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MCDM METHODS-BASED ASSESSMENT OF LEARNING MANAGEMENT SYSTEMS

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Abstract

The paper proposes a Multiple-Criteria Decision-Making (MCDM) methods-based approach to assess Learning Management Systems (LMS). The proposed approach includes the objective weighting method MEREC, used to determine the criteria weights, and CRADIS, applied in assessing alternatives and choosing the optimal one. It is revealed that the objectivity degree decreases when the qualitative type of criteria, which strongly depends on the subjective opinion of decision-makers, is used. The proposed approach gave adequate results, confirmed by conducting a sensitivity analysis based on the TOPSIS, ARAS, and MARCOS methods, and by comparing the results with similar research studies.

Key words: MCDM, MEREC, CRADIS, LMS, objective weighting method.

ОЦЕНА СИСТЕМА ЗА УПРАВЉАЊЕ УЧЕЊЕМ ЗАСНОВАНА НА МЕТОДАМА ВИШЕКРИТЕРИЈУМСКОГ ОДЛУЧИВАЊА

Апстракт

Рад предлаже приступ заснован на методама Вишекритеријумског одлучивања (ВКО) који је намењен оцени система за управљање учењем (енгл. *Learning Management Systems – LMS*). Предложени приступ укључује методу за објективно одређивање тежина под називом *MEREC*, која је употребљена за дефинисање значаја критеријума, и методу *CRADIS*, која је искоришћена за оцену и избор оптималне алтернативе. Утврђено је да ниво објективности опада када се користе квалитативни подаци који доста зависе од субјективног мишљења доносилаца одлука. Примењени приступ пружио је адекватне резултате који су потврђени анализом осетљивости заснованом на *TOPSIS*, *ARAS* и *MARCOS* методама, као и поређењем са сличним истраживањима.

Кључне речи: ВКО, MEREC, CRADIS, системи за управљање учењем.

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INTRODUCTION

The realisation of e-learning requires the application of a particular learning management system (LMS). This software provides a platform containing the necessary educational material, and presents the link between the students and the teachers (Haghshenas, 2019). There are many different LMSs, which can be commercial or free. Each LMS has both advantages and disadvantages, making it difficult for educational institutions to select one. Making a decision requires the observation of many different criteria, which makes the application of the Multiple-Criteria Decision-Making (MCDM) methods suitable for resolving this kind of problem. The MCDM represents a helpful approach to undertaking the decision process that leads to finding appropriate choices. Until now, the MCDM methods have been used for resolving many different problems that belong to various business fields (e. g. Soković et al., 2021; Štirbanović et al., 2021; Randjelović et al., 2020; Popović et al., 2018).

The main aim of this paper is to propose an objective-based and easy-to-use MCDM model that will help find the optimal LMS suitable for application in educational institutions. This model relies on the application of the objective weighting method called the MEthod based on the Removal Effects of Criteria – MEREC (Keshavarz-Ghorabaee et al., 2021), used for determining the criteria weights, and the recently proposed Compromise Ranking of Alternatives from Distance to Ideal Solution – CRADIS (Puška et al., 2022), used for the assessment of alternative LMSs. The process involved three field IT experts in the group decision environment. Six alternative LMSs were submitted for assessment against six evaluation criteria. The main research objectives that drove the whole research process are: (1) checking that the objective weighting method always gives the objective weights; (2) examining the potential of the recently proposed CRADIS method; and (3) defining the optimal LMS for application in the educational institution.

Together with an introduction, the paper comprises six sections to achieve the presented objectives. The section "Background" presents the theoretical background for explaining the research motivation, and the MEREC and CRADIS methods. The "Methodology" section explains the research process. The results obtained by using the aforementioned MCDM methods are presented in the section following that. The "Discussion" section provides observations on the obtained results and their analysis. In the end, we presented adequate conclusions, supported by the key findings.

