Discovering library users' information needs of Ukrainian technical universities based on SEO analysis

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Abstract

The purpose of the work is a multi-criteria evaluation of the websites of libraries of technical institutions of higher education of Ukraine based on SEO analysis and expert evaluation. The use of such a concept will make it possible to identify the information needs of users and offer recommendations for increasing the efficiency of the functioning of library web resources. For this purpose, the study conducted an expert assessment of the quality of the selected resources, their structure and content. Also, using software tools, the author assessed their technical condition, collected statistical data on users, their demographic and age distribution, and their behavior on the websites. The expert evaluation outlined the most important criteria for such an analysis: page design, clarity of the interface, multilingualism, inclusive elements, quality of content, relevance of information, content, and logical structure. INSITES and Nibbler were used to analyze the technical condition and quality of library websites, the presence of technical errors, and broken links. The evaluation of the structure of the websites of libraries of technical higher education institutions of Ukraine, as well as the expert assessment of their visual and logical state, allowed us to determine the rating of resources by usability. SEMrush was used to conduct an SEO analysis of the selected resources. This allowed obtaining data on website traffic, user actions, browsing time, and popular content. The main directions and areas of interest of users of technical university library websites and their behavior were identified. The nature of user interaction with the web resources of university libraries in Ukraine is analyzed, and the most popular elements and sections of the sites, the duration of sessions, and peak periods are determined. The demographic, gender, and socio-economic structure of users are presented. It was emphasized that most website sessions use computers, which indicates insufficient optimization for mobile devices. Based on the results of the research, some problems, directions for further research, and recommendations for libraries to improve and modernize their information resources are presented. The methodology for multi-criteria assessment of library websites proposed in the work can also be used to study user needs and optimize electronic resources of similar institutions

Keywords

user needs, technical higher education institutions, web analytics, traffic analysis, academic libraries, user behavior, content optimization

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1. Introduction

Modern libraries of technical higher education institutions in Ukraine play an important role in providing students and teachers with access to the information they need for their educational and research activities. In the context of the digital transformation of society, libraries face new challenges in adapting to the changing information needs of their users. Library websites have long been key tools for providing access to electronic resources and maintaining communication with users. At the moment, they act as resource centers for providing authoritative information to support the educational process or research. In this regard, it is important to maintain these resources in proper technical condition and to ensure that they are oriented towards meeting user needs. For this, it is necessary to clearly define the structure of users, their requests, and to ensure that the allocation of resources meets their expectations. Of particular importance is the current process of transformation of library activities in the context of the introduction of the latest information technologies, which involves the transition from traditional forms of service to more dynamic and interactive models. The result of such changes is the need to form and change the classical library into a modern information center that will meet the new requirements of society.

Changes in the social, political, and economic life of Ukraine have a significant impact on the effectiveness of meeting the information needs of library users. Expansion of the range of services and their diversity necessitates the active introduction of new computer technologies. Informatization of the library sphere fundamentally changes approaches to documentary communications, expands the capabilities of libraries, and changes their functioning.

To meet the information needs of modern users, information and resource centers are being created to provide access to information using the latest technologies. This allows to guarantee the availability of information resources for all categories of readers. Changes in users' requirements for library services caused by the processes of informatization and computerization of society have also affected the structure of the readership, the motivation for visiting libraries, and their reading priorities. These changes, in turn, affected the development of library information services, which is the basis for further research in this area.

The analysis was conducted using modern web analytics and SEO analysis software tools such as SEMrush, INSITES, and Nibbler. These tools provide detailed data on website traffic, user actions, time spent browsing, and popular sections. The use of web analytics software tools provided sufficiently reliable data in this aspect. This helped to identify the strengths and weaknesses of the resources under study. The identified problems and trends in the use of resources allow us to develop recommendations for improving and modernizing library websites.

Thus, analyzing the web traffic of library websites is an effective method for determining the information needs of users and improving the quality of library services. This data can be used to optimize the design and content of websites, which helps to increase the duration of visits and to make users perform the desired actions. The results of this study can be useful for librarians, administrators, and website developers in the process of improving the information resources of libraries of technical higher education institutions in Ukraine.

The purpose of this article is to study the quality and content of electronic resources of libraries operating at technical institutions of higher education in Ukraine and user behavior

based on the results of a multi-criteria evaluation of library websites based on SEO analysis and expert evaluation.

