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Collaborative Work Alternatives with ChatGPT Based on Evaluation Criteria for its Use in Higher Education: Application of the PROMETHEE-SAPEVO-M1 Method

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Abstract

The objective of this article is to adopt the integration of two methods of Multicriteria Decision Support, based on the axiomatic models PROMETHEE and SAPEVO-M1, aggregating data of a qualitative nature through ordinal entries to analyze collaborative work alternatives with ChatGPT from evaluation criteria for its use in higher education. It is highlighted that the alternative with the best performance is 'Support for Autonomous Learning,' presenting the highest positive flow and the lowest negative flow, exposing a natural preference over the set. In this study, 'Emotional Support' was the worst alternative. It occurs because the tool is still under discussion when addressing issues such as the lack of human interaction, reduced critical thinking, and less empathy.

Keywords: Artificial intelligence; ChatGPT; collaborative work; Higher Education; PROMETHEE-SAPEVO-M1 method.

1. Introduction

In 2022, a technological innovation called ChatGPT, created by OpenAI, captured the attention of both traditional and digital media, marking the end of the year with its launch. Although artificial intelligence (AI) is publicized and masked under numerous meanings, the ChatGPT phenomenon once again highlighted the influence of AI and its positive and negative effects on society. Everything indicates that this technology has become a disruptive innovation directly impacting several specific activity sectors. It is essential to understand this technology based on large language models and know its advantages and weaknesses and what it really means for the sector [1].

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The emergence of ChatGPT can be related to the phenomenon observed by Haenlein and Kaplan [2], known as the 'AI effect', that occurs when the widespread use of an AI-based or derived product leads people to disregard their behavior, claiming that it is not natural intelligence. Furthermore, the exhaustive and widespread use of AI applications leads to the need to consider ethical [3] or explainable [4] aspects of AI. Another important point is that generative AI applications have been made accessible to the general public, which according to Gartner [5], will be responsible for 10% of all data generated by 2025.

Generative text applications revolutionize the market. ChatGPT is responsible for this leap as it generates highly argumentative texts and maintains a realistic dialogue through a relatively simple web interface that follows the imperative model. where the user enters a request. The chatbot returns the results within the multilingual language context. ChatGPT is built using GPT-3, a language model that uses deep learning techniques [6] to generate texts similar to those written by humans, programming codes, stories, poems, etc. In addition, it can perform tasks with a relatively high standard due to more than 175 million parameters that have been trained and is considered the largest language model (probability distributions over a sequence of words) developed with AI [7].

However, even if the rate of valid responses increases, accepting any ChatGPT output without checking its validity or analyzing the content meaning is a mistake, as this task is an essential competence of digital literacy in identifying whether the results are valid, false, or inaccurate [8]. However, one of the most controversial issues about ChatGPT is not the result of the responses themselves but whether this tool will be used by those who need to write a text without the necessary human effort and, therefore, without acquiring the skills for which the intellectual task was designed, thus reducing the effort in the creative process.

This discussion permeates several areas of knowledge, including education, which has always sought to assess knowledge or skills mediated by technology. In this sense, it is essential to observe how ChatGPT tool can contribute to the learning process within the university context, supporting teachers and students. Thus, the problem with using ChatGPT is not in the tool itself but perhaps in the essence of specific educational tasks that may have become obsolete in most cases in which they are employed. It generates a debate about a possible change in the role teachers should play with their students in the face of this new operating way of conducting learning in complex contexts of thought [9]. Higher Education Institutions should not orient themselves towards prohibition, nor should they ignore the existence of these tools and their potential to support learning. The most appropriate approach is to understand what these tools can contribute to the teaching and learning processes, opening spaces for critical analysis, comparing data and information sources, and selecting and formulating appropriate questions. On the other hand, when working with specific competencies, their use must be controlled, observing ethical considerations that require attention.

One of the most prevalent concerns about using ChatGPT is that it threatens writing as an assessment method. Some professors are concerned about students 'outsourcing' their writing assignments to ChatGPT, as the AI system can generate an acceptable and convincing result in seconds without triggering any plagiarism detectors. Such concerns, however, may arise from instructors' resistance to adapting to changing assessment methods, as written assignments are often criticized for needing to be more active and effective in assessing student learning [10]. A further concern for teachers is ChatGPT's inability to understand what is being shared and not bother to assess the relevance or accuracy of the information, as it is just a text-generating machine that produces a passable imitation of what is being shared [11].