BACKGROUND

Literature Review

The researchers focused on assessing and selecting the LMS adequate for application in a particular educational institution (Table 1).

Table 1. Assessment and selection of the LMS

	Authors	Methods
1	Ayouni et al. (2021)	Fuzzy sets, VIKOR
2	Turker et al. (2019)	Fuzzy sets, AHP, TOPSIS, and integrated model
3	Nazir and Cavus (2017)	DEMATEL and ANP
4	Radwan et al. (2016)	Neutrosophic sets, AHP
5	Işık et al. (2015)	Fuzzy sets and AHP

Source: Author's research

The MEREC (Keshavarz-Ghorabaee et al., 2021) method belongs to the objective weighting methods. Even though it is a relatively new method, it has already been used to facilitate the decision-making process in many different areas (Table 2).

Table 2. Application of the MEREC method

	Authors	Application field
1	Rani et al. (2022)	Technology selection
2	Shanmugasundar et al. (2022)	Robot selection
3	Haq et al. (2022)	Material selection
4	Ulutaş et al. (2022)	Pallet truck selection
5	Ecer & Aycin (2022)	Evaluation of the innovation performance
6	Nicolalde et al. (2022)	Material selection
7	Ecer & Zolfani (2022)	Economic freedom assessment
8	Marinković et al. (2022)	Recycling
9	Mishra et al. (2022)	Tourism strategy assessment
10	Simic et al. (2022)	Sustainable policies assessment
11	Hezam et al. (2022)	Alternative fuel vehicle assessment
12	Popović et al. (2022)	E-commerce development strategy assessment

Source: Author's research

The presented research articles show that the MEREC has gained particular popularity among researchers. It resolves problems from technology selection to e-commerce development strategy assessment. However, as Table 2 illustrates, the MEREC method has yet to be used in e-learning or LMS assessment.

The CRADIS method (Puška et al., 2022a) is another relatively new method which has gained great popularity in a short period. This method is based on the combination of the Technique for Order of Preference by Similarity to Ideal Solution – TOPSIS (Hwang & Yoon, 1981), A new additive

Ratio ASsessment – ARAS (Zavadskas & Turskis, 2010), and Measurement Alternatives and Ranking according to Compromise Solution – MARCOS (Stević et al., 2020) methods. The authors intended to retain all the good features of the constituent methods, offering an improved version capable of yielding a compromise solution. The CRADIS method has been used in several research articles presented in Table 3.

Table 3. Application of the CRADIS method

	Authors	Application field
1	Krishankumar and Ecer (2023)	IoT service provider selection
2	Wang et al. (2023)	Occupational risk assessment
3	Puška et al. (2022a)	Waste incinerator selection
4	Puška et al. (2022b)	Pear varieties market assessment
5	Puška et al. (2022c)	Green supplier selection
6	Starčević et al. (2022)	Foreign direct investment impact assessment
7	Wątróbski et al. (2022)	Extension of two developed Python packages
8	Puška et al. (2022)	Agricultural machinery assessment
9	Dordevic et al. (2022)	Production optimization
10	Stojanović et al. (2022)	Global Innovation Index analysis

Source: Author's research

As can be seen from Table 3, the possibilities of the CRADIS method have yet to be observed in the field of e-learning, making room for further elaboration.

This article represents an attempt to create such an approach, based on the MEREC and CRADIS methods, which will facilitate the decision-making process and enable the easier finding of an optimal alternative – in this case, an optimal LMS. Evidently, the methods included in this proposed approach are new, and offer enough room for examination and analysis. Besides, the topics of the LMS's assessment and selection have heretofore been relatively rarely studied, which introduces a very convenient field for the application and observation of the possibilities of the MCDM approaches.

The MEREC Method

The application of any MCDM method requires the definition of criteria weights. In the present case, the MEREC method (Keshavarz-Ghorabaee et al., 2021) is proposed for defining criteria weights. The complete computation procedure of the MEREC method could be illustrated by following a series of steps (Keshavarz-Ghorabaee et al., 2021; Ulutaş et al., 2022).

