E-Learning Websites Selection and Ranking Using Multi-Criteria Decision-Making Methodology

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Abstract: The present research places significant importance on the evaluation and prioritization of E-learning platforms based on a predetermined set of selection criteria. The primary aim of this research project is to select and rank E-learning websites. The issue pertaining to the selection and ranking of e-learning platforms is addressed through the utilization of a methodology known as multiple-criteria decision-making (MCDM). The task of choosing E-learning websites is addressed through the application of the multicriteria decision-making (MCDM) technique known as Weighted-Combinative Distance-based Assessment (W-CODAS), which is specifically designed to tackle such issues. In order to assess the suitability and effectiveness of the proposed method, a comparison is made between the results obtained from methodology which is proposed and those obtained from established approaches such as Visekriterijumsko Kompromisno Rangiranje (VIKOR) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS). The methodology under consideration has not yet been employed to assess, choose, and prioritize the diverse E-learning platforms.

Keywords: Shannon Entropy, Weighted Combinative Distance-based Assessment (W-CODAS), Selection & Ranking, E-Learning websites.

1. Introduction

E-learning websites now play a significant role in the educational sector. E-learning websites are rapidly expanding across various fields of education, and they are doing so in a very productive and efficient way. Nowadays, a few examples of e-learning websites are Byju, Khan Academy, Coursera, and TedEd, etc. E-learning gives students a more significant opportunity to participate in higher education because they can research the concept whenever and wherever they want without listening in the classroom. Due to significant benefits such as portability, accessibility, cost savings, and so on, E-learning system growth has accelerated rapidly. To select and to rank e-learning websites has become increasingly important for developers in recent years, particularly from the perspective of the educational process. As a result, many companies have earned the advantages of an E-learning environment by using various models, technologies, and strategies. Unlike conventional educational systems, e-learning websites are designed to attain a high-quality learning system. Several factors, including the method, service, and content, determine E-learning’s success. The following main components are evaluated when measuring the E-learning system quality, which are: (i) E-learning activities, (ii) E-learning formatters, (iii) E-learning materials, and (iv) E-learning
infrastructure. Different forms of E-learning applications include virtual classrooms, web-based learning, and digital collaboration. In the past, a lot of researchers have proposed various MCDM techniques for selecting E-learning websites. The proposed methodology, Weighted Combinative Distance-based Assessment (W-CODAS), focuses on the process of selecting and ranking E-learning websites. In addition, this research develops a hierarchy to identify the selection indexes/ sub-indexes for the E-learning website selection.

The research paper includes the preceding notable points: (i) a review of past studies that are relevant in section-2; (ii) a description of the methods to be used in section-3; (iii) an empirical study for the current problem in section-4; (iv) methodology validation in section-5; (v) results in section-6; and (vi) significance of proposed method in section-7. Finally, section-8 contains the results derived from the current research.

2. Literature Review
E-learning website selection has been studied by several researchers. The existing literature was examined to explore e-learning websites, the methods and criteria for their selection, the idea of Multiple Criteria Decision Making (MCDM), various approaches associated with MCDM, and the implementation of these techniques in numerous application domains. Dragulancescu (2002) analyzed the concept of information evaluation, based on some quality management concepts, process-based roles, and techniques, to develop some essential criteria for assessing website quality and selecting relevant websites [1]. Palmer (2002) summarized that website success is a first order via three methods jury, agent-collected, and third-party data that defined and rated website usability, design, and performance criteria such as download latency, navigability, site content, interaction, and responsiveness [2]. Büyükoğlan et al. (2007) evaluated websites using MCDM tool in a fuzzy environment. The author examined ten globally and 11 regionally successful Web sites. It is anticipated that the technique, which proposed a metric to check the quality of a websitewould be helpful to both system developers and scholars involved in Web research and e-learning service providers [3]. Kerkiri et al. (2007) used e-learning to represent personalized learning in networked semantic e-learning systems [4]. Lim and Lee (2007) suggested a usability checklist from a pedagogical perspective for ESL/EFL E-learning. On the one side, this checklist can be used by teachers and web developers to build an ESL/EFL E-learning website. Conversely, learners may use the list to evaluate and choose a platform appropriate for their goals and needs [5]. Yang and Chan (2008) followed a research method which is three-phase that included first defining a set of benchmarks based on a comprehensive analysis of the literature, secondly updating and then refining the criteria through in-service teacher and learner interviews, and third validating, finalizing the standards using expert validity surveys [6].

