Visibility Ranking of University E-Learning Websites – CRITIC Method Approach

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Abstract. This study aims to determine the factors that affect the visibility of a website on a search engine and determine the ranking of visibility based on the variables that influence it. Based on the literature review, it was found that the variables that affect the visibility of the website are 9 criteria. Data collection was carried out on 7 e-learning websites of universities in Indonesia which have the mandate to organize teacher professional programs. The ranking mechanism is done by normalizing the data from several variables that have different units and dimensions, followed by finding the weight of each variable using the CRITIC method, which is one of the objective methods of multicriteria decision analysis. The results of weight processing show that the keyword usage level domain variable is the most important variable, and domain level link authority features are the least significant effect on website visibility, while the ranking of visibility shows that Yogyakarta State University has the best ranking. A fairly efficient methods of CRITIC could be modelled with any number of criteria and alternatives that the problem has, since its procedure is very clear and concise.

1. Introduction
The increase in devices connected to the Internet, the creation of social networks or geolocation have led to the massive accumulation of data or big data. The phenomenon has grown exponentially since the launch of the World Wide Web by the British Tim Berners-Lee, at which time global networks transported 100 gigabytes of data per day, a figure that has been increased by a quarter of century later up to 26,600 gigabytes per second [1]. This phenomenon is contributed by the sending of more than 2.7 million emails, the realization of almost 72,000 searches on Google or the viewing of more than 77,000 videos on YouTube, all this, for just one second [2]. Faced with these staggering numbers, it is clear that visibility in digital media has become an increasingly complex task for organizations. Users, eager to find any type of information on the Internet, make a multitude of queries throughout their day to day in any of the existing search engines. These correspond to a series of results related to the terms that you have entered on your computer or mobile device. However, why do the same organizations always appear in the top search positions? What leads them to have maximum visibility on the network? The logic used by current search engines to order their results is inspired by the operation of the Science Citation Index developed by Eugene Garfield in the mid-20th century [3]. According to the ideologist of this popular documentary database, its success lies in its use as a tool to measure scientific productivity through the impact factor [4]. On web pages, this impact factor is defined by search engine optimization (SEO) or organic search engine positioning, which encompasses a series of factors that allow websites to rank among the top rankings search results [5]. In this way, the present research will...
try to reveal which are those factors that influence the visibility of organizations on the Internet. And, for this, the study will be based on the comparative analysis of two study subjects related to the academic world.

2. Methodology

The objectives of this study are twofold, 1) determining the variables that determine the visibility of a website, especially seen from the search engine side 2) determining the visibility ranking of e-learning websites from several universities in Indonesia using the CRITIC method which is one of the multicriteria decision analysis methods. Data were collected using online tools available for nine variables. Data were collected several times with a period of three months in order to get results that had a fairly good level of reliability.

2.1. Sample Data

The data sample in this study is an e-learning website from a university which is a university in Indonesia that is given the authority to organize teacher professional education. There are 12 State Universities in Indonesia that fall into this category, but because not all can be accessed using online tools to get value in terms of visibility, only seven university websites were taken as the research sample. Table 1 shows the list of Universities along with their e-learning URL addresses.

| No | E-learning URL                  | List of Universities                  |
|----|---------------------------------|---------------------------------------|
| 1  | https://elena.unnes.ac.id/       | Universitas Negeri Semarang           |
| 2  | https://elearning.undiksha.ac.id/| Universitas Pendidikan Ganesha        |
| 3  | http://e-learning.um.ac.id/      | Universitas Negeri Malang             |
| 4  | http://Besmart.uny.ac.id         | Universitas Negeri Yogyakarta         |
| 5  | http://elearning.unp.ac.id/      | Universitas Negeri Padang             |
| 6  | http://lms.unn.ac.id/            | Universitas Negeri Makassar           |
| 7  | http://lms.upi.edu               | Universitas Pendidikan Indonesia      |