Step 1. The first step is the creation of a decision matrix that contains the values of the *n* alternatives regarding the involved *m* criteria. The created decision matrix looks like this:

$$X = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1j} & \cdots & x_{1m} \\ x_{21} & x_{22} & \cdots & x_{2j} & \cdots & x_{2m} \\ \vdots & \vdots & \ddots & \vdots & \ddots & \vdots \\ x_{i1} & x_{i2} & \cdots & x_{ij} & \cdots & x_{im} \\ \vdots & \vdots & \ddots & \vdots & \ddots & \vdots \\ x_{n1} & x_{n2} & \cdots & x_{nj} & \cdots & x_{nm} \end{bmatrix}, \tag{1}$$

where x_{ij} represents the ratings of the *i*-th alternative, concerning the *j*-th criterion ($x_{ij} > 0$).

Step 2. The second step is the normalisation of the decision matrix, which involves the calculation of the normalised ratings as follows:

$$r_{ij} = \frac{x_{ij}}{max_i x_{ij}} \; if \; j \in B, \tag{2}$$

$$r_{ij} = \frac{min_i x_{ij}}{x_{ij}} \; if \; j \in NB, \tag{3}$$

where r_{ij} remarks the normalised ratings, *B* is the beneficial criteria, and *NB* is the non-beneficial criteria.

Step 3. The third step is the calculation of the alternative overall performance S_i in the following way:

$$S_i = ln\left(1 + \left(\frac{1}{m}\sum_j \left|ln\left(r_{ij}\right)\right|\right)\right). \tag{4}$$

Step 4. The fourth step is the calculation of the performance of the alternatives S'_{ij} , which involves removing criteria one at a time:

$$S'_{ij} = ln\left(1 + \left(\frac{1}{m}\sum_{k,k\neq j} \left|ln\left(r_{ij}\right)\right|\right)\right). \tag{5}$$

Step 5. The fifth step is the calculation of the absolute deviation's summation E_j, which is performed in the following way:

$$E_j = \sum_i \left|S'_{ij} - S_i\right|. \tag{6}$$

Step 6. The final criteria weights w_j are calculated as follows:

$$w_j = \frac{E_j}{\sum_k E_k}. \tag{7}$$

The CRADIS Method

The CRADIS method is, as its authors have stated (Puška et al., 2022a), a relatively newly proposed approach whose computational procedure involves the following steps (Puška et al., 2022a).

Steps 1 and 2. As in the MEREC method, the procedure of the CRADIS method also requires forming the decision matrix with *n* alternatives and *m* criteria. Additionally, it requires its normalisation.

Step 3. The weighted decision matrix is achieved by using the following equation:

$$v_{ij} = r_{ij} \cdot w_j, \tag{8}$$

where v_{ij} represents the weighted normalised performance rating of the i-th alternative, regarding the j-th criterion.

Step 4. The fourth step is the definition of the ideal t_i and anti-ideal t_{ai} solution; this is performed in the following way:

$$t_i = maxv_{ij}, \tag{9}$$

$$t_{ai} = minv_{ij}. \tag{10}$$

Step 5. Calculating deviations from ideal and anti-ideal solutions is done using the following equations:

$$d^+ = t_i - v_{ij}, \tag{11}$$

$$d^- = v_{ij} - t_{ai}. \tag{12}$$

Step 6. The calculation of the deviation levels of the separate alternatives from ideal and anti-ideal solutions is performed as follows:

$$s_i^+ = \sum_{j=1}^{n} d^+, \tag{13}$$

$$s_i^- = \sum_{j=1}^{n} d^-. \tag{14}$$

Step 7. The utility function relative to the deviation from the optimal alternatives should be calculated for each alternative in the following way:

$$K_i^+ = \frac{s_0^+}{s_i^+}, \tag{14}$$

$$K_i^- = \frac{s_i^-}{s_0^-}, \tag{15}$$

where s_0^+ remarks the optimal alternative that is the least distant from the ideal solution, while s_0^- denotes the optimal alternative that is the most distant from the anti-ideal solution.

