# Development of Websites Ranking Algorithm Based on SEO Metrics*

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**Abstract**
The paper deals with the development of websites ranking algorithm and its web application based on search optimization metrics data. The application provides web page search optimization analysis and website ranking based on it, which will allow both entities and companies to select the best websites to post information about their products or services. The algorithm is based on Entropy Weight and TOPSIS methods of multi-criteria decision analysis.

**Keywords**
Website, ranking, algorithm, SEO, Entropy, TOPSIS.

## 1. Introduction

The development of the Internet and web technologies has led to a growing demand for online sales. Online sales are an effective and convenient way for businesses to increase brand awareness, credibility with potential customers, and sales [1]. Through the Internet and web technologies, both entities and companies sell their products and services, moreover, companies create their websites for online sales, which is associated with high costs, therefore, entities, and small and medium-sized companies find it difficult to pay this cost. To solve this problem, many sites allow businesses to post information about their products or services so that they are easily accessible to end users. Today there are many such websites, their excess creates the need for companies to make the right choice in site selection. Internet users collect text, sentences, and combinations of words in the search engine, and therefore trust the site that they see first from the options offered by the browser. A general criterion for selecting a website for a business is that the site is easily searchable and visible to the user, which is responsible for search engine optimization (SEO) [2]. Sites that rank high in search engines are considered to meet high quality and reliability standards, thus increasing the credibility of that business [23, 24].

Through good SEO, a business can direct its services or products to not one, but at the same time, several target audiences and, if this process is carried out effectively, simultaneously and equally reach those users who may be interested in its products. Many SEO metrics can be used to determine how advanced a website is in search engines.

The use of the above helps us to select a highly rated site for our business, which is an actual issue for business today. The issue's urgency stems from the great practical importance of solving the problem.

Based on the relevance of the mentioned problem, the goal of our work is to develop a ranking algorithm, which will enable the subject or company to select the best website for their business.

Through the application offered by us, companies or entities will be able to choose a website for their business, without specialist consultation, which is related to financial costs.

* *IVUS2024: Information Society and University Studies 2024, May 17, Kaunas, Lithuania*
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Thus, the novelty of the research lies in the development of the website ranking algorithm and its software, thus we finally get a software tool that makes the process of selecting websites for business efficient and easy.

## 2. SEO metrics

SEO metrics are a way to measure your search engine optimization performance and make corrective changes based on metrics [11, 12, 13]. When creating a website, if key metrics are not considered, the website's ability and search engine ranking will be overlooked. Key metrics are extremely important and directly impact Google's ranking factors. One of the reasons why search engine optimization can be effective is to control the metrics data and measure everything. SEO metrics provide key insights into how your organic search strategy is performing [12, 13, 14, 25]. In addition, SEO metrics can be called vital data points of a website to create a better strategy or to drastically improve an existing strategy. Simply put, if we can't measure it, we can't manage that data. Without detailed monitoring, it is impossible to discover the website's potential and increase both organic search traffic and revenue. At the same time, potential threats to existing businesses can be overlooked by digital marketing radars. Moreover, many search engine metrics are ready to perform large-scale marketing opportunities. The search engine is usually always changing, so Google is always ready to update its search algorithm. With all of the above in mind, it's important to regularly monitor SEO metrics to ensure that the website is properly optimized to deliver benefits[1, 2]. To monitor any changes to the site through organic search, it is necessary to focus on the key metrics that have the most impact on the search engine, and ultimately the business [14, 15].

In our research, we have chosen the main metrics that provide important information about the website as evaluation criteria, namely [11, 12, 13]:

- Organic Traffic - This is the visitors who come to the website from various free sources, simply put it is free traffic. These sources include search engines such as Google, Yahoo or Bing. A brand of digital marketing whose goal is to improve organic traffic can be called search engine optimization. Organic Traffic is the most important form of traffic a website can receive. All this is much more important than paid traffic or traffic from social media networks.
- Keyword ranking - This is a web page's ranking, and position, in search results for specific words. Most web pages have multiple keywords when navigating to different pages. Search results will vary based on what Google has deemed to be most relevant for that particular search word or phrase. When a user searches for a specific keyword, the ranking URL will be the web page listed for that keyword. A single web page can rank for a relevant search term and phrase.
- SERP Visibility - This metric represents the estimated monthly traffic received by monitoring the keywords in the project. It is defined as the ratio of the search volume of the query to the click-through rate of the current ranking position. Output value This is a metric that reflects the change in ranking according to its potential.
- Click-Through Rate - This is a ratio that shows how often people clicked on hyperlinks compared to who viewed those links. Click-through rate (CTR) can be used to measure how well your keywords and ads are performing on a web page. CTR is calculated by the number of times an ad is clicked on a web page divided by the number of times the ad is displayed: clicks ÷ views = CTR. For example, if we had 5 clicks and 100 views, then the CTR of the web page would be 5%.
- Bounce Rate - Is an important metric to measure user engagement on each page of a website. It shows which pages are more interesting for visitors and which pages can be improved. It is the number of visitors to a given web page who leave the web page after viewing one page. For example, a user enters a web page, only browses it, and leaves without any clicks, transactions, or any action.
- Website Authority Over Time - This is an SEO concept that involves the overall "power" of a particular domain. Power, in this case, is the ability, the probability, of how a web page's links are ranked in search engines. Its indicator is measured on a scale from 1 to 100. A brand-new