AI provides innovative teaching and learning practices in which educational contexts facing students, teachers, and the system must be observed, all with the potential to transform educational practices profoundly. In this study, the analysis unit will be teachers. Teachers can use ChatGPT to reduce their workloads, gain insights from their students, and facilitate classroom innovation. Therefore, this technology can help teachers by automating assessment, plagiarism detection, administration, and feedback mechanisms. AI-powered apps and systems can also allow teachers to gain insight into their student's learning progress to provide additional guidance and support as needed. Cope et al. [12] suggest that AI has the greatest potential for transformative educational change. Unlike conventional assessment methods that rely on distinct and atypical artifacts to select and provide response tests for retrospective summative sampling, AI-based assessment systems can support the integration of continuous feedback into learning processes, using distinct and atypical artifacts [13].

This work seeks to contribute to the discussion of the application of AI in the learning process of higher education students through ChatGPT, understanding that the tool has a lot to offer in terms of progress toward a digital disruption of the educational system, which is perceived as next in the broader context of digital transformation in education. It is justified because intelligent AI content generation tools open up a new spectrum of educational possibilities thanks to virtual assistants with a wide range of possibilities that have just begun to be established. Therefore, the objective

of this article is to adopt the integration of two methods of Multicriteria Decision Support, based on the axiomatic models PROMETHEE and SAPEVO-M1, aggregating data of a qualitative nature through ordinal entries to analyze collaborative work alternatives with ChatGPT from evaluation criteria for its use in higher education.

2. Materials and methods

The study is exploratory and descriptive, with a quantitative and cross-sectional approach. We conducted the study utilizing a focus group of teachers in a remote meeting (Google Meet) and data collected via electronic form (SURVIO) with a group of professors from Brazilian universities (n=15) who presented after discussing a consensus of answers. The selection criterion is that they are users of the ChatGPT tool in the classroom and influence decisions in managing new technologies in the linked universities.

The method used in this case study is represented by the integration of two Multicriteria Decision Support (MDS) methods: PROMETHEE (Preference Ranking Method for Enrichment Evaluation) proposed by Brans et al. [22] and SAPEVO-M (Simple Aggregation of Preferences Expressed by Ordinal Vectors – Multi Decision Makers) proposed by Gomes et al. [23]. MDS methods make up a field of study of Operations Research (OR) and present techniques that allow the structuring and understanding of a problem in complex and dynamic environments [24] and establish preferences between alternatives under multiple criteria, usually conflicting or that have specific characteristics, helping to obtain solutions for choosing, ranking, ordering, or problematic portfolios. The PROMETHEE method intends to evaluate ordering-type problems, resulting in an overclassification of the alternatives from the most favorable to the least conducive to solving the problem. Therefore, the method selected for this research is PROMETHEE-SAPEVO-M1, which operates as a hybrid model that evolves the SAPEVO method [25]. Therefore, the PROMEHEE-SAPEVO-M1 method will be based on the basic structure of the PROMETHEE method with the insertion of techniques from the SAPEVO-M method, enabling an equivalent evaluation with qualitative inputs in a single decision analysis. Modeling enables the decision-maker to obtain weights in a structured format.

Overclassification relations of alternatives and non-transitivity relations between preferences characterize MDS methods. The PROMETHEE-SAPEVO-M1 modeling provides three forms of analysis, partial, total, or interval evaluations of preferences. This allows the decision maker to have a kind of sensitivity analysis by comparing results presented by each type of situation. PROMETHEE and SAPEVO-M1 methods allow a single decision analysis through a non-compensatory algorithm for sorting problems, considering quantitative and qualitative variables through cardinal and ordinal entries, respectively. However, this study will use qualitative variables through ordinal entries as presented in the alternatives (Table 3) and criteria (Table 4). Due to the lack of highly accurate information [26], it is common to use qualitative assessment in different formats. For example, using qualitative scales allows the structure of the decision-maker's preferences regarding the variables [27]. Therefore, considering aspects of subjectivity in MDS modeling plays a fundamental role in transcribing the decision-maker's preferences [28] for the implemented method and being clear about the manipulations and attributions regarding the problem under evaluation [29 - 32].

2.1. PROMETHEE-SAPEVO-M1 algorithms steps

Moreira et al. [24] consider a matrix M (see Table 1), composed of a set of alternatives A, where $a_i \in A, i = 1, \dots n$, being evaluated according to a set of qualitative criteria, $h, h = 1, \dots L$, and a set of quantitative criteria $j, j = 1, \dots k$. In this study, we will use only qualitative criteria.