Step 8. The eighth step is the determination of the final ranking order of the alternatives by using the following equation:

$$Q_i = \frac{K_i^+ + K_i^-}{2}. \tag{16}$$

METHODOLOGY

An adequate plan for the research activities is necessary to achieve the set scientific objectives. In the present case, the research process was performed through five stages to achieve the objectives presented at the beginning of the article (Figure 1).

After defining the research goal, the alternative LMSs to be assessed were determined, as well as the appropriate set of criteria against which the assessment would be performed. Then, the process required the selection of the decision-makers that will be involved in the evaluation. Three experienced IT experts from educational institutions in the field of e-learning were involved in the initial assessment of the alternative LMSs, relative to the given criteria. In that way, the input data necessary for applying the proposed MCDM model was assured.

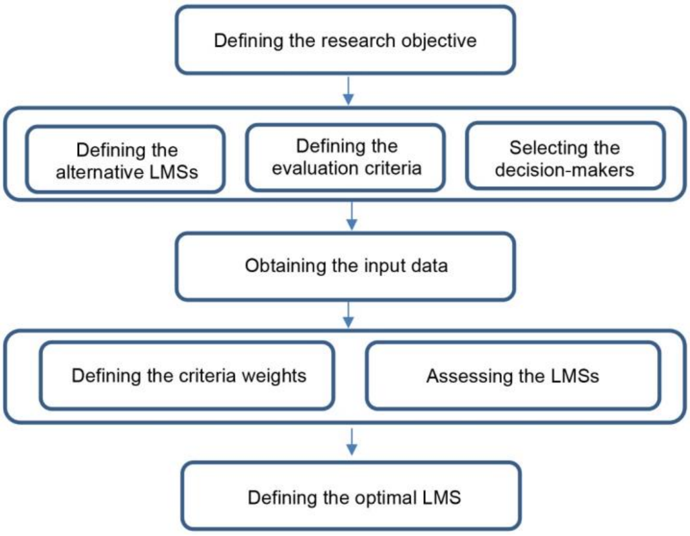

Figure 1. Research process
Source: Author's research

The next step involves defining the criteria weights. This step was achieved using the objective MEREC method, which provided a base for the final assessment of the involved LMSs, achieved using the CRADIS method. Finally, the proposed model revealed the optimal LMS as an option representing a compromise solution regarding the considered criteria.

RESULTS

To begin with, the alternative LMSs to be assessed should be selected. There are many LMSs suitable for implementing e-learning at educational institutions, but in this case, the most popular were chosen and submitted for further evaluation (Table 4).

Table 4. Alternative LMSs

	Alternative	
	Abbreviation	Full name
1	*MO*	Moodle
2	*TA*	Talent LMS
3	*GC*	Google Classroom
4	*BB*	Blackboard
5	*LO*	Looop
6	*DO*	Docebo

Source: Author's research

After a methodical examination of the available literature, a set of six criteria was selected based on the articles of Su et al. (2022), Muhammad and Cavus (2017), Zare et al. (2016), and Radwan et al. (2016). The evaluation criteria were chosen by applying the domination method. The list of the selected criteria is presented in Table 5.

Table 5. Evaluation criteria

	Criteria		Criteria	Explanation
	Abbreviation	Full name	type	
1	*CS*	Computer skills	min	Ability to work in an online environment
2	*SL*	Self-regulated learning ability	max	The ability to self-motivation, set, and gain the learning objectives
3	*CO*	Comprehension	max	Understanding of the received information
4	*CR*	Creativity	max	Bringing new ideas, concepts, and methods
5	*FL*	Flexibility	max	Building an adaptive learning environment
6	*SU*	Support	max	Available assistance when it is needed

Source: Author's research

Three decision-makers, proven IT experts from the e-learning field, were asked to estimate the alternative LMSs under consideration against the involved criteria using a grade scale ranging from one to five. The decision-makers were selected based on their experience working with different LMS types. This way, the data needed for applying the introduced MCDM model was obtained and presented in Tables 6 through 8.

