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RANKING OF THE SOFTWARE PACKAGES FOR PROJECT MANAGEMENT USING INTEGRATED MCDM METHODS

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ABSTRACT

In this paper, the ranking of selected software packages for project management is performed. The aim is to rank project management software packages based on predefined criteria and to show that MCDM methods can yield varying results even when analyzing the same problem. This shows that MCDM can be a useful tool for simplifying the observed problem, but the final decision should be given by the decision-maker.

When deciding using quantitative MCDM methods, it is necessary to know the criteria weights and input data that will be used for comparing alternatives. In this paper, AHP, CRITIC and CILOS methods for determining criteria weights and VIKOR, TOPSIS, COPRAS, SAW and GRA methods for alternative ranking will be used.

A brief literary review of the chosen methods will be presented, followed by a comparative analysis of the software packages. Finally, tabular and graphic representations of the alternative rankings obtained from the different methods are provided.

Keywords: project management, MCDM method, ranking, alternative, criteria.

INTRODUCTION

Software Project Management is an umbrella term used to refer to the systematic execution of processes such as planning, monitoring, staffing, and leading software projects to minimize the cost of software production while attaining high quality end product (Lee & Chen, 2022). Project managers need to choose a suitable set of tools in the marketplace to improve productivity and avoid violating time and budget constraints (Akbar et al., 2022).

When decision-making, a lot of factors can influence the final decision. Multi-criteria decision-making (MCDM) methods help with eliminating complex and unnecessary information thus making the decision process easier. The MCDM process deals with situations involving the selection, sorting and ranking of the best alternative from several options based on selected criteria with the help of mathematical models (Chakraborty et al., 2024).

The topic of selecting the optimum project management software has been widely researched and can be found in multiple papers, for example: Akbar et al., 2023; Cicibas et al., 2010; Manole & Avramescu, 2017; Milojević et al., 2023; Mitrović et al., 2011; Milin et al., 2012.

When using quantitative MCDM methods it is necessary to know the criteria weights and input data that will be used for evaluating optimal alternative. In this paper, several MCDM methods will be used for determining criteria weight and alternative ranking.

Though they help with decision-making process, MCDM methods can give different results even when criteria weight or input data is not changed. A number of papers deal with comparative analysis of the mentioned methods, such as Podvezko, 2011; Radulescu & Radulescu, 2024; Özcan & Çelik, 2021; Sari, 2018; Opricovic & Tzeng, 2004; Kokoç & Ersöz, 2019; Misra & Ray 2012; Ustinovichius, 2007.

Most approaches to determining weight criteria can be divided into subjective and objective (Žižović et al., 2020). Subjective approaches are based on determining criteria weight using information from decision-makers or experts included in the decision process and reflects the subjective opinion and intuition of decision-makers which means that decision-makers influence the decision-making process (Žižović et al., 2020). Subjective techniques require the participation of the decision-maker in the weighting procedure (Paradowski, 2021). Contrary to subjective approaches, objective approaches are based on determining criteria weight using data that is present in the initial decision matrix and disregard the opinion of decision-makers (Žižović et al., 2020). Objective weighting methods determine criterion weights based on mathematical formulas (Paradowski, 2021).

In this paper 3 approaches are used: AHP, CRITIC and CILOS.

The Analytic Hierarchy Process (AHP) is a subjective multi-criteria decision-making approach in which factors are arranged in a hierarchic structure (Saaty, 1990). It is used to derive ratio scales from both discrete and continuous paired comparisons. These comparisons may be taken from actual measurements or from a fundamental scale which reflects the relative strength of preferences and feelings (Saaty, 1987). In AHP criteria weights are assessed subjectively given that the decision-maker can provide scaled preferences of pairs of decision criteria and alternatives with acceptable inconsistency (Aomar, 2010).

Criteria Importance Through Intercriteria Correlation (CRITIC) is an objective approach which considers both contrast intensity and conflict which are contained in the structure of the decision problem (Diakoulaki et al., 1995). This approach uses the standard deviation quantifies the contrast intensity of the corresponding criterion and the linear correlation coefficient (Diakoulaki et al., 1995).

Criterion Impact Loss (CILOS) is an objective method that is used for determining a relative impact loss experienced by the criterion of an alternative, when another criterion is chosen to be the best (Zavadskas & Podvezko, 2016). It considers the significance (impact) loss of each criterion, when one of other criteria obtains the optimal largest or smallest value.

For alternative ranking, 5 methods were used: VIKOR, TOPSIS, SAW, COPRAS and GRA. A short description of selected methods is given below.