The main tasks of the work are:

- determination of the main information needs of library users based on SEO analysis of their websites;
- determination of the main shortcomings in the structure and quality of resources, based on expert evaluation and technical evaluation of websites;
- development of a multi-criteria website evaluation methodology, which includes analysis of search engine optimization, content structure and user interaction.;
- assessment of the possibilities of applying the developed methodology for the optimization of similar web resources (analogous);
- providing recommendations to administrators of library web resources regarding their optimization based on the results obtained;
- the technical quality of the websites of the libraries of technical institutions of higher education of Ukraine, the peculiarities of their construction (structure, rubric) and functioning,
- studying the composition of the user audience of selected information resources,
- study web traffic of selected resources, based on the obtained data, draw conclusions about the areas of interest of the user audience;
- generalization of the proposed methodology for assessing the quality of library resources.

The main objectives of the research are to analyze sources on the topic of scientific issues, study the technical quality of websites of libraries of technical higher education institutions of Ukraine, the peculiarities of their construction (structure, headings) and functioning, characterize the composition of the user audience of selected information resources, study the web traffic of selected resources, and, based on the data obtained, conclude the sphere of interest of the user audience.

The object of the study is the websites of the libraries of ten Ukrainian technical higher education institutions that are ranked at the top of the Ukrainian higher education institutions ranking (for 2023).

The subject of the study is the information needs of users of libraries of technical universities through the practice of their interaction with selected web resources.

2. Analysis of sources

The university library website is a key tool in facilitating effective access to information and resources for all users of the university community. The analysis of the literature on the study of library sites can include various aspects that help to understand the importance of these web resources in the context of serving users and improving their experience of finding the necessary information on the sites. Based on our tasks, the sources that contain the analysis of websites of university libraries as important tools in the system of user service are considered. Many works have been devoted to the analysis of the activity of library websites in the professional literature. Thus, in the study, the author [1] writes about digital accessibility, which

is becoming more and more important for the public, especially for those who have limited access to information, such as people with disabilities, the elderly or those with low literacy. An assessment of the accessibility of library websites was conducted to further develop recommendations for improving digital accessibility in libraries and ensuring equal access to information for all users.

In work [2], the author emphasizes that the creation of a website is a great creative work of the entire library team in order to cover all proposals for the development of general requirements that the website must meet, and such criteria as content quality, stability must be included here and relevance of information resources, ease of navigation, unity of design of all sections and compliance with such principles as openness during its creation and operation - provision of complete information about all aspects of the library's activities, funds, services, service rules; an individual approach to different groups of users (a teacher's page and a student's page are highlighted on the site), as well as informativeness - maximum filling with information resources (catalogs, card files, databases).

Examining library websites in the global information space, in work [3] the author proposes a mechanism for identifying the shortcomings of websites and ways to improve the information policy of libraries in the Internet space, which is the analysis of library websites using special methods. Scientists [4] investigated the features of the means of informing the library's website about its international activities, because a certain category of users is interested in international cooperation between libraries. The author places special emphasis on conducting a detailed analysis of the information needs of potential site visitors in his work [5], because the site is created specifically for readers, not for the librarians themselves, so the interests of users should be taken into account first of all when developing the general structure and strategy of filling the virtual resource. In the study [6], a comprehensive analysis of visual patterns, requirements and norms in website design was made, as well as the disclosure of the significance of the interaction of the aesthetic and functional aspects of the site to ensure the maximum efficiency of its use. In order to solve the set goals, official data from the Osvita.ua website from the article "Top-200 Ukraine 2023 Higher Education Ranking is presented" [7], in which a comprehensive evaluation of higher education institutions according to certain criteria is defined.

The authors in the work [8] emphasize that in the process of innovative development of education, an important factor in its modernization is information and library support, which should be considered as a purposeful activity to create digital information resources and ensure access to them based on the wide use of the latest ICT to meet information needs users - education seekers, pedagogical, scientific, scientific-pedagogical workers.

Other authors [9] highlight the advantages and generalize the experience of using information and communication technologies in the educational process of institutions of higher education in central Ukraine and note that institutions of higher education in Ukraine have a sufficient number of high-quality information and communication technologies, successfully solve the problems of organizing distance learning and adapt to new challenges and threats in the period of war and pandemic in the conditions of the development of the digital economy.