website always starts with one authority score and this score slowly increases as the site generates more and more authoritative links over time. Websites with a high DA (Domain Authority) score have a better chance of ranking in search engines and getting more organic traffic.

- Page Speed - This is the loading speed, which measures how quickly the content of a web page loads. From an SEO point of view, fast page speed is essential. Loading speed depends on many factors, such as web hosting and application size. Web page loading speed is also different for desktop and mobile versions of a web page.
- Conversion Rate - An SEO conversion rate is the percentage of a specific action taken by organic website visitors. To calculate it, we need to divide the number of users who perform this action during a specific period by the total number of visitors to the website. The CRO process involves understanding how users move through a website, what actions they take, and what prevents them from achieving their goals [1, 11, 12, 13].

## 3. Related work

[3] In the paper, the authors propose a ranking algorithm for e-commerce websites that uses the Fuzzy Topsis(Technique for Order of Preference by Similarity to Ideal Solution) method, the algorithm is based on user ratings. The approach proposed therein focuses on the evaluation of e-commerce websites by users, with linguistic variables representing fuzzy triangular numbers. The weights of evaluation criteria are also determined by linguistic variables. Alternatives (websites) are ranked using the TOPSIS method. In the mentioned approach, the ranking result of the websites is completely dependent on the evaluation of the users.

[4] The paper deals with the use of SEO metrics in the evaluation of the quality of Wikipedia articles. It presents the results of an analysis of various SEO indicators related to multilingual Wikipedia and its reference.

[5] The paper proposes a technique for increasing the ranking of websites using grazing optimization. [6] The paper proposed ranking of B2C websites using AHP(analytic hierarchy process) and Fuzzy TOPSIS methods, in which evaluation criteria and their weights are determined by a human-expert. [7] The paper proposes the evaluation of e-commerce websites using the Fuzzy Hierarchical TOPSIS method.

Thus, there are many scientific studies related to the evaluation and ranking of websites, for which multi-criteria decision analysis methods are actively used. In most of them, websites are evaluated by a human expert, which may not always give you an objective result.

## 4. Defining the problem

The problem is choosing high-ranking websites for businesses to post information about their services and products. The problem is similar to a multi-criteria decision problem: Given a set of websites $S=\{s_1, s_2, s_3, \ldots, s_m\}$ and a set of evaluation criteria $C=\{c_1, c_2, c_3, \ldots, c_n\}$ - which are SEO metrics.

For each site $s_i$, we must determine the value of the metric $c_j$, and then we must determine the decision matrix, based on which we must calculate the weights of the evaluation criteria and rank the websites, to select the best one. The decision matrix has the following form:

**Table 1**
decision matrix

| | Organic Traffic | Keyword Rankings | SERP Visibility | Click-Through Rate | Bounce Rate | Page Authority Over | Page Speed | Conversion Rate |
|---|---|---|---|---|---|---|---|---|

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| WebSite 1 | $x_{11}$ | $x_{12}$ | $x_{13}$ | $x_{14}$ | $x_{15}$ | $x_{16}$ | $x_{17}$ | $x_{18}$ |
| WebSite 2 | $x_{21}$ | $x_{22}$ | $x_{23}$ | $x_{24}$ | $x_{25}$ | $x_{26}$ | $x_{27}$ | $x_{28}$ |
| WebSite 3 | $x_{31}$ | $x_{32}$ | $x_{33}$ | $x_{34}$ | $x_{35}$ | $x_{36}$ | $x_{37}$ | $x_{38}$ |
| WebSite 4 | $x_{41}$ | $x_{42}$ | $x_{43}$ | $x_{44}$ | $x_{45}$ | $x_{46}$ | $x_{47}$ | $x_{48}$ |
| WebSite 5 | $x_{51}$ | $x_{52}$ | $x_{53}$ | $x_{54}$ | $x_{55}$ | $x_{56}$ | $x_{57}$ | $x_{58}$ |
| ... | ... | ... | .. . | ... | ... | ... | .. . | ... |
| WebSite m | $x_{m1}$ | $x_{m2}$ | $x_{m3}$ | $x_{m4}$ | $x_{m5}$ | $x_{m6}$ | $x_{m7}$ | $x_{m8}$ |