2.2. CRITIC Method

CRITIC method, original by Diakoulaki, Mavrotas and Papayannakis, was presented in 1995 in the journal Computers Operation Research [6]. Its name is the acronym for CRiteria Importance Through Intercriteria Correlation, and it weights each criterion according to expression [1] based on the data taken by the different alternatives for said criterion. In this paper, the method used to calculate the weight of the variables that affect the visibility of a website is the CRITIC method. After getting the weight of each variable, the ranking of each e-learning website sample is obtained by multiplying the weight of the variable by the data normalization value from each sample website. The CRITIC method is applicable in adjustment stages and combined with a multi-criteria methodology, based on clear quantitative information, demonstrates the relative importance of each of the criteria that will help to make a better decision. It is based on the analysis of a data matrix from which all the information contained in the criteria to be evaluated (explanatory variables) is extracted [7]. With this analysis, supported by the valuation ratio, the first form Ratio CRITIC is obtained, each explanatory variable is normalized in order to have values that oscillate between 0 and 1, which will allow us to calculate their global ratios [8] and with this ratio the value per variable of the subject in question was calculated. CRITIC is based on the standard deviation approach [7], so it is subsequently calculated for each variable. With its result, the Correlation Coefficient is calculated, used to measure the dependence between two variables [7], and subsequently the correlation coefficients between the variables are calculated. The standard deviation and Pearson's correlation coefficient will give us the information necessary to obtain the relative weighting (P or C) of each of the explanatory variables using the following expression. Usually, it is difficult to compare between different kinds of indictors because of the different dimension. Therefore, the standardized transformation to these indicators must be done.

2
Step 1: The data is grouped in the form of an X matrix whose rows represent the values of the criteria while the columns are attribute based values.

\[
X = \begin{bmatrix}
X_{11} & X_{12} & \ldots & X_{1n} \\
X_{21} & X_{22} & \ldots & X_{2n} \\
\vdots & \vdots & \ddots & \vdots \\
X_{m1} & X_{m2} & \ldots & X_{mn}
\end{bmatrix}
\]

(i = 1,2,…,m and j = 1,2,…,n) (1)

\(x_{ij}\) shows the value of alternative to i for criteria to j.

Step 2: Matrix decisions are converted into normal or normalized values by performing calculations based on equations:

\[
X_i = \frac{X_i(k) - \min X_i(k)}{\max X_i(k) - \min X_i(k)}
\]

\[
X_i = \frac{\max X_i(k) - X_i(k)}{\max X_i(k) - \min X_i(k)}
\]

(2) (3)

\(X_i\) is the result of the normalization process for the alternative value to i for the criterion j. There are two equations for obtaining the value of \(X_i\), namely by using the min-max scale, which means that all values will be transformed into a scale between [0,1].

Step 3: Where \(C_j\) is the relative weight (amount of information contained in variable) j, \(\sigma_j\) is the standard deviation of variable j and \(r_{ij}\) is the correlation coefficient of criteria i and j. As a final step, the information is normalized to obtain objective weights (W), using the following equation:

\[
c_j = \sigma_j \sum_{i=1}^{m} (1 - r_{ij}), \quad i = 1,2, \ldots, n
\]

(4)

\(C_j\) is the correlation coefficient between the two criteria. It can be concluded that this method gives the higher weight to the criterion which has high standard deviation and low correlation with other criteria [9]. Namely higher value of \(C_j\) means that a greater amount of information is obtained from the given criterion so the relative significance of the criterion for the decision-making problem is higher.

\[
w_j = \frac{c_j}{\sum_{i=1}^{m} c_i}
\]

(5)

where \(w_j\) is the target weight of variable j, \(C_j\) is the relative weight of the variable, \(C_i\) is the sum of the weight of the variables j. Here it should be noted that normalization does not take into account the type of criteria.

3. Results and Discussion

Results of the e-learning websites test based on domain level link authority features (A), Page level link factors (B), Page level KW and Content features (C), Page level, Keyword Agnostic features (D), Domain Level Brand features (E), User, Usage & Traffic / Query data (F), Social Metrics (G), Domain Level Keyword Usage (H), and Domain Level keyword Agnostic Features (I) are showed in Table 2.

As can be seen in said Table 2, depending on the criterion that we use, the ordering from best to worst of the companies varies. Our goal is to obtain an ordering and weighting based on the nine criteria and their importance. For this, we determine for each criterion the maximum, minimum and range (maximum-minimum).
Table 2. Testing Result for Websites Performance Based on Criteria