Table 1. Evaluation matrix

		Alternatives				
		$\boldsymbol{a_1}$	$\boldsymbol{a_2}$	$\boldsymbol{a_3}$	...	$\boldsymbol{a_n}$
Criteria	h_1	a_{11}	a_{21}	a_{31}	...	a_{n1}
	h_L	a_{1L}	a_{2L}	a_{3L}	...	a_{nL}
	j_1	a_{11}	a_{21}	a_{31}	...	a_{n1}
	j_k	a_{1k}	a_{2k}	a_{3k}	...	a_{nk}

Qualitative evaluation, set of criteria h, $h = 1$, $\dots L$, is characterized by a comparative analysis among the alternatives belonging to set A, for each criterion belonging to set h. The analysis is based on an assessment of preference present on an importance scale [24], as shown in Table 2.

Table 2. Ordinal scale of importance

Verbal Expressions	Punctuation

Absolutely worse/less important	-3
Much worse/less important	-2
Worst/less important	-1
Equivalent	0
Best/more important	1
Much better/more important	2
Absolutely better/more important	3

The comparison matrix among the elements of set A is obtained for each qualitative criterion. Through the equation below, the values are normalized, obtaining a degree of importance of that alternative given criterion (1).

$$v = \frac{\sum a_{ij} - \min a_{ij}}{máx\ a_{ij} - \min a_{ij}} \tag{1}$$

Obtaining the importance values of the alternatives in the evaluated criterion, these are submitted to a new maximization evaluation, $P_j(a_1, a_2) = P(x) = P[f(a_1) - f(a_2)]$ (2). However, if there is need to minimize the criterion, it is used $P_j(a_1, a_2) = P(x) = P[f(a_2) - f(a_1)]$ as a function. Once a new matrix is obtained, the values will be normalized by a function with linear variation. In the end, there is a normalized matrix for each criterion belonging to set h.

$$P(x) = \begin{cases} \frac{x}{r} & x \leq r \\ 1 & x > r \end{cases} \tag{2}$$

Considering a single-decision analysis, obtaining the weights will consider the qualitative criteria in a single set j, where $j = 1, \dots, L + k$. Considering the ordinal scale of importance (Table 4), it will be obtained how important a given criterion is about the others in the set. This evaluation considers a maximum and minimum possible sum value within a set of criteria j. The maximum sum is obtained by $x = (n - 1) * 3$, representing the highest possible sum value within that evaluation. The closer a criterion is to this value, the greater its dominance in the set. The minimum sum is obtained by $x = (n - 1) * -3$, representing the smallest possible sum value within the evaluation [33, 34]. The smaller the value of a criterion and the closer to the minimum sum it is, the criterion will have little importance in the set. The values obtained in the evaluation will be normalized by the equation below. After normalization, the sum of the degrees obtained will be equivalent to 1, and the weights will be weighted according to their respective criteria (3).

$$v = \frac{\sum a_{ij} - (maxsum)}{(maxsum) - (minsum)} \tag{3}$$

Next, we calculated the global weighted preference index. With the normalized matrices and the weights obtained, we calculated each compared pair, the global weighted preference index $\pi(a_1, a_2)$, indicating the preference percentage of alternative a_1, about alternative a_2, as follows.

$$\pi(a_1, a_2) = \sum_{j=1}^{n} \alpha_j P_j(a_1, a_2) \tag{4}$$

The next step will be preference assessments. In the modeling, three types of evaluations will be used jointly: partial, total, and interval preference evaluations, and characteristics of the PROMETHEE variants I, II, and III, respectively.

Partial preference evaluation: using the positive importance flow, characterized by the sum of the preferences of a_1, over all other alternatives belonging to the set of alternatives, and the negative importance flow, represented by the sum of the preferences of all alternatives over a_1, it is possible to obtain a partial pre-order of the alternatives, where (5, 6, 7, 8, and 9):

$$\Phi^+(a_1) = \frac{1}{n-1} \sum_{x \in A}^{n} \pi(a_1, x) \tag{5}$$

$$\Phi^-(a_1) = \frac{1}{n-1} \sum_{x \in A}^{n} \pi(x, a_1) \tag{6}$$

$$a_1\ is\ preferable\ to\ a_2 (a_1 P a_2) \quad if \quad \begin{cases} \Phi^+(a_1) > \Phi^+(a_2)\ e\ \Phi^-(a_1) < \Phi^-(a_2) \\ \Phi^+(a_1) = \Phi^+(a_2)\ e\ \Phi^-(a_1) < \Phi^-(a_2) \\ \Phi^+(a_1) > \Phi^+(a_2)\ e\ \Phi^-(a_1) = \Phi^-(a_2) \end{cases} \tag{7}$$