Decision Matrix [21, 22] is a fundamental tool based on multiple criteria and used to compare alternatives. Simply put, it is a powerful tool used to evaluate various options and make the best choice based on pre-defined criteria. It is a structured approach to comparing options by assigning weights to criteria and evaluating each alternative against those criteria, with the result being clear and objective. To support and strengthen the fundamental decision, a matrix is used by assigning weights to the criteria, which makes it more accurate and efficient.

The value of $x_{ij}$ in the decision matrix is determined through a special API. As can be seen from the decision matrix, the criteria for evaluating websites are search engine optimization metrics.

## 5. Ranking algorithm

The ranking algorithm is based on the Entropy Weight and TOPSIS methods of multi-criteria decision analysis [8, 10, 19, 20]. The Entropy Weight method [16, 17] is used to calculate the weight values of the evaluation criteria, the use of the mentioned method is due to the specificity of the problem because in our case the values of the evaluation criteria are not determined by human experts**.** Thus, the biggest advantage of the Entropy Weight method is to avoid the interference of human factors on the weight of the indicators, which enhances the objectivity of the evaluation results.

TOPSIS is a multi-criteria expert method that is a mechanism for evaluating, ranking, and selecting alternatives. The TOPSIS method has many advantages in the multidimensional space of data processing. It is easy to use and programing. The number of steps remains the same regardless of the increase in the number of attributes. The disadvantage of the method is that the use of Euclidean distance does not take into account the ratio of attributes[19, 20].

The algorithm includes the following stages:

**Step 1.** Determination of the decision matrix - to determine the decision matrix, the user must define the alternatives (websites), using a special API, we must evaluate the given alternatives according to the criteria.

**Step 2**. Calculation of evaluation criteria weights:

**Step 2.1** Normalization of the decision matrix by means of the following formula:

$$r_{ij} = \frac{x_{ij}}{\sum_{i=1}^{m} x_{ij}} \tag{1}$$

**Step 2.2** Calculate the entropy using the following formula:

$$e_j = -h \sum_{i=1}^{m} r_{ij} \ln r_{ij}, \qquad j = 1, \ldots, n \tag{2}$$

where $h=\frac{1}{\ln(m)}$ , m is the number of alternatives.

**Step 2.3** Calculate the vector of weights using the following formula:

$$W_j=\frac{1-e_j}{\sum_{j=1}^{n}(1-e_j)} \tag{3}$$

**Step 3.** Ranking of alternatives:

**Step 3.1** normalize the matrix using the following formula:

$$r_{ij}=\frac{x_{ij}}{\sqrt{\sum_{i=1}^{m}x_{ij}^2}} \tag{4}$$

**Step 3.2** Determine the weighted normalized matrix using the following formula:

$$V_{ij}=w_j*r_{ij} \tag{5}$$

**Step 3.3** Define positive ideal and negative ideal solutions as follows:

A positive ideal decision:

$$V^{+¿}=\{v_1^{+¿},v_2^{+¿},\ldots,v_n^{+¿}\}¿ \tag{6}$$

where

$$v_j^{+¿}=\begin{cases}max(v_{ij})\ If\ criterion\ j\ has\ a\ positive\ impact\\ min(v_{ij})\ If\ criterion\ j\ has\ a\ negative\ impact\end{cases}¿ \quad i=1,\ m,\ \ j=1,n$$

Negative Ideal Decision:

$$V^{-¿}=\{v_1^{-¿},v_2^{-¿},\ldots,v_n^{-¿}\}¿ \tag{7}$$

$$v_j^{-¿}=\begin{cases}min(v_{ij})\ If\ criterion\ j\ has\ a\ positive\ impact\\ max(v_{ij})\ If\ criterion\ j\ has\ a\ negative\ impact\end{cases}¿ \quad i=1,\ m,\ \ j=1,\ n$$

