A method for determining and evaluating webometric indicators of public libraries

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Abstract. **The complexity of modern social communications and the transformation of society's information environment create unique competition among public digital libraries to attract readers. Library websites play an important role in managing the activities of digital libraries and improving their position in the information space. In general, the website is considered the "calling card" of the electronic library. It is not only a means of communication between readers and the library, but also a source of information that allows you to evaluate the activities of the library based on information about the use of library website by readers. The purpose of the study is to develop a data processing method to improve the efficiency of evaluating public library information resources and websites. A method and algorithm for expert assessment of a site using fuzzy logic are proposed. The article presents the possibilities of using web analytics to determine webometric indicators of a library website, study user behavior patterns, as well as analysis that improves the functionality of the site. Libraries are offered a comprehensive method for multi-criteria evaluation of websites. The essence of this method is that with this method we can not only evaluate the website in a traditional way, but also get the following useful results: full evaluation of websites, evaluation of websites according to certain criteria, selective comparison and ranking of websites are presented. An analysis of classification criteria for evaluating public library websites is presented. To minimize subjectivity when evaluating a website, the evaluation process can involve not only experts, but also a wider audience through online and offline surveys. In general, assessment of electronic public library websites is necessary not only to determine the rating of libraries, but also to make the right management decisions, as well as to determine the needs and interests of readers.**

Keywords: Assessment, electronic public library, webometrics, website.

I. Introduction

Today, the development of public libraries is determined by the globalization of activities, increasing the level of technology and intellectualization. During the development of digital technologies, the information-library sector is becoming a center of cognitive resource management in people's intellectual practice, and remote service to the population through websites has become more and more widespread. The website of public libraries is their lifeline and websites are mainly used as an advertising platform to present the virtual image of the library and the information and services provided by the library. According to analysis, library websites in the web space today, analytical tools for effective performance evaluation are becoming more and more popular. Specifically, webometrics is a tool for measuring websites, web pages, phrases on web pages, website visits, hyperlinks, web search results [1].

In the development of new recommendations for improving the efficiency of user services to provide high-quality remote service based on information from public library websites, it is necessary to study data on the number of visits, duration of website use by users,

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determine the goals of user visits and determine webometric indicators [2]. Analyzing and testing information access using webometric indicators, and also allows users to independently compare library sites.

II. Methods of Determining Webometric Indicators of Library Websites

Webometric research on webometric tools and its current state includes four main directions. These are:

1. Analysis of web page content [3] - [4];
2. Analysis of the structure of web links;
3. Website usage analysis (including users' search and browsing behavior) [5];
4. Analysis of web technologies (search engine performance) [6].

Public libraries are the main knowledge center for users and it is important that information is presented on relevant homepages through websites, but even the highest scoring libraries are observed to meet only half of these requirements. The role of library websites in marketing and quality assurance related to these issues should be taken seriously by library professionals. Islam and Alam studied and analyzed the library websites of private universities in Bangladesh [7]. Their study showed that some private university libraries in Bangladesh proposed different criteria to classify the main indicators in this study for their websites. Although libraries have a higher number of web pages, but their number of link pages is very small, so it turns out that websites with self-linking, external links do not have an international impact factor. Because library websites provide access to many resources, monitoring their performance and understanding user flow is critical to promoting these resources. Evaluating library website performance has become a key factor in determining the relative success or failure of a library service [8].

A. The purpose of the study

The purpose of the study is to increase the information content of libraries and develop their services by evaluating their websites according to various criteria.

To realize the goal, a number of tasks are solved: analysis of criteria and methods of evaluation of libraries, scientific and educational resources, clarification of evaluation criteria and addition of new criteria.

Although there is general agreement on the content of library websites, each library's mission should be reflected. For this reason, public library websites should generally provide a wider range of information appropriate to their broad range of activities than other libraries. When evaluating websites, it is important to consider not only the presence of these indicators, but also the way in which they are presented.

B. Library monitoring

- in the forming of operational tasks and strategic goals;
- in the development of library development concepts;
- when making a decision about the organizational structure of the library;
- monitoring the flow of users and increasing the number of visits to the library;
- used in cases such as library activity research in various fields [9].

The purpose of monitoring of public libraries is often formed on the basis of the problem areas of their activities. These are the following:

- preparation for using the quality assessment system;
- to determine the optimal set of evaluation indicators, taking into account the actual and expected capabilities of the library;
- to study the unsatisfied demand of users for library documents;
- helps to determine the true extent of monitoring indicators such as dealing with refusals and satisfaction of users of library services.

The quality of library services can also be assessed based on the results of an annual user satisfaction survey [10].

Users' need for information is increasing and thematic queries are becoming more complex. In particular, users are increasingly delegating information retrieval and preprocessing tasks to library professionals. Today, in addition to the thematic survey, there is a growing demand for webometric analysis of search results.