The VIKOR method was developed as a multi-criteria decision-making method to solve a discrete decision problem with noncommensurable and conflicting criteria (Opricovic and Tzeng, 2004).

The TOPSIS method is based upon the concept that the chosen alternative should have the shortest distance from the ideal solution and the farthest from the negative-ideal solution (Hwang and Yoon, 1981).

The SAW method is one of the oldest, simplest and the most widely-used decision-making methods. This method is the basis of most MADM methods such as the PROMETHEE and AHP methods. Finding the weighted sum of the performance ratings for each alternative considering all attributes is the basic concept of the SAW method. (Taherdoost, 2023).

The COPRAS method was utilized to assess the superiority of one option over another and enables the comparison of options. The COPRAS technique systematically rates and assesses options based on their importance and utility level. This method is built on the premise of linear normalization, which allows for the direct comparison of diverse criteria by converting them into a common scale. Moreover, it incorporates the relative importance of each criterion into the decision-making process, enabling decision-makers to articulate and integrate their preferences and priorities into the analysis (Taherdoost, 2024).

The GRA method is quantitative and systematic approach, subsystem of grey system theory and most widely used in solving complex system (Patil et al, 2019). Grey System theory is focused on decision-making with partial information known and partial unknown. The information between known and unknown information is called as grey information (Patil et al, 2019).

A literary review of chosen approaches for determining criteria weights is given in Table 1, while the literary review for chosen methods for alternative ranking is in Table 2.

Table 1. Literary review of methods for determining criteria weight.

Method	Developed by	References
Analytic Hierarchy Process (AHP)	Saaty, T. L. (1970)	Saaty, 1970 Saaty, 1980 Saaty, 1987 Vaidya & Kumar, 2006
Criteria Importance Through Intercriteria Correlation (CRITIC)	Diakoulaki, D. Mavrotas, G. & Papayannakis, L. (1995)	Diakoulaki et al., 1995 Žižović et al., 2020 Krishnan et al., 2021
Criterion Impact Loss (CILOS)	Zavadskas, E. K. & Podvezko, V. (2016)	Zavadskas & Podvezko, 2016 Ayan, B. et al., 2023

Table 2. Literary review of methods for alternative ranking.

Method	Developed by	References
Višekriterijumska Optimizacija i Kompromisno Rešenje (VIKOR)	Opricovic, S. (1998)	Opricovic, 1998 Opricovic & Tzeng, 2007 Nikolić et al., 2010
Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)	Hwang, C.L. & Yoon, K.S. (1981)	Hwang & Yoon, 1981 Chakraborty, 2022
Simple Additive Weighting (SAW)	MacCrimmon, K.R. (1968)	MacCrimmon, 1968 Goodridge, 2016 Taherdoost, 2023
Complex Proportional Assessment (COPRAS)	Zavadskas, E. K., Kaklauskas, A. & Sarka, Z. (1994)	Zavadskas et al., 1994 Popovic et al., 2012 Taherdoost, 2024
Grey Relational Analysis (GRA)	Ju-Long, D. (1982)	Ju-Long (1982) Patil et al. (2019)

MATERIAL AND METHODS OF WORK

There are many software packages used for project management. Given the large number of software packages, the list of a few selected software packages was made. Software packages are selected based on previous papers involving project management software comparison (Cicibas et al., 2010; Manole & Avramescu, 2017; Milin et al., 2012; Milojević et al., 2023; Mitrović et al. 2011).

When making comparisons certain criteria were used, such as tasks (ability to create and follow tasks), resource management (ability to schedule, allocate and optimize resources), projects (ability to plan and follow progress of project) and data & analytics (ability to follow performance). Each criterion has its' subcriteria. In Table 3 and 4 comparative analysis of the software packages is shown.

Table 3. Comparative analysis of the project management software packages (https://www.g2.com/).

Group	Feature	ProjectManager.com	Microsoft Project	Wrike	Asana	BaseCamp
Resource Management	Scheduling	+	+			
	Definition	+	+			
	Allocation		+			
	Optimization		+			
Data & Analytics	Data Consolidation		+			
	Performance		+			

Table 4. Comparative analysis of the project management software packages (continuation)

Group	Feature	ProjectManager.com	Microsoft Project	Wrike	Asana	BaseCamp
Projects	Planning	+	+	+	+	+
	Project Map	+	+	+	+	
	Gantt	+	+			+
	Calendar View	+	+	+	+	+
	Views	+		+	+	+
	Templates				+	+
	Dashboards	+		+		+
	Baselining/KPIs					+
Tasks	Creation &Assignment	+	+	+	+	+
	Due Dates	+	+	+	+	+
	Task Prioritization	+	+	+	+	+
	To-Do Lists	+	+	+	+	+
	Dependencies	+	+	+	+	
	Mass Updates			+	+	
	Drag & Drop	+		+	+	+
	Recurring Tasks	+		+	+	