Table 6. Initial decision matrix – first decision-maker

	CS	*SL*	*CO*	*CR*	*FL*	*SU*
MO	3	4	5	5	4	5
TA	3	3	3	3	3	3
GC	2	2	3	1	1	3
BB	4	4	3	2	3	4
LO	2	3	4	3	4	3
DO	2	4	5	3	4	4

Source: Author's research

Table 7. Initial decision matrix – second decision-maker

	CS	*SL*	*CO*	*CR*	*FL*	*SU*
MO	4	3	3	4	3	2
TA	3	4	2	2	2	4
GC	4	5	2	2	2	4
BB	3	2	3	3	1	2
LO	4	2	4	2	3	3
DO	5	3	2	4	2	3

Source: Author's research

Table 8. Initial decision matrix – third decision-maker

	CS	*SL*	*CO*	*CR*	*FL*	*SU*
MO	4	3	3	4	3	2
TA	3	4	2	2	2	4
GC	4	5	2	2	2	4
BB	3	2	3	3	1	2
LO	4	2	4	2	3	3
DO	5	3	2	4	2	3

Source: Author's research

Figure 2 presents the defined criteria weights based on the standpoints of each decision-maker separately, using the MEREC method.

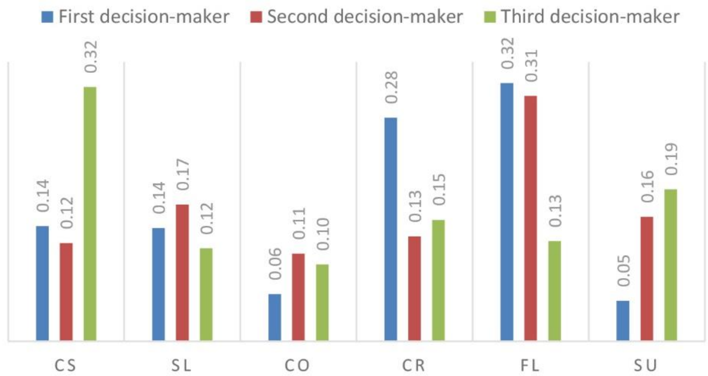

Figure 2. The criteria weights
Source: Author's research

As Figure 2 depicts, the decision-makers accorded different significance to the criteria.

The optimal LMS was defined separately for each decision-maker involved in the procedure, using the CRADIS method. Table 9 presents the results for the first decision-maker.

Table 9. Assessment results – first decision-maker

Alternatives	Q_i	Rank
MO	0.98	1
TA	0.71	4
GC	0.48	6
BB	0.67	5
LO	0.84	3
DO	0.90	2

Source: Author's research

According to the first decision-maker, the assessment results highlight the optimal alternative LMS *MO – Moodle* (0.98).

Table 10 shows the ranking results based on the input data received from the second decision-maker.

Table 10. Assessment results – second decision-maker

Alternatives	Q_i	Rank
MO	0.87	1
TA	0.71	4
GC	0.72	3
BB	0.51	6
LO	0.73	2
DO	0.65	5

Source: Author's research

Again, the first place belongs to the alternative *MO – Moodle* (0.87). Table 11 presents the ranking results from the third input data set.

Table 11. Assessment results – third decision-maker

Alternatives	Q_i	Rank
MO	0.87	1
TA	0.68	5
GC	0.79	3
BB	0.58	6
LO	0.77	4
DO	0.85	2

Source: Author's research

Table 11 illustrates the assessment results obtained by the input data of the third decision-maker. As can be seen, the alternative *MO – Moodle*, is again in first place (0.87).