Liu et al. (2011) used a four-phase testing process to evaluate English learning websites by creating fifty-eight refined evaluation criteria. The author ensured about findings that they were representative and systematic using quantitative and qualitative analysis methods [7]. Abdellatif et al. (2011) used the quality characteristics and weights on them from questionnaires selected by trained developers in our methodology. The suggested quality characteristics are information technology, system reliability, service material, and system functionality [8]. Baklizi and Aighyaline (2011) evaluated Jordanian universities’ E-Learning websites using the ISO/IEC 9126 standard, which assesses the software using six characteristics, and each element has a set of sub-characteristics [9]. Nilashi and Janahmadi (2012) employed the Analytic Hierarchy Process (AHP) and fuzzy reasoning techniques to provide a novel approach for evaluating and ranking the aspects that impact e-learning websites[10]. Juinn and Tan (2013) used the unified philosophy and discussed and explored Taiwanese college students adopting English E-learning websites [11].

Ecer (2014) combined the AHP and COPRAS-G techniques to produce a hybrid prototype that evaluates the quality of bank-related websites. The research also contributes to a better understanding the
relative weights of rating components connected to website quality [12]. Urh et al. (2015) incorporated gamification in the higher education e-learning process using this approach. The differences in techniques, methods, game mechanics, and dynamics were investigated [13]. Nagpal et al. (2015) introduced the FAHP method used to address quality responsibility in an independent evaluation, which analyzes the materials of the essential items on a given website [14]. Jain et al. (2015) recommended WDBA method for evaluating and choosing E-learning websites. The new technique, WDBA, is compared with the existing methodology, which is the approach for order preference by likeness to the perfect solution [15]. Aslam et al. (2016) created a method on the user's mental model basis to evaluate e-learning usability. This study aimed to decouple the above model and how the designers perceive it [16]. Kabak et al. (2017) proposed two methods, ANP and TOPSIS, for determining the relative weights of various distant education websites [17]. Garg and Jain (2017) proposed three steps: summarizing and detecting selection indicators, computing selection index weights using the Fuzzy Analytic Hierarchy Process, and presenting options using the three MADM analytical methods: COPRAS, VIKOR and WDBA for evaluating the website [18].

Yasmina et al. (2020) examined how big data analytics (BDA) skills affect firm performance using multi-factor decision-making (MCDM). IF-DEMATEL, ANP, and simple additive weighting were utilized in this investigation (SAW). BDA capabilities affect operational performance more than market performance[19].

Gong et al. (2021) highlighted our LHFS-TODIM integrated MCDM system. This strategy searched for and implemented the most excellent network teaching e-learning website. LHFS examine professionals' language abilities, the best–worst method (BWM) weights evaluation criteria, and an updated TODIM approach ranks e-learning websites in this new method [20].

Basset et al. (2020) suggested plithogenic MCDM. The author used AHP, VIKOR, and TOPSIS methods. Financial ratios were compared to determine economic performance. Here, Egypt's ten largest steel businesses are compared using financial criteria to evaluate the methodology [21]. Naveed et al. (2020) used AHP, GDM, and FAHP to examine the various dimensions of the E-Learning system. This study shows CSF dimensions and quantifications. After finding them in the literature, the five distinct dimensions and twenty-five parts of the E-Learning system were investigated further. [22].