C. Criteria of library websites

- Online catalog statistics. Measures the total number of searches performed within the system to find items.
- Searches by category. It allows websites to know how end users use directories.
- Check items. Allows comparison of librarian requests with requests made through book delivery services.
- Electronic services. It helps librarians to determine the level of demand for which types of media (physical and electronic).
- Update items. Libraries determine the possibility to clarify the processes carried out and to update the library information [11].
- Online surveys. This allows librarians to gauge the popularity of books
- Interlibrary subscription requests. It measures the volume and specific items available for interlibrary patron requests.
- Library reports. Statistical information helps librarians to better serve the public and optimize internal management.
- User visits. This indicator determines the level of visits of applicants to librarians and the use of mass media [12].

III. Criteria for Evaluating Webometric Indicators of Library Websites

On the basis of the studied methods, the webometric indicators were summarized and the data was pre-processed on the basis of the analysis, and the information classification of the system for determining the webometric indicators of public library websites was developed. This classification of information is reflected in “Fig. 1”.

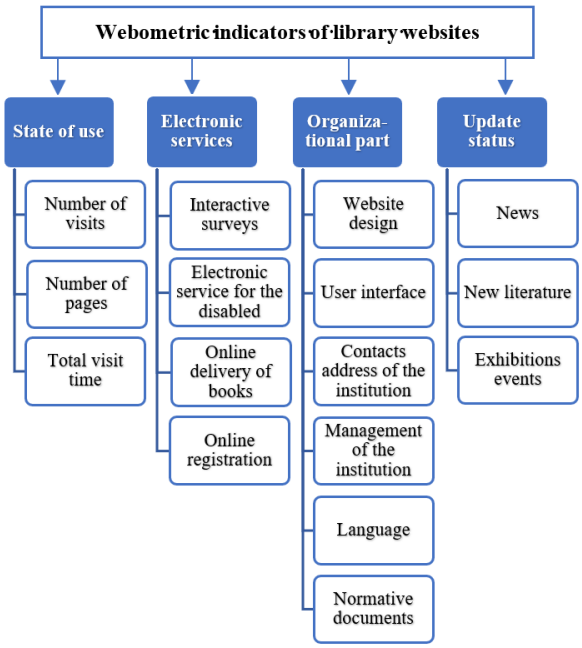

Fig.1. Information classification of the system for determining webometric indicators of public library websites.

Above is an analysis of several quantitative and qualitative criteria for evaluating library websites. It is not difficult to evaluate the performance of the website based on criteria that accept quantitative values, such as the number of visitors to the library's website in a certain period of time, the frequency of updating the website content, the number of interactive services. However, quality indicators such as relevance of website content, completeness and reliability of information, ease of website interface, on the one hand, have ambiguous values, and on the other hand, they are subjective in nature. Therefore, the method of fuzzy variables is proposed to solve this type of problem.

Thus, to evaluate the effectiveness of library websites, the fuzzy variable Ω_R = *"Assessment of library website effectiveness"* is introduced, which receives fuzzy values $M = \{M_1, M_2, M_3, M_4\}$. Here M_1 = *"Low effective"*, M_2 = *"Medium effective"*, M_3 = *"Very effective"*, M_4 = *"Highly effective"* are the term values.

A scoring method of expert evaluation is presented to determine the carrier of the set Ω_R consisting of M term-values. The factors that have a strong influence on the effectiveness of the website were selected on Table 1.

Although there are actually several factors for evaluating a website, the 7 most important factors have been selected in this project.

TABLE 1 CRITERIA FOR EVALUATING WEBOMETRIC PERFORMANCE OF PUBLIC LIBRARY WEBSITES

Indicator symbol	Indicator name	Evaluation criteria
A_1	relevance of library website content	0 – not relevant; 1 – less relevant; 2 – moderately relevant; 3 – more relevant; 4 – very expensive
A_2	ease of use of the library website	0 – uncomfortable; 1 – less convenient; 2 – moderately comfortable; 3 – very convenient; 4 – very comfortable
A_3	completeness of library website content	0 – partial information can be obtained; 1 – medium fullness; 2 – almost complete; 3 – complete; 4 – the presence of hyperlinks
A_4	reliability of library website content	0 – resources are not available; 1 – there are some reliable sources; 2 – average reliability; 3 – reliable; 4 – availability of verification
A_5	the number of visits to the library website	0 – up to 10 in 1 month; 1 – up to 100 in 1 month; 2 – up to 1000 in 1 month; 3 – up to 10,000 in 1 month; 4 – more than 10000 in 1 month
A_6	average time of visit to the library website	0 – 1-5 seconds; 1 – 6-10 seconds; 2 – 11-30 seconds; 3 – 31-60; 4 – more than 1 minute
A_7	number of interactive services available on the library website	0 – does not exist; 1 – 1-2; 2 – 3-5; 3 – 6-9; 4 – 10 and above

These factors $A_1, A_2, A_3, A_4, A_5, A_6$ *and* A_7 characterize the level of efficiency of the library website.

The set carrier Ω_R is determined on the basis of a Table 2 filled by experts and it is in the range [0;28].