**Step 3.4** Determine the distance to the ideal positive and ideal negative decision for each alternative:

$$d_i^{+¿}=\sqrt{\sum_{j=1}^{n}(v_{ij}-v_j^{+¿})^2}¿ \tag{8}$$

$$d_i^{-¿}=\sqrt{\sum_{j=1}^{n}(v_{ij}-v_j^{-¿})^2}¿ \tag{9}$$

**Step 3.5** Calculate the alternative closest to the ideal decision. which is calculated by the following formula:

$$R_i=\frac{d_i^{-¿}}{d_i^{-¿}+d_i^{+¿}¿}¿ \tag{10}$$

## 6. Review of a practical example

Let's consider a practical example to better demonstrate the work of the algorithm. As an example, we use five real websites that we want to rank, we evaluate the SEO metrics of these sites according to real values, by means of which the decision matrix is determined. The names of the websites in the decision matrix have been changed for privacy reasons. Page Speed is a criterion with a negative impact.

**Table 2**

Decision matrix

| | Organic Traffic | Keyword Rankings | SERP Visibility | Click-Through Rate | Bounce Rate | Page Authority Over Time | Page Speed | Conversion Rate |
|---|---|---|---|---|---|---|---|---|
| WebSite 1 | 3 % | 51, 00 | 55, 00 | 10, 67 % | 72, 90 % | 70 | 1,5 MS | 5, 8 % |
| WebSite 2 | 3,1 % | 60, 00 | 56, 00 | 11 % | 60, 50 % | 68 | 2,4 MS | 5, 5 % |
| WebSite 3 | 2 % | 64, 00 | 47, 00 | 9, 23 % | 50, 10 % | 49 | 3 MS | 4, 9 % |
| WebSite 4 | 1,3 % | 20, 00 | 30, 00 | 4 % | 28, 10 % | 20 | 3,1 MS | 4 % |
| WebSite 5 | 0,4 % | 18, 00 | 20, 00 | 2 % | 27, 10 % | 19 | 4 MS | 2 % |

As a result of normalization of the given decision matrix, we get the following matrix (Table *3*):

**Table 3**

Normalized decision matrix

| | Organic Traffic | Keyword Rankings | SERP Visibility | Click-Through Rate | Bounce Rate | Page Authority Over Time | Page Speed | Conversion Rate |
|---|---|---|---|---|---|---|---|---|
| WebSite 1 | 0,31 | 0,24 | 0,26 | 0,29 | 0,31 | 0,31 | 0,11 | 0,26 |
| WebSite 2 | 0,32 | 0,28 | 0,27 | 0,30 | 0,25 | 0,30 | 0,17 | 0,25 |
| WebSite 3 | 0,20 | 0,30 | 0,23 | 0,25 | 0,21 | 0,22 | 0,21 | 0,22 |
| WebSite 4 | 0,13 | 0,09 | 0,14 | 0,11 | 0,12 | 0,09 | 0,22 | 0,18 |
| WebSite 5 | 0,04 | 0,08 | 0,10 | 0,05 | 0,11 | 0,08 | 0,29 | 0,09 |

By deleting the normalized matrix, we calculate the entropy, which is given in the table below (Table 4):

**Table 4**

Calculation of entropy

| Organic Traffic | Keyword Rankings | SERP Visibility | Click-Through Rate | Bounce Rate | Page Authority Over Time | Page Speed | Conversion Rate |
|---|---|---|---|---|---|---|---|
| 0,90 | 0,93 | 0,96 | 0,91 | 0,95 | 0,92 | 0,97 | 0,97 |

Calculate the weights of the evaluation criteria given in the table below (Table 5):

**Table 5**

Weights of evaluation criteria

| | Organic Traffic | Keywor d Rankings | SERP Visibility | Click-Through Rate | Boun ce Rate | Page Authority Over Time | Page Speed | Convers ion Rate |
|---|---|---|---|---|---|---|---|---|
| W | 0,20269 | 0,14946 | 0,08085 | 0,18276 | 0,09 | 0,16564 | 0,05814 | 0,06830 |

After determining the weights, we can move to the stage of ranking the websites, for this we need to normalize the matrix presented in Table 2, which has the following form (Table 6):