RESULTS AND DISCUSSION

In Table 5 decision matrix is presented. For simplicity and a better view of the table, criteria are presented as *C*, where: *C1* – Ease-of-use; *C2* – Customer support; *C3* – Value for money; *C4* – Functionality; *C5* – Price. Values for criteria Ease of use, Customer support, Value for money and Functionality are given on a scale from 1 to 5, where 1 depicts the lowest score and 5 the highest. Value for criterion Price is given based on the Premium/Pro package price, since every software offers multiple packages with different pricing. Alternatives are presented as *A*, where: *A1* – Microsoft Project; *A2* – Asana; *A3* – BaseCamp; *A4* – ProjectManager.com; *A5* – Wrike.

Table 5. Decision matrix (https://www.softwareadvice.com/).

	Ease of use [1-5]	Customer support [1-5]	Value for money [1-5]	Functionality [1-5]	Price [$/user per month]
Criteria requirement	max	max	max	max	min
Microsoft Project	4.1	4.1	4.1	4.4	30
Asana	4.4	4.3	4.4	4.4	24.99
BaseCamp	4.3	4.3	4.2	4.2	15
ProjectManager.com	4	3.9	3.7	3.9	26
Wrike	4.1	4.3	4.2	4.3	25

First, it is necessary to determine criteria weights. Since the AHP method is subjective and requires input from the decision-maker. In Table 6 pairwise comparison matrix for AHP method is shown. Values are given based on the authors' preferences and Saaty's scale.

Table 6. Pairwise comparison matrix.

Criteria	*C1*	*C2*	*C3*	*C4*	*C5*
C1	1	5	2	3	7
C2	1/5	1	1/4	1/6	1
C3	1/2	4	1	2	4
C4	1/3	6	1/2	1	3
C5	1/7	1	1/4	1/3	1

The criteria weights that are obtained by the chosen approach are given in Table 7. It can be seen that for the AHP method, the most important criterion is Ease of use, yet the most important criterion for CRITIC and CILOS methods is Functionality. It can also be seen that the criteria weights for the CRITIC and CILOS methods are not the same. This can lead to different alternative rankings even when an alternative ranking method is the same.

Table 7. Criteria weights determent by the chosen methods.

	C1	*C2*	*C3*	*C4*	*C5*
AHP	0.431	0.060	0.255	0.194	0.060
CRITIC	0.16	0.15	0.12	0.25	0.32
CILOS	0.09	0.17	0.07	0.64	0.03

In Table 8 rank of the alternatives is given when criteria weights are determined by the AHP method. It can be seen that the ranking of alternatives using VIKOR, SAW and GRA methods is the same. Same can be seen when TOPSIS and COPRAS methods are used. In Figure 1 graphic representation of ranking is presented.

Table 8. Rank of the alternatives when criteria weights are determined by the AHP method.

w_i = (0.431; 0.060; 0.255; 0.194; 0.060)					
	VIKOR	TOPSIS	COPRAS	SAW	GRA
A1	4	4	4	4	4
A2	1	2	2	1	1
A3	2	1	1	2	2
A4	5	5	5	5	5
A5	3	3	3	3	3

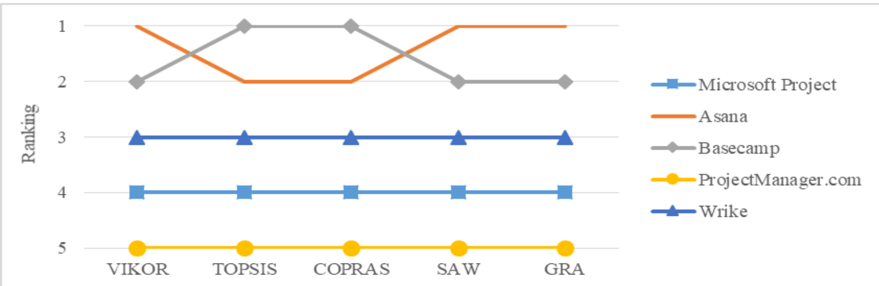

Figure 1. Software Ranking Comparison Using AHP-Derived Criteria Weights.

In Table 9 rank of the alternatives is given when criteria weights are determined by the CRITIC method. It can be seen that the ranking of alternatives using VIKOR, COPRAS and SAW methods is the same. It can also be seen that alternative ranking using TOPSIS and GRA methods differentiates from others. In Figure 2 graphic representation of ranking is presented.