The previous weights, as well as the ranking results, were obtained based on the input data gained from each decision-maker separately. By observing the results, it can be concluded that the alternative *MO – Moodle* is optimal for use in the educational institution. However, to check this conclusion, the geometric mean of the data obtained from the decision-makers was calculated by using the following equation:

$$x_{ij} = \left(\prod_{j=1}^{k} x_{ij}^{k}\right)^{\frac{1}{K}}, \tag{17}$$

where x_{ij}^{k} represents the performance rating of the i-th alternative relative to the j-th criterion, obtained from the k-th respondent ($k = 1,2,\ldots,K$), and K denotes the number of decision-makers.

After that, the MEREC and CRADIS methods were applied. The obtained results are presented in Table 12, while their comparison is presented in Figure 3.

Table 12. Results obtained by using the geometric mean of the data received from all three decision-makers

Criteria	w_j	Alternatives	Q_i	Rank
CS	0.10	*MO*	0.96	1
SL	0.17	*TA*	0.65	4
CO	0.14	*GC*	0.58	5
CR	0.23	*BB*	0.54	6
FL	0.26	*LO*	0.77	3
SU	0.10	*DO*	0.82	2

Source: Author's research

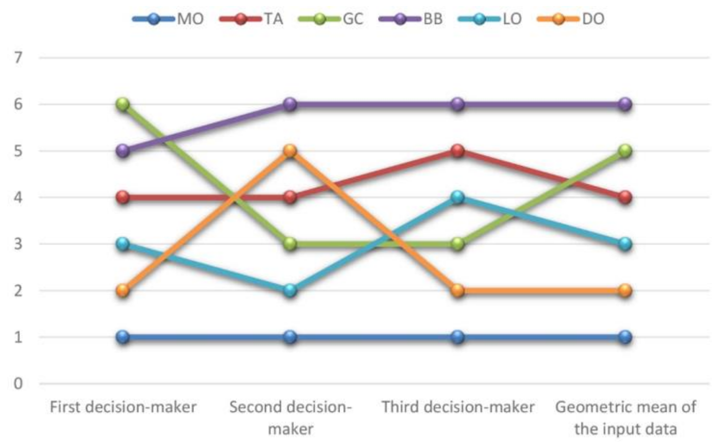

Figure 3. Comparison of the obtained ranking results
Source: Author's research

Figure 3 illustrates that the ranking results match entirely where the first positioned alternative is concerned (*Moodle*). There are some modest variations of the ranking positions of the other alternatives. However, they do not affect the conclusion that alternative *MO – Moodle* is the most acceptable in the present conditions.

DISCUSSION

Performing e-learning requires adequate LMSs that are logical, flexible, and convenient for the end users, i.e., students. Various LMS with different features exist on the market, and selecting one that will meet the user's needs is essential. In this paper, the MCDM assessment of the LMSs based on the MEREC and CRADIS methods was conducted.

The MEREC method was applied to define the criteria weights to reduce the subjectivity of the decision process. However, in this particular case, qualitative criteria were used to evaluate the alternatives, so the input data was obtained from three decision-makers. This fact raises the question of whether the objective weighting method can express its full potential if the data needed for further analysis is gathered from decision-makers, i.e., respondents. Involving more decision-makers in gathering the initial data would reduce subjectivity, but they are inevitably biased to a certain extent. In this situation, the objective type of the MCDM methods could be designated as 'semi-objective'.