**Table 6**

Normalized decision matrix

| | Organic Traffic | Keywor d Rankings | SERP Visibility | Click-Through Rate | Bounce Rate | Page Authority Over Time | Page Speed | Convers ion Rate |
|---|---|---|---|---|---|---|---|---|
| WebSite 1 | 0,607 | 0,486 | 0,559 | 0,579 | 0,639 | 0,621 | 0,230 | 0,558 |
| WebSite 2 | 0,627 | 0,572 | 0,569 | 0,597 | 0,530 | 0,604 | 0,368 | 0,529 |
| WebSite 3 | 0,404 | 0,610 | 0,478 | 0,501 | 0,439 | 0,435 | 0,460 | 0,472 |
| WebSite 4 | 0,263 | 0,191 | 0,305 | 0,217 | 0,246 | 0,178 | 0,475 | 0,385 |
| WebSite 5 | 0,081 | 0,171 | 0,203 | 0,108 | 0,238 | 0,169 | 0,613 | 0,193 |

Let's define a weighted normalized decision matrix, which has the following form (Table 7):

**Table *7***

Weighted normalized decision matrix

| | Organic Traffic | Keywor d Rankings | SERP Visibility | Click-Through Rate | Bounce Rate | Page Authority Over Time | Page Speed | Conver sion Rate |
|---|---|---|---|---|---|---|---|---|
| WebSite 1 | 0,123 | 0,073 | 0,045 | 0,106 | 0,059 | 0,103 | 0,013 | 0,038 |
| WebSite 2 | 0,127 | 0,085 | 0,046 | 0,109 | 0,049 | 0,100 | 0,021 | 0,036 |
| WebSite 3 | 0,082 | 0,091 | 0,039 | 0,091 | 0,040 | 0,072 | 0,027 | 0,032 |
| WebSite 4 | 0,053 | 0,028 | 0,025 | 0,040 | 0,023 | 0,029 | 0,028 | 0,026 |
| WebSite 5 | 0,016 | 0,026 | 0,016 | 0,020 | 0,022 | 0,028 | 0,036 | 0,013 |

Determine positive ideal and negative ideal decision, using them to calculate the distance to ideal positive and ideal negative decision for each alternative. by means of which we can determine the decision closest to the ideal decision (Table 8):

**Table 8**

Ranking result

| | di- | di+ | Ri | Rank |
|---|---|---|---|---|
| WebSite 1 | 0,17 | 0,02 | 0,9 | 2 |
| WebSite 2 | 0,18 | 0,01 | 0,92 | 1 |
| WebSite 3 | 0,13 | 0,06 | 0,68 | 3 |
| WebSite 4 | 0,05 | 0,15 | 0,24 | 4 |
| WebSite 5 | 0,00 | 0,18 | 0,00 | 5 |

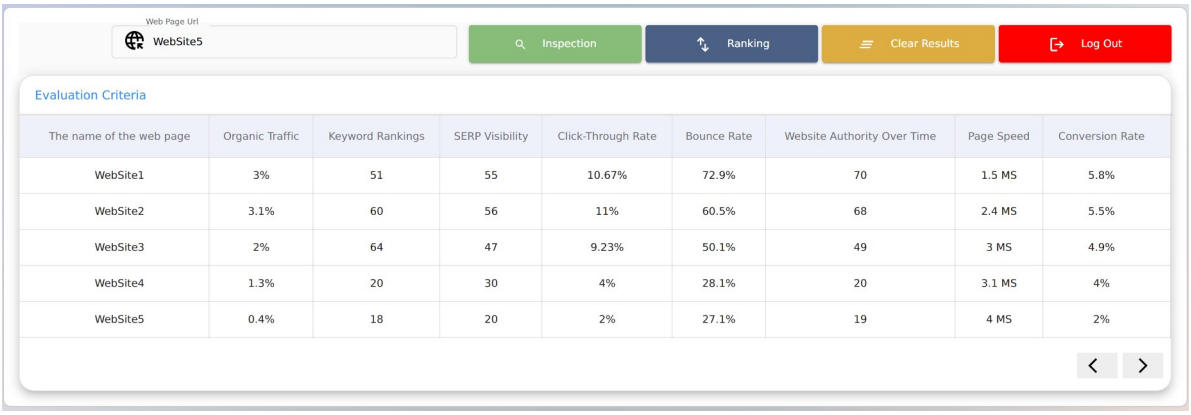
From the data presented in the table(Table *4*), it is clearly seen that WebSite 2 is the best option out of the five listed websites.

## 7. Algorithm Implementation

The algorithm presented in the paper is implemented by our web application, which has a responsive design, so that it can be used both on a computer and a mobile device. The Web API back end of the web application is developed on the .NET platform, and the front end is developed using Angular.

To use the application, users must register and authenticate, Because the application uses a paid API (Application Programming Interface).