This literature shows that assessing e-learning websites is an MCDM challenge with contradicting selection indices. Existing techniques like VIKOR, AHP, TOPSIS, and DBA have drawbacks, including additional pair-by-pair comparisons, reliance on expert judgment for data gathering, discrepancy owing to the interrelation of selection indices, or for considering the priority weights for selection indices. This method employs W-CODAS to represent the challenge of selecting e-learning websites as an MCDM problem. The strategy and approach proposed are validated by ranking the twenty-one most popular websites globally [3, 23]. It was concluded that a hybrid model based on W-CODAS could assist pupils and developers in grading these websites.

3. The Methodology: W-Codas
The indicated work proposes the W-CODAS strategy for optimising e-learning websites, which combines the Shannon Entropy method with the CODAS technique. Here, we'll break out the procedure so you can grasp it completely [26].

3.1 Shannon Entropy Approach
The technique of Shannon's Entropy places emphasis on the calculation of weights for performance indices utilized in various decision-making scenarios. Once the performance ratings of the various alternatives for all performance indices have been gathered, a decision matrix is created in order to establish a foundation for calculating the weight. The implementation technique for this method is as follows:
The decision matrix is created of size \([m \times n]\) is \([A_{ij}]_{max}\), where 'm' is the number of alternatives, and 'n' is the performance indexes.

\[
[A_{ij}]_{m \times n} = \begin{bmatrix}
    n_1 & n_2 & \cdots & n_n \\
    m_1 & A_{11} & A_{12} & \cdots & A_{1n} \\
    m_2 & A_{21} & A_{22} & \cdots & A_{2n} \\
    \vdots & \vdots & \vdots & \ddots & \vdots \\
    m_n & A_{m1} & A_{m2} & \cdots & A_{mn}
\end{bmatrix}
\]

The \([A_{ij}]_{max}\) matrix is normalized by Eq.1.

\[
\text{norm} [A_{ij}]_{m \times n} = \frac{A_{ij}}{\sum_{i=1}^{m} A_{ij}}
\]  

(1)

The next step is to calculate the entropy value for each 'n' (performance index), which can be done using eq. (2)

\[
E_{ij} = -k \sum_{n=1}^{n} \text{norm}[A_{ij}](\ln(\text{norm}[A_{ij}])))
\]  

(2)

Where \(k = \frac{1}{\ln (n)}\)

Now by eq. (3) the priority weights of each 'n'(performance index) are calculated.

\[
[w_i]_{m \times 1} = \frac{E_{ii}}{\sum_{i=1}^{n} E_{ii}}
\]

(3)

DAS

In 2016, Ghorabaee et al. [23-24] introduced the CODAS method as a viable a strategy to successfully address decision-making difficulties. The estimation encompasses two specific type of distance, namely Euclidean distance and taxicab distance. The underlying principle of taxicab distance is that the magnitudes of two possibilities are not always equivalent when measured using Euclidean distance. The CODAS methodology is executed systematically:

1) The decision matrix \([A_{ij}]_{m \times n}\) is formulated which consists of performance ratings of alternatives w.r.t.all 'n' (performance indexes).
2) The linear normalisation approach is employed for the purpose of normalising the decision matrix, as seen below:

\[
norm[A_{ij}]_{mxn} = \begin{cases} 
\frac{A_{ij}}{\max A_{ij}} & \text{if } j \in N_b \\
\frac{1}{A_{ij}} & \text{if } j \in N_c
\end{cases}
\]  

(5)

3) The weight matrix \([w_{i}]_{mX1}\), which was derived using the Shannon entropy technique, is subjected to matrix multiplication with another matrix \(\norm[A_{ij}]_{mxn}\) obtained as follows:

\[
\text{weighted}[A_{ij}]_{mxn} = [w_{i}]_{mx1} \ast \norm[A_{ij}]_{mxn}
\]  

(6)

4) In this step, the negative ideal solution is identified as:

\([nsj]_{nx1} = \min(\text{weighted}[A_{ij}]_{mxn})\)