The result regarding the criteria weights showed the fluctuations aroused by the input data obtained from the decision-makers. According to the first and second decision-makers, the criterion *FL – Flexibility* is of the highest importance, while the third decision-maker saw *CS – Computer skills* as the most important. When the geometric mean of the obtained weights was determined, it showed that the most crucial criterion is *FL – Flexibility* (0.26). It is entirely acceptable that flexibility is the most significant because the ability to adapt to user requirements and changes in the working environment is vital in current business conditions. The results of the other authors who observed the topic of LMS selection gave priority to the other evaluation criteria. For example, Su et al. (2022) considered the self-regulated learning ability the essential criterion. The existing difference in the criteria weights is caused by the following: (1) different sets of criteria were used, and (2) the decision-makers' opinions varied. Although different approaches to defining the criteria weights were applied, the prevailing opinion is that there are other reasons for the existing differences. Namely, the main objective of the methods is to give optimal solutions, so the standpoint is that all of them should give approximately unique results if they are correctly created and similar input data is used.

For the assessment of the alternative LMSs, the new CRADIS method was used. To check the obtained results, the TOPSIS (Hwang & Yoon, 1981), the ARAS (Zavadskas & Turskis, 2010), and the MARCOS (Stević et al., 2020) methods were used. The rest of the places varied, but the first place belonged to *MO – Moodle* in all observations (Figure 4).

As the input data shows, *Moodle* did not have the best performance ratings regarding all criteria. However, despite that, *Moodle* fulfills all the requirements to a satisfying degree, and represents a compromise solution. The authors of the articles that considered the same topic obtained similar results, emphasising *Moodle* as the most convenient LMS (Ayouni et al., 2021; Turker et al., 2019; Radwan et al., 2016). This statement confirms that *Moodle* is most frequently used in many educational institutions for conducting e-learning courses.

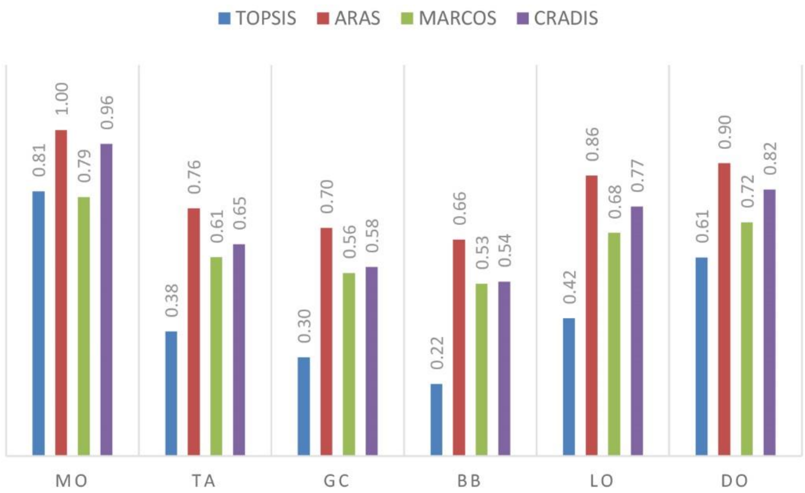

Figure 4. Comparison of the results obtained by chosen MCDM methods
Source: Author's research

This study sheds light on the potential and usefulness of the recently introduced MEREC and CRADIS methods. It gives an overview of their former usage, and confirms their applicability in the field of information technologies. Also, the study justifies the need for the application of mathematically based methods in scientific research. As far as practice is concerned, applying the MCDM approach in the case of LMS selection enables educational institutions to make more informed and reliable decisions regarding the available options. Additionally, applying the proposed approach could provide valuable and helpful support for resolving other problems related to making business decisions.

CONCLUSION

The main objective of this article was to propose the MCDM model for the assessment and determination of the optimal LMS convenient for application in educational institutions for the purpose of implementing e-learning. To that end, six alternative LMSs were assessed against six evaluation criteria with the help of the MEREC and CRADIS methods. Theory and practice confirm the results' reliability regarding the selection of *Moodle* as the optimal LMS.