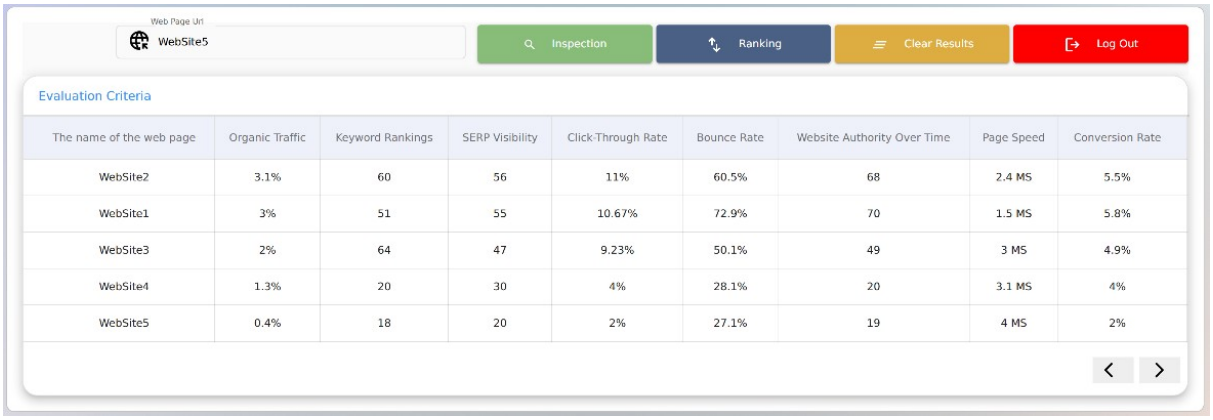
Therefore, users who are not authorized to the service cannot use the application. A fragment of the application is given below in Figure 1, on which the user writes the address of the desired website in the Web Page URL input and presses the Inspection button. Using the API service, the application determines the relevant website search engine optimization metrics data, which will be added to the decision matrix. The user of the application will similarly search all the websites from which he wants to select the best one. (see Figure. 1)




| The name of the web page | Organic Traffic | Keyword Rankings | SERP Visibility | Click-Through Rate | Bounce Rate | Website Authority Over Time | Page Speed | Conversion Rate |
|---|---|---|---|---|---|---|---|---|
| WebSite1 | 3% | 51 | 55 | 10.67% | 72.9% | 70 | 1.5 MS | 5.8% |
| WebSite2 | 3.1% | 60 | 56 | 11% | 60.5% | 68 | 2.4 MS | 5.5% |
| WebSite3 | 2% | 64 | 47 | 9.23% | 50.1% | 49 | 3 MS | 4.9% |
| WebSite4 | 1.3% | 20 | 30 | 4% | 28.1% | 20 | 3.1 MS | 4% |
| WebSite5 | 0.4% | 18 | 20 | 2% | 27.1% | 19 | 4 MS | 2% |

**Figure 1.** Website search and analysis results

By clicking on the ranking button, the application will implement the algorithm and show the ranked websites according to the ranking, which clearly shows the best website (Figure. 2).




| The name of the web page | Organic Traffic | Keyword Rankings | SERP Visibility | Click-Through Rate | Bounce Rate | Website Authority Over Time | Page Speed | Conversion Rate |
|---|---|---|---|---|---|---|---|---|
| WebSite2 | 3.1% | 60 | 56 | 11% | 60.5% | 68 | 2.4 MS | 5.5% |
| WebSite1 | 3% | 51 | 55 | 10.67% | 72.9% | 70 | 1.5 MS | 5.8% |
| WebSite3 | 2% | 64 | 47 | 9.23% | 50.1% | 49 | 3 MS | 4.9% |
| WebSite4 | 1.3% | 20 | 30 | 4% | 28.1% | 20 | 3.1 MS | 4% |
| WebSite5 | 0.4% | 18 | 20 | 2% | 27.1% | 19 | 4 MS | 2% |

**Figure 2**. Ranked list of sites

## 8. Conclusion

As a result of the research presented in the paper, an algorithm and a web application have been developed, which realizes the mentioned algorithm. The developed algorithm ensures evaluation of selected websites according to SEO metrics and their ranking. We have taken eight basic SEO metrics as evaluation criteria for websites, which provide important information about the sites, but this does not mean that the presence of eight criteria is necessary for the algorithm to work, therefore the algorithm allows to increase or decrease the number of evaluation criteria. A web application is a flexible tool for businesses to ease the website selection process and select the best site to display information about their products or services.

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