5) Now, for each of the alternatives, the Euclidean and taxicab distance is calculated as given below

\[
ED_i = \sqrt{\sum_{j=1}^{n} \text{weighted}[A_{ij}] - [ns_j]}
\]  

(8)

\[
TD_i = \sum_{j=1}^{n} |\text{weighted}[A_{ij}] - [ns_j]|
\]  

(9)

6) The formulation of the relative preference matrix is presented as follows:

\[
R_p = [R_{ik}]_{mxn}
\]

Where \(R_{ik} = (ED_i - ED_k) + (\phi(ED_i - ED_k) \ast (TD_i - TD_k))\)

Here \(k \in 1 \ldots m\) and \(\phi\) presented below is a threshold function that is employed for the purpose of analysing the equivalence of Euclidean distances between two alternative options. The threshold function is:

\[
\phi(y) = \begin{cases} 
1 & \text{if } |y| \geq \tau \\
0 & \text{if } |y| < \tau
\end{cases}
\]  

(10)

Here \(\tau\) ranges from 0.02 – 0.05.

7) The determination of the final value of the preference index may be conducted as follows for each possible alternative:

\[
P = \sum_{k=1}^{m} R_{ik}
\]  

(11)

8) On basis of preference index value calculated, the various alternatives are evaluated and assigned a hierarchical position in step 7.
Fig 1. Hierarchical development of E-Learning website selection and ranking by using W-Codas

The issue that pertains to select and rank of E-learning websites is succinctly outlined via the use of the provided flow chart in Fig 1. Initially, the quality and e-learning-specific factors are identified and further categorized. Then, the proposed W-CODAS methodology is applied to the alternatives and criteria. At last, the ranking of E-learning website has been obtained.

4. Empirical Study
The suggested methodology's applicability was demonstrated using a data set obtained from earlier research [3]. This dataset included 21 websites and seven ranking factors. The websites listed below are all related to the Turkish educational sector. Tables 2 and 3 offer descriptions of the data sets used in the current study. The performance ratings of these 21 websites are also included in Table 3.

Table2: Criteria for evaluation and their priority weights

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Evaluation criteria</th>
<th>Definition</th>
<th>Priority weights</th>
</tr>
</thead>
<tbody>
<tr>
<td>EC1</td>
<td>“Understandable content”</td>
<td>place a premium on the content’s readability and clarity.</td>
<td>0.09</td>
</tr>
<tr>
<td>EC2</td>
<td>“Complete content”</td>
<td>rent evaluation criteria aim to ensure that data is accurate and valid.</td>
<td>0.17</td>
</tr>
</tbody>
</table>
The fulfillment of the customer's criteria is referred to as personalization.

Security is concerned with concerns such as data integrity, illegal access, and so on.

Navigation is concerned with its ease of use.

Interactivity is concerned with the interaction between the learner and the e-learning website.

The entire style and look of websites are included in the user interface.