$$a_1\ is\ indifferent\ to\ a_2 (a_1 I a_2) \quad if \quad \Phi^+(a_1) = \Phi^+(a_2)\ e\ \Phi^-(a_1) = \Phi^-(a_2) \tag{8}$$

$$a_1\ is\ incomprable\ to\ a_2(a_1Ra_2) \quad if \quad \begin{cases}\Phi^+(a_1) > \Phi^+(a_2)\ e\ \Phi^-(a_1) > \Phi^-(a_2)\\ \Phi^+(a_1) < \Phi^+(a_2)\ e\ \Phi^-(a_1) < \Phi^-(a_2)\end{cases} \tag{9}$$

Total preference assessment: This assessment consists of using the preference (P) and indifference (I), relationships, using the net flow of importance obtained by the following equation, enabling the generation of a complete pre-order, where (10, 11, and 12):

$$\Phi(a_1) = \Phi^+(a_1) - \Phi^-(a_1) \tag{10}$$

$$a_1\ is\ preferable\ to\ a_2(a_1Pa_2) \quad if \quad \Phi(a_1) > \Phi(a_2) \tag{11}$$

$$a_1\ is\ indifferent\ to\ a_2(a_1Ia_2) \quad if \quad \Phi(a_1) = \Phi(a_2) \tag{12}$$

Evaluation of preference for intervals: in this evaluation, each alternative a_1 an interval with lower and upper limits $[x(a_1), y(a_1)]$ is defined, allowing a pre-order of the alternatives, where (13, 14, and 15):

$$\begin{cases}x_{a_1} = \Phi(a_1) - \alpha\sigma_{a_1}\\ y_{a_1} = \Phi(a_1) + \alpha\sigma_{a_1}\end{cases} \tag{13}$$

$$a_1\ is\ preferable\ to\ a_2\ (a_1Pa_2) \quad if \quad x_{a_1} > y_{a_2} \tag{14}$$

$$a_1\ is\ idifferent\ to\ a_2\ (a_1Ia_2) \quad if \quad x_{a_1} \le y_{a_2} e\ x_{a_2} \le y_{a_1} \tag{15}$$

Note that the degree of indifference (I) is not necessarily transitive, while the degree of preference (P) is still transitive. Assuming three alternatives $a_1, a_2\ e\ a_3$ we have $a_1Ia_2\ and\ a_2Ia_3$ but a_1Pa_3 as shown in Fig. 1:

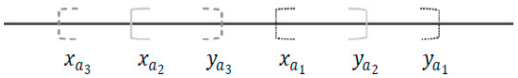

Fig 1. Relationship of $a_1, a_2, and\ a_3$

3. Case Study

The ChatGPT technology fosters the discussion that it will be necessary to train university professors and students for the correct use of ethics and to prioritize critical thinking to obtain their maximum potential in the learning process. Therefore, its exemplary implementation as a support in the classroom will depend on many factors that currently seem promising but are not free of risks, uncertainties, and obstacles that must be overcome. However, this tool brings benefits presented in the recent literature to provide new learning experiences, for example, involving them in conversation and providing feedback and corrections; private lessons; help with homework; provide explanations to help students understand complex concepts; in addition to helping students organize and manage their time; and provide personalized and interactive learning information [14].

When disruptive education technologies enter the classroom, teaching and learning are often subject to a series of challenges. Education professionals, policymakers, and teachers are always responsible for managing the situation. Not facing these challenges can expose inappropriate pedagogical practices. In this sense, teachers must turn challenges into opportunities and adapt to changes as they arise [13]. McMurtrie [10] argues that AI tools like ChatGPT will somehow become part of everyday writing, just as calculators and computers have become part of math and data science. Likewise, Sharples [15] suggests involving students and teachers in training and leveraging these AI tools to support learning rather than preventing students from using them.