According to the results of a sociological study conducted in Ukraine, despite the high availability of information sources, at the time of entering the university, the vast majority of students do not consider themselves sufficiently informed about the benefits of studying in the

chosen educational and professional program. These questions are studied by scientists [10] as part of their research. In our opinion, libraries should be actively involved in these processes and highlight information about educational programs on their websites.

The task of technical universities is to train competitive specialists in the IT sphere, because informatization, digital transformation, high technologies, in particular WEB technologies, put the state of Ukraine in front of the global challenges of creating a digital state [11].

Librarians of the University of Texas [12],[13], on the pages of the Journal of Web Librarianship, offered step-by-step instructions on how to collect, analyze, and interpret statistics on the use of the library website using the Google Analytics service.

An interesting addition to the comprehensive study of this issue is the study of German scientists [14] regarding the prospects of digitization in the library and information spheres.

In [15], the authors analyzed the library websites of Iranian government universities related to the Ministry of Science from the perspective of Google's five effective search engine optimization (SEO) factors and emphasized the role of search engine optimization in academic libraries. The same authors in their other work [16] presented a comparative study of websites of US university libraries from the standpoint of "Google SEO" and "Accessibility" and conducted a correlation analysis.

The problems of creating Institutional Repositories (on the example of the University of Ilorin, Library, Nigeria) as a new way of ensuring the availability of intellectual results of academic and scientific institutions in electronic access on the Internet in open access are analyzed in work [17].

Article [18] analyzed university library website resources and used the Technology Acceptance Model (TAM) to study ULWR) and classified users based on academic roles and then analyzed them as subgroups.

Scientists [19], investigating the improvement of library services on the impact of IT and emphasize that the configuration of information technologies and related facilities in the library should be easy to use and contribute to the satisfaction of users' needs, and library managers should take care of the distribution of resources so, to attract as many interested users as possible.

The opinion of the author of the work [20] that libraries can successfully develop chatbots with artificial intelligence with minimal technical knowledge and resources is relevant today. User experience considerations are also important, including editing library FAQs to be concise and clear, testing and ensuring accessibility of chatbot text and elements, and ongoing maintenance of chatbot content. The article [21] emphasized that more research is needed to further study and the capabilities of ChatGPT4.0 or later, when text-to-image, text-to-voice, text-to-text, text-to-video, web search, may affect future help services academic libraries. Library websites should call for chatbots, which will complement their informative capabilities. In the future, we plan to expand our research in this direction.

3. Methods

The following general scientific research methods were used to achieve the goal and solve the tasks set:

- Theoretical analysis - identifying existing theoretical models for analyzing user behavior on the Internet and determining their user needs.

- The empirical method is collecting data on user behavior using web analytics tools (SEMrush, INSITES, and Nibbler.)
- Observations - based on the collected data, identifying the elements of websites that are of the greatest interest.
- Descriptive statistics - to identify the main trends related to the behavior of users.
- Cluster analysis is used to identify groups of users united by their areas of interest.
- Expert analysis - involvement of specialists with the appropriate profile and qualifications to visually assess the quality of the content of resources.

The application of the above-mentioned scientific methods will make it possible to identify key trends in behavior, as well as to determine the main information needs of students and teachers of technical higher education institutions in Ukraine. The results of the study can be used to optimize the structure and content of library websites, which will help to increase their efficiency and better meet the information needs of users.

Also, the proposed multi-criteria assessment methodology can be used by librarians for regular assessment of websites.

4. Results and Discussion

The main users of information resources of academic libraries in Ukraine are mainly students and staff, who use them for quick access to educational and research materials, as well as for information about the library's functioning. To improve the interaction of users with library resources, it is necessary to adapt electronic resources to their needs. This will attract more users, which, in turn, can contribute to the development of science and improve the quality of academic education.

To do this, information on university web resources should be structured in such a way as to meet the basic expectations of users while adhering to the logical structure of the site. To design a typical structure of a website for an academic library of a Ukrainian higher education institution, it is necessary to study user interests and analyze existing resources to determine the degree of satisfaction of needs and identify the main ways users interact with these resources.

One possible way to improve the accessibility of library materials is to develop recommendations for creating a universal template for library websites. This is because the content of the resources is approximately the same, but their placement and interface may differ from institution to institution. A user who is accustomed to the structure of their favorite site may not find the information they need on another site because of the non-intuitive interface, or it may take them longer to find it. A unified approach to structuring and presenting information on library websites will help to improve the user experience and increase the efficiency of resource use.