The main conclusions are as follows. Firstly, the objectivity of the objective weighting methods depends on the input data. When the input data is exact and quantitatively expressed, a higher degree of objectivity is reached. When input data is qualitative and depends on the opinions of decision-makers, the final results are 'semi-objective'. The degree of subjectivity could be decreased by involving more decision-makers. Secondly, the CRADIS method successfully incorporates the good aspects of the TOPSIS, ARAS, and MARCOS methods, and enables the determination of the compromise solution quickly and efficiently. Besides, it is understandable and easy to use, making it very convenient for resolving various problems. Thirdly, the optimal LMS for application is defined by using the proposed MCDM approach. The results pointed towards *Moodle* as the optimal solution in relation to the given conditions. This choice is verified by applying the other known MCDM methods, and comparing them with the studies performed by the other authors.

Besides the obtained scientific results, this article has some limitations, too. These limitations are the following. Only six criteria were involved in the decision-making process. As can be seen in other articles (e.g., Muhammad & Cavus, 2017; Zare et al., 2016; Radwan et al., 2016), introducing a more significant number of criteria and sub-criteria in the evaluation would increase the relevance of the process. Additionally, the model is based on crisp numbers, which do not adequately express the environment's vagueness. As the papers by Krishankumar and Ecer (2023), and Puška et al. (2022b, 2022c) show, it would be adequate to use a fuzzy, grey, or neutrosophic extended model. Furthermore, the criteria weights were defined by using only one method. They would be more relevant if the objective-subjective approach were applied. Finally, the results would be more representative if more than only three decision-makers were involved.

Despite the mentioned limitations, the proposed MCDM model based on the MEREC and CRADIS methods proved its applicability in assessing LMSs. Besides, it could also be used for assessing and determining the optimal solutions for other business problems. All these limitations automatically represent propositions for future research.

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ОЦЕНА СИСТЕМА ЗА УПРАВЉАЊЕ УЧЕЊЕМ ЗАСНОВАНА НА МЕТОДАМА ВИШЕКРИТЕРИЈУМСКОГ ОДЛУЧИВАЊА

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Резиме

У циљу извођења учења на даљину неопходна је примена одговарајућег система за управљање учењем (Learning Management System – LMS) – платформе која садржи неопходан наставни материјал те представља спону између предавача и студената. У понуди је више различитих бесплатних и комерцијалних LMS система намењених управљању активностима учења на даљину и контроли оствареног напретка. С обзиром на чињеницу да сваки од њих има своје особености, веома је сложен задатак изабрати један који ће у највећој мери задовољити постављене критеријуме. У овом раду предложена је примена једноставног објективног модела заснованог на методама вишекритеријумског одлучивања који може помоћи у проналажењу оптималног LMS система погодног за примену у образовним институцијама. Предложени модел заснива се на објективној методи за дефинисање тежина критеријума под називом MEREC (MEthod based on the Removal Effects of Criteria) (Keshavarz-Ghorabaee et al., 2021) и недавно предложеној CRADIS методи (Compromise Ranking of Alternatives from Distance to Ideal Solution) (Puška et al., 2022), која је искоришћена за коначну оцену алтернативних LMS система. Шест алтернативних LMS система подвргнуто је евалуацији у односу на шест критеријума, а у сам процес била су укључена три стручњака из области информационих технологија који се непосредно баве учењем на даљину. Основни циљеви спроведеног истраживања били су: утврђивање степена објективности метода за дефинисање тежина које су означене као „објективне", опсервирање потенцијала CRADIS методе и дефинисање LMS система оптималног за коришћење у образовним институцијама. Спроведено истраживање је довело до следећих закључака: (1) степен објективности метода за дефинисање тежина условљен је нивоом поузданости коришћених података; (2) нова CRADIS метода објединила је добре аспекте TOPSIS, ARAS и MARCOS метода и омогућила је дефинисање компромисног решења у складу са постављеним условима; и (3) примена предложеног вишекритеријумског приступа означила је Moodle као оптималан LMS за коришћење у образовним институцијама.