Table 9. Rank of the alternatives when criteria weights are determined by the CRITIC method.

w_i = (0.16; 0.15; 0.12; 0.25; 0.32)					
	VIKOR	TOPSIS	COPRAS	SAW	GRA
A1	4	5	4	4	4
A2	2	2	2	2	1
A3	1	1	1	1	2
A4	5	4	5	5	5
A5	3	3	3	3	3

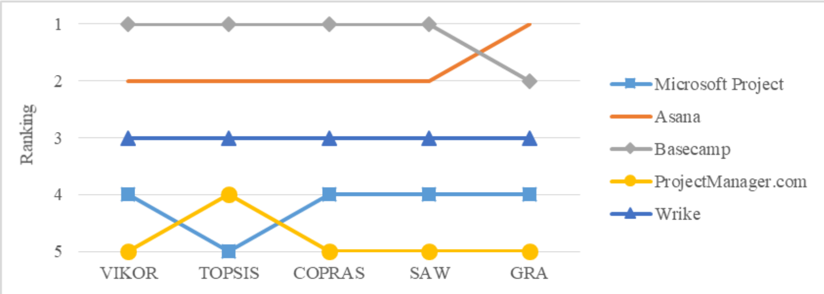

Figure 2. Software Ranking Comparison Using CRITIC-Derived Criteria Weights.

In Table 10 rank of the alternatives is given when criteria weights are determined by the CILOS method. It can be seen that the ranking of alternatives using VIKOR and TOPSIS methods is the same. It can be seen that alternative ranking using COPRAS, SAW and GRA methods differ from others. In Figure 3 graphic representation of ranking is presented.

Table 10. Rank of the alternatives when criteria weights are determined by the CILOS method.

w_i = (0.09; 0.17; 0.07; 0.64; 0.03)					
	VIKOR	TOPSIS	COPRAS	SAW	GRA
A1	2	2	3	2	2
A2	1	1	1	1	1
A3	4	4	2	3	4
A4	5	5	5	5	5
A5	3	3	4	4	3

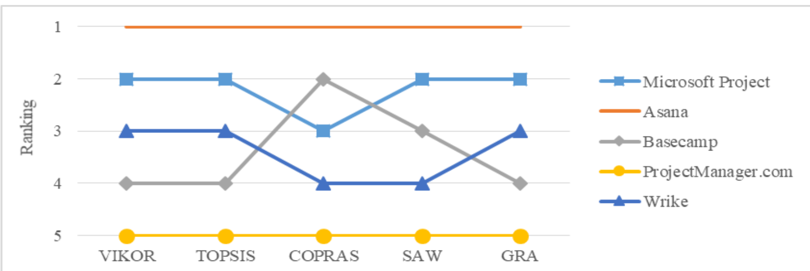

Figure 3. Software Ranking Comparison Using CILOS-Derived Criteria Weights.

As the previous tables demonstrate, alternative ranking methods yield varying results even when criteria weights are consistent. This discrepancy arises from the diverse normalization techniques and mathematical methodologies utilized.

CONCLUSIONS

This study demonstrates the significant impact of MCDM method selection on the ranking of alternatives in the context of project management software evaluation. MCDM methods are powerful tools for decision-making. Even though MCDM tends to be objective, they still need decision-maker input thus introducing subjectivity and affecting alternative ranking.

Different criteria weights are expected given the fact that we used three different approaches. From our perspective, the Analytic Hierarchy Process (AHP) method offers the most realistic weighting approach in this domain because it directly incorporates decision-maker preferences, rather than relying solely on mathematical ratios between criterion values.

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The lack of consensus in alternative rankings across these different weighting methods underscores a crucial point: there's no single "best" answer. Instead, the most robust solution emerges from a thorough comparison and synthesis of results.

Our findings indicate that Asana and Basecamp are overall best alternatives thus the best solution for the observed problem. Specifically, Asana and Basecamp share the first place when the criteria weights are determent using AHP method. Basecamp is considered overall best when the criteria weights are determent using CRITIC method, while Asana is the best alternative according to all methods used when the criteria weights are determent using CILOS method.

These results confirm the fact that MCDM methods provide invaluable insights into optimal alternatives based on given criteria. Still, it is advised that decision-makers make final decision using given information. As shown in the paper, different MCDM methods can give different rankings of alternatives. The choice of criteria weighting method significantly influences the final outcome.

DECLARATIONS OF INTEREST STATEMENT

The authors affirm that there are no conflicts of interest to declare in relation to the research presented in this paper.

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