TABLE 2 $\boldsymbol{\Omega_R}$ IS MATRIX FOR CALCULATING THE SET CARRIER

Factors	Term values			
	M_1	M_2	M_3	M_4
A_1	0	0-1	1-2	2-4
A_2	0-1	1-2	1-3	2-4
A_3	0	1-2	2-3	2-4
A_4	0-1	0-2	1-3	3-4

A_5	0-2	1-2	2-3	2-4
A_6	0-1	0-2	1-3	3-4
A_7	0-1	1-2	2-3	3-4
$\sum M_i$	**0-6**	**4-13**	**10-20**	**17-28**

For each fuzzy set, the value of the relevance function $\mu_{M_j}(x_i)$ of the trapezoidal form defined by the term-values $M_1,\ M_2,\ M_3,\ M_4$ is determined.

$$\mu_{M_1}(x) = \begin{cases} 1, & 0 \le x \le 2 \\ \dfrac{6-x}{4}, & 2 < x < 6 \\ 0, & 6 \le x \end{cases}$$

$$\mu_{M_2}(x) = \begin{cases} 0, & x \le 4 \\ \dfrac{x-4}{5}, & 4 < x < 9 \\ 1, & 9 \le x \le 11 \\ \dfrac{13-x}{3}, & 11 < x < 13 \\ 0, & 13 \le x \end{cases}$$

$$\mu_{M_3}(x) = \begin{cases} 0, & x \le 10 \\ \dfrac{x-10}{6}, & 10 < x < 16 \\ 1, & 16 \le x \le 18 \\ \dfrac{20-x}{2}, & 18 < x < 20 \\ 0, & 20 \le x \end{cases}$$

$$\mu_{M_4}(x) = \begin{cases} 0, & x \le 17 \\ \dfrac{x-17}{6}, & 17 < x < 23 \\ 1, & 23 \le x \le 28 \end{cases}$$

"Fig. 2" shows the graph of the relevance function. The graph of the function $M_1,\ M_2,\ M_3,\ M_4$ describes the relevance of term-values with a certain interval.

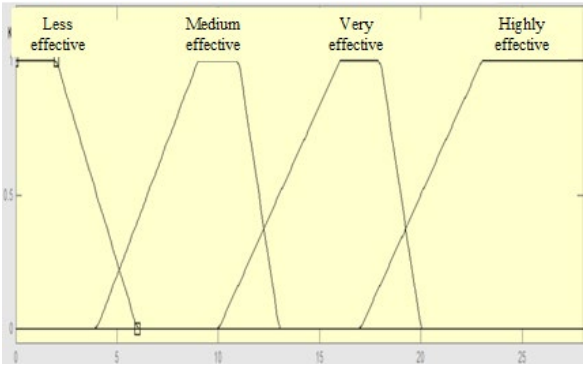

Fig. 2. the relevance function of the fuzzy variable "Assessment of the effectiveness of the library website".

For each factor, the score of the experts is set and filled in as in Table 3.

TABLE 3 LIBRARY WEB SITE PERFORMANCE INDICATOR MATRIX

Web site	A_1	A_2	A_3	A_4	A_5	A_6	A_7	K_{r_i}	μ_{D_1}	μ_{D_2}	μ_{D_3}	μ_{D_4}
r_1	2	3	1	2	2	2	1	13	0	0.5	0	0
r_2	3	2	1	2	1	2	0	11	0	1	0	0
r_3	4	2	3	1	2	3	2	17	0	0	1	0
r_4	3	4	2	2	1	0	1	13	0	0.5	0	0
r_5	1	2	3	1	4	4	3	18	0	0	1	0.17

$K_{r_i} = \sum_{i=1}^{7} A_i$, $max\mu_{M_i}$ – is an assessment of the effectiveness of a library website.

Based on the data presented in Table 3, the following conclusions can be drawn:

For example, r_2 website rating is *"medium effective with a weight of 1"*; the r_5 website is rated as *"fairly effective with a weight of 1, highly effective with a weight of 0.17"*.

The application of this method allows websites to make decisions in conditions of uncertainty and inaccuracy of their evaluation parameters. Asessment is carried out using the expert assessment method. Highly qualified specialists or scientists working in the library field are involved as experts.

IV. SUMMARY

The proposal of the evaluation criteria of library websites listed above serves as a factor in the development of libraries' services by increasing the information content and evaluating their websites according to various criteria.

A number of tasks aimed at carrying out this research were solved, the criteria and methods of evaluating the scientific and educational resources of libraries were analyzed, the evaluation criteria were clarified and new criteria were added.

Ease of use of web analytics to monitor library website, study user behavior patterns leads to solutions that improve website functionality. These include defining user tasks during development, conducting user tests to better understand the phenomenon, monitoring data to verify the effectiveness of input, and collecting additional data. Studying and evaluating data about the duration of use of websites and the number of visits helps to determine the goals of users' visits and develop new recommendations. Web analytics tools are useful for tracking and evaluating the behavior of public library website users, identifying user content, identifying tracking methods, and subsequently improving performance. Also, the proposed method of fuzzy variables for evaluating the effectiveness of public library websites allows to make decisions in the presence of criteria with quality indicators, as well as in conditions of inaccuracy and uncertainty of information.

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