| A  | B  | C   | D   | E   | F   | G   | H   | I   |
|----|----|-----|-----|-----|-----|-----|-----|-----|
| UNNES | 163 | 5  | 0.17 | 3.8 | 70  | 1,074,175 | 0  | 103 | 1,474 |
| UNDIKSHA | 5  | 4  | 0.63 | 7  | 55  | 132,237  | 0  | 13  | 1,959 |
| UM   | 448 | 5  | 0.51 | 15 | 70  | 475,809  | 19 | 61  | 2,844 |
| UNY  | 247 | 4  | 0.08 | 2.7 | 57  | 546,952  | 2  | 103 | 1,474 |
| UNP  | 11  | 4  | 0.46 | 10.8| 62  | 192,735  | 57 | 102 | 1,359 |
| UNM  | 54  | 5  | 0.35 | 7.2 | 72  | 694,998  | 83 | 101 | 1,764 |
| Fmax | 5   | 4  | 0.63 | 15 | 70  | 1,074,175| 83 | 103 | 4,382 |
| Fmin | 4   | 0.08 | 2.7 | 57 | 132,237 | 0  | 2   | 1,359 |
| Best | 2,470 | 5  | 0.63 | 15 | 70  | 1,074,175| 83 | 2   | 1,359 |
| Worst| 5   | 4  | 0.08 | 15 | 55  | 132,237  | 0  | 103 | 4,382 |

We normalize the information and in this case the normalization is by the range and the results showed in Table 3.

Table 3. Normalisation Result for Websites Performance Based on Criteria

| A  | B  | C   | D   | E   | F   | G   | H   | I   |
|----|----|-----|-----|-----|-----|-----|-----|-----|
| UNNES | 0.064 | 1,000 | 0.164 | 0.911 | 0.882 | 1,000 | 0.000 | 0.000 | 0.962 |
| UNDIKSHA | 0.000 | 0.000 | 1,000 | 0.650 | 0.000 | 0.000 | 0.000 | 0.891 | 0.802 |
| UM   | 0.180 | 1,000 | 0.782 | 0.000 | 0.882 | 0.365 | 0.229 | 0.416 | 0.509 |
| UNY  | 1,000 | 1,000 | 0.945 | 0.537 | 0.941 | 0.924 | 0.470 | 0.594 | 0.432 |
| UNP  | 0.002 | 0.000 | 0.000 | 1,000 | 0.118 | 0.440 | 0.000 | 1,000 | 0.000 |
| UNM  | 0.001 | 0.000 | 0.691 | 0.341 | 0.412 | 0.064 | 0.687 | 0.010 | 1,000 |
| UPI  | 0.020 | 1,000 | 0.491 | 0.634 | 1,000 | 0.597 | 1,000 | 0.020 | 0.866 |
| Stddev | 0.367 | 0.535 | 0.383 | 0.339 | 0.421 | 0.387 | 0.394 | 0.427 | 0.360 |

The values of correlation coefficient are then calculated and shown in Table 4. In Formula (5), \(w(k)\) to every indictor and to every visibility may be different.

Table 4. Correlation coefficient values of the criteria

| A  | B  | C   | D   | E   | F   | G   | H   | I   |
|----|----|-----|-----|-----|-----|-----|-----|-----|
| A  | 1.00 | 0.46 | 0.44 | -0.17 | 0.44 | 0.53 | 0.11 | 0.15 | -0.28 |
| B  | 0.46 | 1.00 | 0.04 | -0.23 | 0.95 | 0.76 | 0.27 | -0.47 | 0.14 |
| C  | 0.44 | 0.04 | 1.00 | -0.66 | 0.04 | -0.35 | 0.22 | 0.09 | 0.27 |
| D  | -0.17 | -0.23 | -0.66 | 1.00 | -0.31 | 0.35 | -0.33 | 0.24 | -0.19 |
| E  | 0.44 | 0.95 | 0.04 | -0.31 | 1.00 | 0.71 | 0.49 | -0.65 | 0.24 |
| F  | 0.53 | 0.76 | -0.35 | 0.35 | 0.71 | 1.00 | 0.00 | -0.27 | -0.10 |
| G  | 0.11 | 0.27 | 0.22 | -0.33 | 0.49 | 0.00 | 1.00 | -0.59 | 0.37 |
| H  | 0.15 | -0.47 | 0.09 | 0.24 | -0.65 | -0.27 | -0.59 | 1.00 | -0.76 |
| I  | -0.28 | 0.14 | 0.27 | -0.19 | 0.24 | -0.10 | 0.37 | -0.76 | 1.00 |
According to the CRITIC method, we can get the results: \( w(A) = 0.0855 \), \( w(B) = 0.1199 \), \( w(C) = 0.1119 \), \( w(D) = 0.1163 \), \( w(E) = 0.0947 \), \( w(F) = 0.0908 \), \( w(G) = 0.1085 \), \( w(H) = 0.1617 \), and \( w(I) = 0.1107 \). Then the relational degree can easily get by using Formula (5). CRITIC method has to assign weights to the criteria that involve in decision making process. The final score obtained for each website across each criterion was calculated by multiplying the weight of each criterion with the weight of each website. Website which has the highest score is suggested as the best visibility and decision maker may consider that one as the best decision choice.