One opportunity for teachers is the introduction of innovative assessments. Most of the time, teachers perceive and use assessments to assess student learning. Most teachers, however, may need more skills to use assessment in learning [16]. In this regard, Higher Education Institutions can take this opportunity to enhance teacher skill sets in assessment to leverage disruptive AI applications such as ChatGPT to enhance student learning. Teachers can use flipped learning to ensure that the most critical parts of the work are completed in class and to focus more on multimedia assignments or oral presentations rather than classroom assignments. In addition, teachers can spend more time giving feedback and reviewing student work. In this sense, after preliminary research, the forms of use of ChatGPT were verified (Table 3) and the evaluation criteria of ChatGPT (Table 4), both with a focus on Higher Education.

Table 3. Practice forms for the use (alternatives) ChatGPT for Higher Education

Alternatives	Description	Authors

Virtual Assistant for Teachers (VAT)	... can be used as a virtual assistant for teachers, helping them prepare lessons, answer students' questions, provide feedback, and more.	[13]
Support for Autonomous Learning (SAL)	... can be used as a tool to support students' autonomous learning, allowing them to ask questions, access relevant information, and practice specific skills (for example, improving writing skills or creating tutorials).	[10,13,18]
Generate Ideas (GEI)	... can help generate ideas for solving problems or creating projects in individual or group work; using the platform can stimulate creativity.	[13,19]
Use of Gamification (UOG)	... can be used to create educational games, encouraging students to practice specific skills while having fun.	[17]
Emotional Support (EMS)	... can be used as an emotional support channel for students, helping them deal with personal problems, anxiety, stress, and issues of ethical use.	[13]

Table 4. ChatGPT evaluation criteria for Higher Education

Criteria	Description	Authors
Ease of Use (EOU)	... involves assessing how easily users can ask questions and receive answers based on an intuitive, easy-to-use interface to learn effectively.	[1]
Flexibility (FLE)	... can adapt to different courses and disciplines' unique needs and requirements. Furthermore, ChatGPT can be tailored to a specific task or domain, allowing you to generate more accurate and relevant responses.	[20]
Cost-benefit (COB)	... the technology is cost-effective compared to other learning tools available (e.g., free version (Free Plan) vs. subscription (ChatGPT Plus USD$20/mo.).	[13]
Content Relevance (COR)	... an important measure that involves evaluating whether the answers are useful and relevant to the question asked and whether they provide adequate and accurate information.	[11]
Effectiveness (EFF)	... is technology able to help students learn and achieve their learning goals?	[13]
Accurate of Answers (AOA)	... assessment measure involving the model's ability to understand the questions and provide relevant and accurate answers.	[21]
Response Complexity (REC)	... in text generation tasks, assessing whether the generated responses are adequate is possible by providing valuable and understandable responses in terms of complexity.	[13]

Students who prefer hands-on, experiential learning will benefit from using ChatGPT as a learning aid. Among the benefits of ChatGPT is that it allows students to learn through experimentation and experience. Using ChatGPT, students can evaluate different strategies and approaches to solving problems and achieving goals through game-based learning [17] or other student-centered pedagogies. The ChatGPT application has the potential to serve as a means of generating different scenarios for students to work together to solve problems and achieve goals. With the help of appropriate instructional strategies, ChatGPT can facilitate collaboration and teamwork among participants.

As the ChatGPT tool is recent and there are few empirical studies on the natural effect of this technology on learning and acceptance and use of this technology should increase in the form of educational practices, this study seeks to contribute to the originality of the theme supported by Multicriteria Decision Support (MDS) methods: PROMETHEE and SAPEVO-M1.

3.1. Result Analysis

The results made it possible to obtain a sensitivity analysis of the problem. We used the PROMETHEE-SAPEVO-M1 Software Web (v.1) to support the analysis and generate graphs (Moreira et al., 2020). Fig. 3 exposes the graphical analysis interface. The positive and negative flow provide the partial ranking, the complete ranking handles the net flows, and the ranking by intervals is built by the lower and upper limit, with all values detailed in Table 5. The performances concerning the partial outranking were analyzed. In the Partial Pre-ordering graphic exposed in Figure 5, the right line represents the positive flows and the left line the negative flows, whereas the higher the positive and the lower the negative, the better the alternative is, represented by the crossing of lines. The alternative with the best performance is the 'Support for Autonomous Learning', presenting the highest positive flow and the lowest negative flow, exposing a total preference over the set (see Table 6). The following most preferable alternatives are 'Virtual Assistant for Teachers', 'Use of Gamification', 'Generate Ideas', and 'Emotional Support', respectively. In this study, 'Emotional Support' was the worst alternative. As justified, it occurs because the tool is still under discussion when dealing with issues such as the lack of human interaction, reduced critical thinking, and less empathy [13].