<table>
<thead>
<tr>
<th>Label</th>
<th>Website Name</th>
<th>Label</th>
<th>Website Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>ELW1</td>
<td><a href="http://www.online-degree-enlightenment.com">www.online-degree-enlightenment.com</a></td>
<td>ELW12</td>
<td><a href="http://www.kidsplus.com.tr">http://www.kidsplus.com.tr</a></td>
</tr>
<tr>
<td>ELW3</td>
<td><a href="http://www.elearninginstitute.ca">www.elearninginstitute.ca</a></td>
<td>ELW14</td>
<td><a href="http://www.idealearning.com">http://www.idealearning.com</a></td>
</tr>
<tr>
<td>ELW4</td>
<td><a href="http://www.online-education-resources.com">www.online-education-resources.com</a></td>
<td>ELW15</td>
<td><a href="http://www.sanal-kampus.com">http://www.sanal-kampus.com</a></td>
</tr>
<tr>
<td>ELW7</td>
<td><a href="http://www.universalclass.com">www.universalclass.com</a></td>
<td>ELW18</td>
<td><a href="http://www.enocta.com">http://www.enocta.com</a></td>
</tr>
<tr>
<td>ELW8</td>
<td><a href="http://www.sp.edu.sg">www.sp.edu.sg</a></td>
<td>ELW19</td>
<td><a href="http://www.buelc.boun.edu.tr">http://www.buelc.boun.edu.tr</a></td>
</tr>
<tr>
<td>ELW10</td>
<td><a href="http://www.geolearning.com">www.geolearning.com</a></td>
<td>ELW21</td>
<td><a href="http://www.euniversite.org">http://www.euniversite.org</a></td>
</tr>
<tr>
<td>ELW11</td>
<td><a href="http://businessacademy.sbs.com.tr">http://businessacademy.sbs.com.tr</a></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>E-Learning Website Evaluation criteria</th>
<th>EC1</th>
<th>EC2</th>
<th>EC3</th>
<th>EC4</th>
<th>EC5</th>
<th>EC6</th>
<th>EC7</th>
</tr>
</thead>
<tbody>
<tr>
<td>ELW1</td>
<td>0.71</td>
<td>0.88</td>
<td>0.08</td>
<td>0.12</td>
<td>0.29</td>
<td>0.38</td>
<td>0.8</td>
</tr>
<tr>
<td>ELW2</td>
<td>0.92</td>
<td>0.92</td>
<td>0.5</td>
<td>0.71</td>
<td>0.86</td>
<td>0.88</td>
<td>0.92</td>
</tr>
<tr>
<td>ELW3</td>
<td>0.94</td>
<td>0.86</td>
<td>0.38</td>
<td>0.71</td>
<td>0.94</td>
<td>0.92</td>
<td>0.68</td>
</tr>
<tr>
<td>ELW4</td>
<td>0.8</td>
<td>0.94</td>
<td>0.59</td>
<td>0.94</td>
<td>0.92</td>
<td>0.92</td>
<td>0.68</td>
</tr>
<tr>
<td>ELW5</td>
<td>0.71</td>
<td>0.92</td>
<td>0.92</td>
<td>0.8</td>
<td>0.71</td>
<td>0.71</td>
<td>0.71</td>
</tr>
<tr>
<td>ELW6</td>
<td>0.41</td>
<td>0.2</td>
<td>0.2</td>
<td>0.68</td>
<td>0.29</td>
<td>0.32</td>
<td>0.29</td>
</tr>
<tr>
<td>ELW7</td>
<td>0.38</td>
<td>0.29</td>
<td>0.92</td>
<td>0.68</td>
<td>0.68</td>
<td>0.5</td>
<td>0.59</td>
</tr>
<tr>
<td>ELW8</td>
<td>0.92</td>
<td>0.92</td>
<td>0.5</td>
<td>0.71</td>
<td>0.29</td>
<td>0.59</td>
<td>0.71</td>
</tr>
</tbody>
</table>
The matrix presented in Table 4 is regarded as a decision rating matrix within the framework of the W-CODAS approach. The decision rating matrix is normalised using Equation (3), and further stages of the W-CODAS method are executed as described in Equations (4) to (10).

In conclusion, the final preference index value for all e-learning websites has been computed utilising Equation (11). The values of the preference index and the final rankings for each of the E-learning websites are shown in Table 5.

The E-learning website that possesses the lowest preference index value is positioned at the topmost rank, namely number one, whilst the website exhibiting the greatest value is positioned at the lowest rank, specifically number twenty-one.