**Table 5. Weight Results Based on Criteria**

|    | standard dev | Sum (1-\( r_{ij} \)) | stddevXsum (1-\( r_{ij} \)) | Weight |
|----|--------------|-----------------------|-------------------------------|--------|
| A  | 0.3669       | 6.3164                | 2.3172                        | 0.0855 |
| B  | 0.5345       | 6.0769                | 3.2483                        | 0.1199 |
| C  | 0.3831       | 7.9142                | 3.0320                        | 0.1119 |
| D  | 0.3388       | 9.3019                | 3.1515                        | 0.1163 |
| E  | 0.4211       | 6.0934                | 2.5657                        | 0.0947 |
| F  | 0.3871       | 6.3604                | 2.4620                        | 0.0908 |
| G  | 0.3941       | 7.4649                | 2.9418                        | 0.1085 |
| H  | 0.4269       | 10.2668               | 4.3827                        | 0.1617 |
| I  | 0.3604       | 8.3260                | 3.0007                        | 0.1107 |

According to Table 5, Domain Level Keyword Usage (H) and Page Level link factors (B) are the most and least important criteria respectively. The last step in this method is to compute the final score of each website. Then get the sum of each column and the sum represents the score of each single website.

**Table 6. Final Result for e-learning website Based on CRITIC Method**

| Uni | A    | B    | C    | D    | E    | F    | G    | H    | I    | Score | Ranking |
|-----|------|------|------|------|------|------|------|------|------|-------|---------|
| 1   | 0,0055 | 0,0493 | 0,0162 | 0,0191 | 0,0382 | 0,0544 | 0,0000 | 0,0866 | 0,0236 | 0,2929 | 5       |
| 2   | 0,0002 | 0,0394 | 0,0599 | 0,0352 | 0,0300 | 0,0067 | 0,0000 | 0,0109 | 0,0314 | 0,2137 | 6       |
| 3   | 0,0152 | 0,0493 | 0,0485 | 0,0754 | 0,0382 | 0,0241 | 0,0188 | 0,0513 | 0,0456 | 0,3663 | 3       |
| 4   | 0,0839 | 0,0493 | 0,0570 | 0,0422 | 0,0387 | 0,0507 | 0,0386 | 0,0362 | 0,0493 | 0,4460 | 1       |
| 5   | 0,0004 | 0,0394 | 0,0076 | 0,0136 | 0,0311 | 0,0277 | 0,0000 | 0,0017 | 0,0702 | 0,1916 | 7       |
| 6   | 0,0002 | 0,0394 | 0,0437 | 0,0543 | 0,0338 | 0,0098 | 0,0564 | 0,0858 | 0,0218 | 0,3452 | 4       |
| 7   | 0,0018 | 0,0493 | 0,0333 | 0,0362 | 0,0393 | 0,0352 | 0,0822 | 0,0850 | 0,0283 | 0,3904 | 2       |

Table 6 shows the results of the final score for each e-learning website and its ranking. The website that gets the highest score based on calculations with the CRITIC method approach is the best e-learning website in terms of visibility. The Yogyakarta State University e-learning website (besmart.uny.ac.id) is the best website with a score of 0.4460. The achievements obtained by Yogyakarta State University are influenced by the high value of A (domain level link authority features) which is far above the e-learning website of other websites. As a result, the proposed CRITIC model rank for e-learning website is: besmart.uny.ac.id (score: 0.4460), lms.upi.edu (score: 0.3904), e-learning.um.ac.id (score: 0.3663), lms.unm.ac.id (score: 0.3452), elena.unnes.ac.id (score: 0.2929), elearning.undhiksa.ac.id (score: 0.2137) and the last rank is elearning.unp.ac.id (score: 0.1916).
4. Conclusion
The CRITIC method can be performed to evaluate the alternatives with quantitative variables since it allows a more objective view of the solution to the problem. When obtaining the weighting of the e-learning website visibility variables, we examined many dimensions of visibility, and each dimension was measured by a specific test online. The difference in the weight or weighting of each variable referring to its category. A fairly efficient methods of CRITIC could be obtained, since it can be modelled with any number of criteria and alternatives that the problem has, since its procedure is very clear and concise. As a result, in overall ranking for the proposed model rank for e-government website is: 4, 7, 3, 6, 1, 2, 5. One of the things that need to be considered in the development of future research is the addition of sample university website data and the use of more than 1 tool to increase the validity of the results.

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