4.1. Rationale for choosing the object and subject of research

The object of the study is the websites of the libraries of ten Ukrainian technical higher education institutions (HEIs), which took the highest positions according to the results of

research by the Center for International Projects "Euroeducation" and international experts of the IREG Observatory on Academic Ranking and Excellence in 2023 [18].

A comprehensive assessment of higher education institutions is carried out according to the following criteria [18]:

- the presence (position) of the HEI in international rankings;
- number of patents obtained;
- scientific achievements;
- diverse activities of educational institutions;
- is an indicator of the number of applications submitted by applicants to higher education institutions;
- average competitive score of applicants, etc.

The criteria in this ranking include various indicators, such as scientific achievements, diverse activities of educational institutions, and the presence (position) of the HEI in international rankings. In 2023, the main indicators that influenced the formation of the ranking of educational institutions were:

- The QS ranking is an assessment of an educational institution's presence in the world's best universities.
- The number of patents obtained is an opportunity to assess the inventive activity and quality of scientific training in an educational institution.
- The number of applications submitted by applicants to HEIs and the average competitive score demonstrate the popularity of HEIs [18].

Ten technical universities were selected from the available two hundred higher education institutions of Ukraine using analysis. Table 1 below lists these institutions, their e-mail addresses, and the addresses of the official websites of the libraries of the respective educational institutions.

Table 1

List of Ukrainian higher education institutions and official websites of their libraries selected for the study

	Name of the institution	Library name / email address
1	National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute" (NTUU KPI)	Denysenko Scientific and Technical Library, https://kpi.ua/library
2	Lviv Polytechnic National University (LPNU)	Scientific and Technical Library of Lviv Polytechnic National University, https://library.lpnu.ua/!/up
3	National Technical University "Kharkiv Polytechnic Institute" (NTU KhPI)	Scientific and technical library of the National Technical University "Kharkiv Polytechnic Institute", http://library.kpi.kharkov.ua/

4	Kharkiv National University of Radio Electronics (KNURE)	Scientific Library of the National Technical University of Radio Electronics, https://nure.ua/branch/naukova-biblioteka
5	National Technical University "Dnipro Polytechnic" (NTU DP)	Scientific and technical library of the National Technical University "Dnipro Polytechnic", https://lib.nmu.org.ua/
6	National Aviation University (NAU)	Scientific and Technical Library of the National Aviation University, https://www.lib.nau.edu.ua/
7	Zhukovsky National Aerospace University "Kharkiv Aviation Institute" (KAI)	Scientific and Technical Library of the National Aerospace University "Kharkiv Aviation Institute", https://library.khai.edu/
8	Vinnytsia National Technical University (VNTU)	Scientific and Technical Library of Vinnytsia National Technical University, https://lib.vntu.edu.ua/
9	Ivan Puluj Ternopil National Technical University (TNTU)	Scientific and Technical Library of Ivan Puluj Ternopil National Technical University, https://library.tntu.edu.ua/
10	Donetsk National Technical University (DonNTU)	Scientific and technical library of Donetsk National Technical University, https://donntu.edu.ua/library

The study focused on institutions that train specialists in technical specialties. It should be noted that, unlike data obtained from the Internet, libraries have information resources whose quality and reliability can be trusted. For technical specialties, the accuracy of information is critical for the research and development of new technologies.

In addition to improving the functions related to educational and research processes, website analysis of academic libraries of technical universities is also important for ensuring the optimization of other processes, namely:

1. Improving access to information resources. Using library websites, you can access useful resources such as scholarly articles, e-books, databases, dissertations, and other educational and research materials. Optimizing such sites will help make these resources more accessible to students, teachers, and researchers, providing them with easy and quick access to the information they need.
2. Increase the visibility and influence of the university. High visibility of the library website in search engines can increase the prestige and influence of the university. This can help attract more students, researchers, and partners, which will contribute to the development of the university and its research programs.
3. Support for scientific activities. Optimized library websites will facilitate more efficient searching for scholarly literature and other resources. This can speed up research and learning processes, helping students and faculty find relevant information faster and with less effort.
4. Ensuring competitiveness. In the modern world of education and science, competition among universities is constantly growing. With an optimized library website, a

technical university can stand out among other educational institutions, demonstrating its commitment to technology and modern methods of teaching and research.