Table 5. Lower and upper limits for construction of global preference analysis by intervals

	VAT	SAL	GEI	UOG	EMS	Positive Flows	Net Flows	Intervals (standard error=0.021)

VAT	0	0.023	0.055	0.035	0.039	0.152	0.009	x=-0.012	y=0.03
SAL	0.035	0	0.065	0.044	0.054	0.187	0.07	x=0.049	y=-0.091
GEI	0.048	0.045	0	0.031	0.03	0.154	-0.028	x=-0.049	y=--0.007
UOG	0.044	0.019	0.037	0	0.027	0.116	-0	x=-0.021	y=0.021
EMS	0.027	0.03	0.025	0.017	0	0.099	-0.051	x=-0.072	y=-0.03
Negative Flows	0.143	0.117	0.182	0.116	0.15				

Note: Lower limits (x) and Upper Limits (y)

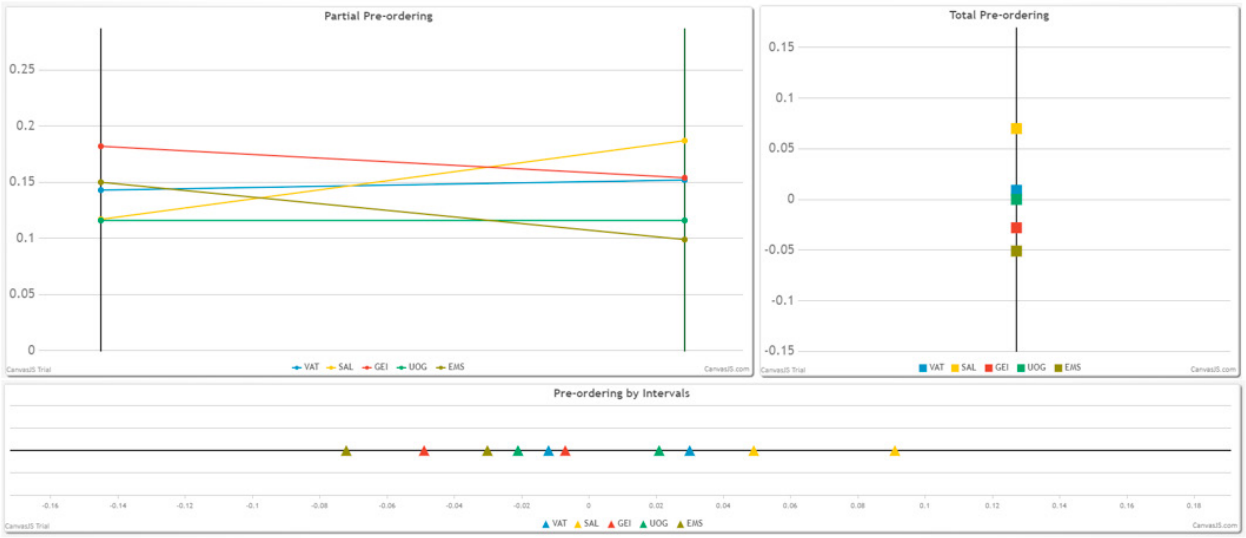

Fig 2. Charts generated by the web platform based on the three models of preference analysis

Table 6. Complete ranking in PROMETHEE-SAPEVO-M1

Alternatives	Net Flow (ϕ)	Rank
SAL	0.07	1ª
VAT	0.009	2ª
UOG	-0	3ª
GEI	-0.028	4ª
EMS	-0.051	5ª

4. Conclusion

Adopting the PROMETHEE-SAPEVO-M1 methodology is expected to enable a decision analysis model, which allows an evaluation as close to reality as possible regarding the use of the ChatGPT tool by professors in the university environment. Modeling will allow decision-makers (in this case, teachers, professors, and researchers) to indicate their preferences and subjectivities regarding the input data and expose the results and the entire decision-making evaluation process in a transparent format equivalently. The results of this research can contribute to a better understanding on the part of teachers about the main alternatives and criteria selected in this study based on ranking order. It could help prepare university students to recognize the potential of AI in this new tool (ChatGPT) and boost a broader debate on the tool at universities. Consequently, this study limits the selection of the grouping of alternatives and criteria that were the most observed in the scientific literature. However, new alternatives and criteria may be suggested and analyzed in future studies.

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