<table>
<thead>
<tr>
<th>E-Learning Website</th>
<th>Preference index value</th>
<th>Rank</th>
<th>Learning Website</th>
<th>Preference index value</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>ELW1</td>
<td>6.052</td>
<td>20</td>
<td>ELW12</td>
<td>-1.467</td>
<td>10</td>
</tr>
<tr>
<td>ELW2</td>
<td>-3.664</td>
<td>4</td>
<td>ELW13</td>
<td>1.947</td>
<td>16</td>
</tr>
<tr>
<td>ELW3</td>
<td>-3.381</td>
<td>6</td>
<td>ELW14</td>
<td>-1.595</td>
<td>9</td>
</tr>
<tr>
<td>ELW4</td>
<td>-3.861</td>
<td>3</td>
<td>ELW15</td>
<td>-1.850</td>
<td>8</td>
</tr>
<tr>
<td>ELW5</td>
<td>-3.602</td>
<td>5</td>
<td>ELW16</td>
<td>3.114</td>
<td>17</td>
</tr>
<tr>
<td>ELW6</td>
<td>4.569</td>
<td>18</td>
<td>ELW17</td>
<td>-0.078</td>
<td>13</td>
</tr>
<tr>
<td>ELW7</td>
<td>-0.686</td>
<td>12</td>
<td>ELW18</td>
<td>-4.197</td>
<td>1</td>
</tr>
<tr>
<td>ELW8</td>
<td>-0.797</td>
<td>11</td>
<td>ELW19</td>
<td>0.972</td>
<td>15</td>
</tr>
<tr>
<td>ELW9</td>
<td>-4.062</td>
<td>2</td>
<td>ELW20</td>
<td>-2.823</td>
<td>7</td>
</tr>
<tr>
<td>ELW10</td>
<td>5.635</td>
<td>19</td>
<td>ELW21</td>
<td>0.535</td>
<td>14</td>
</tr>
<tr>
<td>ELW11</td>
<td>9.238</td>
<td>21</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5. Methodology Validation

The validation of the W-CODAS methodology in this study involves a comparison with the widely recognised VIKOR and TOPSIS methodologies. These approaches are utilised for the assessment and optimal selection of E-Learning websites on dataset-I. After gathering the rankings of e-learning websites by three methodologies, namely W-CODAS, VIKOR, and TOPSIS, the statistical analysis known as Spearman's rank correlation is employed to assess the associations between the sets of ratings received from each approach. Spearman's coefficient is a statistical measure used to assess the significance of a correlation between two or more sets of evaluations or rankings. To illustrate the concept, let us use a hypothetical set of 'n' options that are accompanied by two distinct ranking systems, denoted as R1 and R2.

First, determine the ranking differences ($d_i^2$) between R1 and R2, and then calculate Spearman's rank ($r_s$) using the equation below:

$$r_s = 1 - \frac{6 \sum d_i^2}{n(n^2 - 1)}$$

(12)

The range of possible values for the trigonometric function ($r_s$) spans from -1 to 1. A numerical value closer to +1 indicates a robust positive correlation between the two sets of rankings, whereas a value closer to -1 indicates a significant negative correlation. Moreover, in the event of a correlation between the two distinct sets of rankings, the degree of the relationship may be assessed by employing the calculated Spearman's rank coefficient. The correlation results for dataset-I, as determined by Spearman's Rank correlation, are presented in Table 5.

Table 6: Comparison of E-learning websites ranking by VIKOR, TOPSIS & W-CODAS

<table>
<thead>
<tr>
<th>E-Learning Websites</th>
<th>Ranking by VIKOR</th>
<th>Ranking by TOPSIS</th>
<th>Ranking by W-CODAS</th>
<th>Spearman's rank calculation of VIKOR &amp; W-CODAS</th>
<th>Spearman's rank calculation of TOPSIS &amp; W-CODAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>ELW1</td>
<td>14</td>
<td>12</td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ELW2</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ELW3</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ELW4</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ELW5</td>
<td>8</td>
<td>7</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ELW6</td>
<td>21</td>
<td>20</td>
<td>18</td>
<td>0.8805195</td>
<td>0.8292555</td>
</tr>
<tr>
<td>ELW7</td>
<td>18</td>
<td>19</td>
<td>12</td>
<td></td>
<td></td>
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<tr>
<td>ELW8</td>
<td>7</td>
<td>5</td>
<td>11</td>
<td></td>
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</tr>
<tr>
<td>ELW9</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ELW10</td>
<td>16</td>
<td>15</td>
<td>19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ELW11</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>ELW12</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td></td>
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</tr>
</tbody>
</table>
The findings are shown in Table 6, demonstrating that Spearman’s rank correlation coefficient was 0.880, 0.829. The resulting rank correlation offers a substantial positive connection between the rankings achieved using the W-CODAS approach and those acquired using TOPSIS and VIKOR.