5. Compliance with modern user requirements. Modern users expect fast and convenient access to information. Website optimization will help ensure a positive user experience, including fast page loading, mobile responsiveness, and easy navigation.
6. Analysis of user behavior. Analyzing data on website traffic and user behavior will help you identify which sections of the site are most popular, which resources are most in demand, and identify potential problems and opportunities for improvement.

4.2. Selection of technical means for collecting statistical information

To determine the preferences and areas of interest of users of libraries of higher education institutions, it is necessary to analyze the indicators of resource utilization of these institutions. Web analytics tools provide detailed information about the state of the site, including the number of visitors, their actions on the pages, time spent browsing, and popular content. These parameters allow you to optimize the design and content of the site, which helps to increase the duration of visits and the desired actions by users.

Analyzing data about site traffic and user behavior helps identify the most popular sections of the site, requested resources, potential problems and opportunities for improvement. There are many services for analyzing the main parameters of information resources, which are classified according to different criteria. Important are the choice of how to collect information, the cost, the way the results are presented (heat maps, graphs, tables, etc.), and the flexibility of filter settings to display the necessary data. This is important because accurate data helps to make informed decisions to improve the user experience and the efficiency of using library resources.

When choosing a specific tool for analytics processing, you need to start from the data that you need to obtain with its help.

Many different software products in the modern information services market allow you to collect a wide variety of relevant statistical information, as well as analyze web resources and explore their strengths and weaknesses. In general, such programs can be divided into:

1. Software products that require the integration of a special tracking code into website pages to collect data about visitors, their behavior, and other metrics. The most popular software products of this type:

- Google Analytics. Traffic tracking, analysis of user behavior, conversions.
- Adobe Analytics. Detailed analytics and marketing insights.
- Matomo. Analysis of traffic and user behavior.
- Hotjar. Heat maps, recording of user sessions, polls.
- Crazy Egg. Heatmaps, session recording, A/B testing.
- Software products that work based on the analysis of traffic from search engines and do not require additional interventions in the code. The most popular software products of this type:
- SimilarWeb. Analysis of traffic, sources, demographics, and competitors.
- SEMrush. SEO analysis, keyword research, and competitive analysis.

- Ahrefs. Analysis of backlinks, keywords, and competitive analysis.
- Moz Link Explorer. Analysis of backlinks, domain authority, and competitive analysis.

2. Software products that analyze the technical condition of websites.

- Nibbler. Analyzes websites for technical errors, SEO, accessibility, and usage.
- Insite. Analysis of technical aspects of the site, SEO, accessibility, and performance.
- Lighthouse. Analysis of the quality of websites.

Each of these technologies has its advantages and disadvantages.

The choice of technical tools depends on the specific goals and purpose of the study, as the capabilities and data of different software products may differ and have no common points of contact. For a comprehensive approach and reliability of the results, it is worth using several tools at the same time to get the most complete picture of the website's resources and its opportunities for improvement.

Taking into account technical limitations, the inability to access websites to enter the traffic tracking code, as well as the cost of tariff plans and indicators available in the test version, the following systems were chosen:

- SEMrush - provides free temporary access to all resources related to traffic analysis;
- Nibbler, Insite to analyze the technical condition of websites and determine their position in search engines.

To accurately reflect the main parameters of user interaction with the site, analysis with SEMrush involves the use of various indicators and reports. Here are some of them:

3. Analysis of the resource audience. It allows you to determine the number of registered users, the geography of visitors (countries, regions), demographic data (age, gender of users), devices and platforms from which users visit resources (mobile, desktop, operating systems, browsers), etc.
4. Traffic evaluation. It consists of many indicators of website traffic. Within the framework of this work, the most important are:

- Analysis of the number of views and impressions of content (Content Views and Impressions). It helps to determine which content is most popular among your website users. This can indicate which topics or content formats your audience is most interested in.
- Organic Traffic score. Allows you to determine which keywords drive traffic to your website through organic search. This can help you understand what topics and content your audience is interested in.
- Competitors' Traffic analysis. Allows you to compare your website traffic with competitors in your niche. This can help you identify the strengths and weaknesses of your content compared to your competitors.

- Backlinks Analysis. Allows you to determine which sites link to your website. This can indicate which resources or content are of interest to other webmasters and may be of interest to your audience.

5. Analysis of keywords (Top Keywords). It helps to identify the most popular keywords that users use to find a website. This gives you an idea of what topics or products the audience is most interested in.

