	**0.345**	**0.471**	**0.260**	**0.740**	**0.363**
Variant 22	0.12	0.12	0.12	***0.12***	***0.12***	***0.40***	**0.411**	**0.479**	**0.326**	**0.674**	**0.375**
Variant 23	0.14	0.14	0.14	***0.14***	***0.14***	***0.30***	**0.485**	**0.488**	**0.389**	**0.611**	**0.388**
Variant 24	0.16	0.16	0.16	***0.16***	***0.16***	***0.20***	**0.554**	**0.496**	**0.439**	**0.561**	**0.399**

Source: Authors' calculations

Table 11 shows the different options for ranking alternatives depending on the change in weight criteria.

Figure 4. Graph of sensitivity analysis



Source: Authors' calculations

Sensitivity analysis was performed to assess how changes in the weights assigned to the criteria would change the range of alternatives. Scenarios 1 to 24, which correspond to different weights assigned to each criterion, and which represent different priorities given to the criteria are shown in Figure 4.The obtained results show that assigning different weights (priorities) to the criteria leads to different ranks, ie. that the model is sensitive to these weights.

However, the sensitivity of the VKO method to changes in the weight coefficients of the criteria is not sufficient data on the basis of which we can draw a conclusion about the reliability of the results given by the VKO method. Comparative analyzes of authors (Rodrigues et al., 2014; Anojkumar et al., 2014; Liu et al., 2013; Wang, and Tzeng, 2012) can be presented in the literature, who try to discover those characteristics of the choice problem that condition equality, ie differences in the solutions of individual VKO methods. However, the same choice that suggests several methods is not a sufficient guarantee of rationality and quality of the obtained solution.

Conclusions

This paper presents the implementation of the hybrid DEMATEL - TOPSIS model in the decision - making process on the choice of the model of organization of the financial function in agriculture enterprises. The DEMATEL method was used to get the weighting coefficients of the criteria which served for the evaluation of alternatives. The criteria for selecting the model evaluation were made based on the analysis of the available literature. Model estimation and selection were performed using the multicritical TOPSIS method. The paper presents practical applications and sensitivity analysis of the TOPSIS method.

The organization of the financial function is one of the most important elements and affects on the success of the business of agricultural enterprises. It depends on the size, ie the scope of work of the financial function, organizational structure and the type and size of agricultural enterprises. Previous research has identified two basic forms of organization in the European and Anglo-Saxon conceptions. The European conception is based on the classical principles of organization of the authoritative system, while the Anglo-Saxon defines the division of decision making in the form of rights and responsibilities. It occupies one of the five key places in the functional scheme, which certainly differs depending on the factors we have analyzed in the paper. Although the financial function with its tasks is to a certain extent an independent function, it exists in cooperation with other segments of the business entity by providing support for the realization of their activities. In this regard, the proposed model allows us to choose the organizational structure of the financial function, depending on the potentials available and the requirements that lie ahead.

Conflict of interests

The authors declare no conflict of interest.

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