1. Results

According to the methodology and framework proposed in this study, the alternative (E-learning website) exhibiting the lowest preference index value is assigned the top rank or position, while subsequent ranks or positions are assigned in ascending order of preference index values until the alternative with the highest value is placed at the bottom. In essence, it may be stated that a lower reference index value corresponds to a higher ranking. Figure 2 presents a visual representation illustrating the comparative rankings of the 21 E-learning websites based on seven distinct ranking criteria, denoted as EC1-EC7. The website www.enocta.com (ELW18) is positioned at the lowest rank, specifically number -1, as indicated by its preference index.

Table 6: E-Learning Websites Rankings

<table>
<thead>
<tr>
<th>ELW13</th>
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<tr>
<td>ELW21</td>
<td>13</td>
<td>11</td>
<td>14</td>
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</tbody>
</table>

Figure 2: E-Learning Websites Rankings
The ranking results acquired using the W-CODAS approach are also compared to those obtained using the current methods, TOPSIS and VIKOR. Figure 3 demonstrates the significant association between the TOPSIS, VIKOR, and W-CODAS ranks via a graphical depiction of the comparative rankings of these three techniques.

Figure 3: VIKOR, TOPSIS, and W-CODAS ranks

2. Significance Of W-Codas

Humans have grown more reliant on information technology in today's environment. The e-learning websites handle and regulate every aspect of learning. Due to this dependence, websites and apps with a wide range of functions are created. Every software developer aspires to create highly dependable e-learning websites at the lowest possible cost. W-CODAS is used in this study to choose the best e-learning websites. Although other MCDM techniques have previously been deployed, such as TOPSIS, VIKOR, weighted criteria value, and so on, W-CODAS has significant benefits, as shown below.

- The W-CODAS has a significant advantage over other types in that it considers both Euclidean and Taxicab distances. As a result, the relative assessment value used to rank e-learning websites is calculated by combining both distances that directly increase ranking accuracy.

- W-CODAS considers priority weights of performance indexes since priority weights directly impact ranking outcomes in any MCDM scenario.

- W-CODAS is a systematic and straightforward calculation procedure that accurately represents the basic principle of real-world MCDM situations.

3. Conclusion, Implications, And Future Scope

Conclusions: This review centres on the imminent issue of evaluating, ranking, and selecting E-learning websites, which holds substantial implications for the educational sector. The W-CODAS (Weighted Shannon Entropy method blended with CODAS approach) is a novel and innovative strategy that has been employed for the first time to tackle the present issue by framing it as a Multiple Criteria Decision Making (MCDM) problem. The inclusion of a case study serves to illustrate the practicality and effectiveness of the
suggested W-CODAS approach in addressing the present issue of E-learning website selection. The inclusion of a validation process in the current work, which involves comparing the W-CODAS ranking findings to established MCDM systems like TOPSIS and VIKOR, and employing Spearman’s rank correlation test, enhances the robustness and credibility of the research.

**Implications:** The primary significance of this study is that it only looked at one dataset of e-learning websites. Because of its exploratory and interpretative character, this study opens up a lot of websites for further investigation, especially in terms of e-learning website evaluation and rankings.

**Future Scope:** New e-learning websites may be considered, various approaches such as the best-worst method for priority weight calculation can be used, more datasets can be considered, and the sensitivity analysis idea can be applied, among other things.

**References**