These indicators allow you to gain a deep understanding of the interests of the user audience and identify the content that can be most effective in attracting users' attention. Analyzing this data allows you to identify the strengths and weaknesses of the resource, as well as determine the areas for its optimization.

The study was conducted in December 2023 - May 2024.

4.3. Analyzing the quality and technical condition of websites

We analyzed the quality of websites using a combined method:

- by expert evaluation of the visual and logical state.
- Use INSITES and Nibbler software products to analyze the technical condition of the resources.

The expert evaluation involved the involvement of library staff and potential users. Three criteria assessed the quality:

- "0" - poor quality of the proposed criterion or its absence
- "1" - average quality of the proposed criterion
- "2" - high quality of the proposed criterion

After the evaluation, all the scores were summed up, which allowed us to determine the rating of resources by usability.

Figure 1 and Figure 2 show the results of the expert assessment of the resources under study. Based on the results of processing these data, a summary table of expert assessment was compiled.

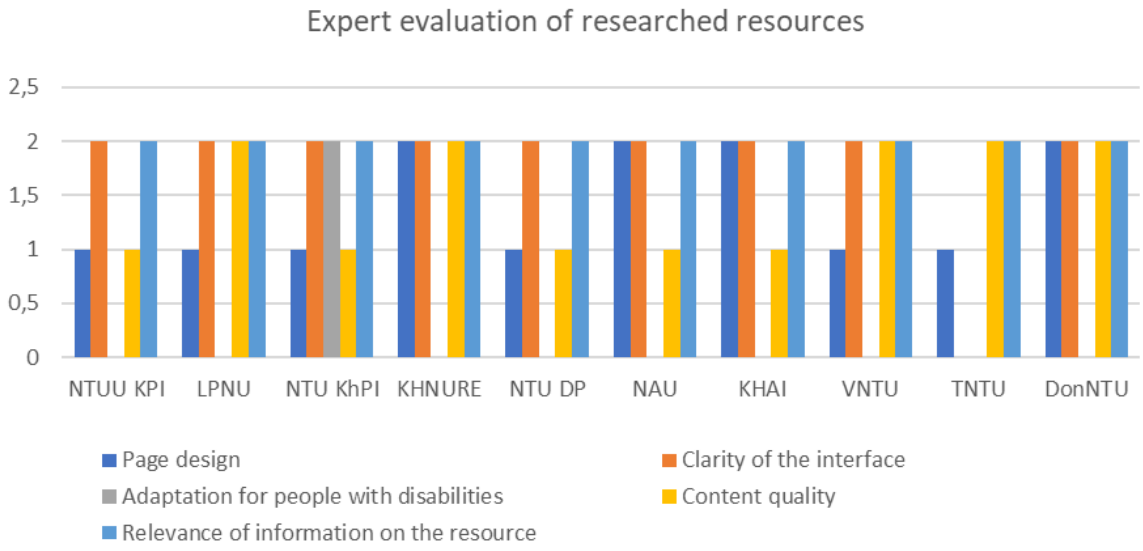

Figure 1: Results of expert evaluation of the studied resources

The technical analysis was carried out using INSITES and Nibbler software products, which allow assessing the technical condition of websites by various aspects of their functioning. For this purpose, many criteria are used. The following criteria were selected based on the specifics of the functioning and purpose of the resources:

- HTML and CSS validation: checking for compliance with standards and detecting errors in the code;
- Page loading speed: assessment of website performance and page loading time.
- Image optimization: Analyze image sizes and formats to improve loading speeds.
- mobile optimization: Checking the adaptability of a website to mobile devices.
- rating: A comprehensive assessment of the quality of a website expressed in points.
- Recommendations: Suggestions for improving various aspects of the site.
- content quality: Analysis of the uniqueness and relevance of textual content.
- number of pages: Assessment of the number and variety of pages on the website.
- Metadata: Analysis of meta tags and their relevance to page content.
- Integration with social networks: Assessment of the availability and effectiveness of integration with social platforms.

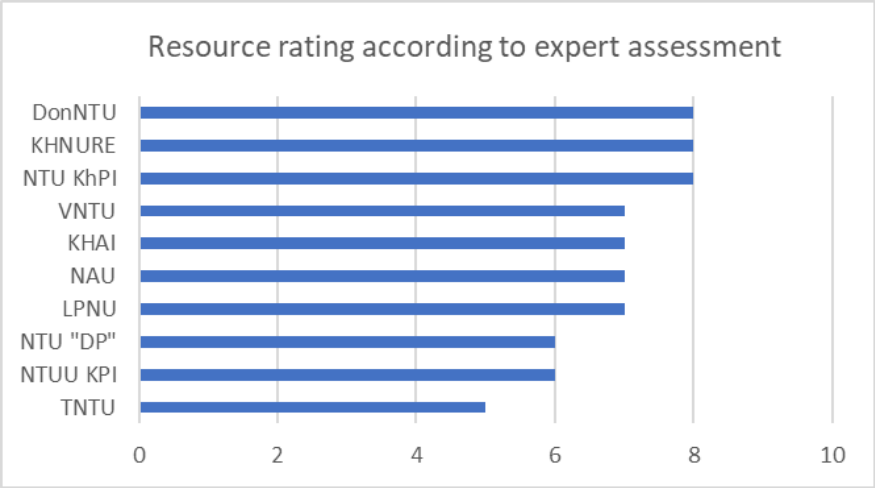

Figure 2: Rating of the studied resources based on the results of expert evaluation

The INSITES service uses a scale from 0 to 100 points to evaluate the quality of websites, where 100 is the highest possible score, indicating the perfect quality of a website by all criteria. Here is an example of a quality scale that can be used to interpret the results of the INSITES analysis:

- 0-19: Deficient quality
- 20-39: Low quality
- 40-59: Average quality
- 60-79: Good quality
- 80-89: Outstanding quality
- 90-100: Excellent quality.

Below, the diagram shows the quality rating of the technical condition of the studied sites based on the results of the INSITES and Nibbler assessments (Figure 3).

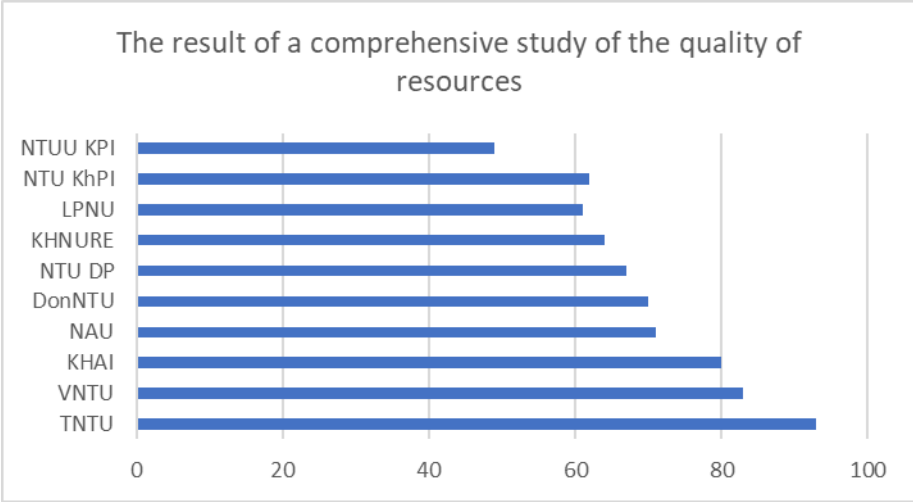

Figure 3: Ranking of processed resources, based on the results of the technical assessment with the assistance of INSITES

Based on this, the technical condition of the resources can be considered satisfactory. Thus, the analysis of the quality and technical condition of scientific and technical libraries' websites is an important component of the strategy for their optimization and improvement. Such analysis includes certain key aspects that help to understand the current state of the site and identify areas for its further improvement and optimization.

4.4. Analysis of the audience of resources

Before starting to collect and analyze statistical data, it is necessary to identify the audience under study. Since the subject of the study is academic libraries, this implies certain peculiarities regarding users. The mode of access to the library resources depends on the users belonging to a certain category.

Two categories of users are possible: authorized users who have access to all resources (teachers, students, and other employees of the institution) and third-party users who have access to general information only.

To determine user interests, the structure of the user audience, the geography of users, and other indicators related to direct visits to the studied resources, we analyzed the data obtained using SEMrush.

The table below shows the data on the possible number of authorized users obtained from these institutions. These data are used as a basis for further research (Table 2).

Table 2
The number of authorized users of the researched resources received

Name of the university	Number of users	Students	Teachers	Data obtained from

1	National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute" (NTUU KPI)	23800	21500	2300	The system does not provide information
2	Lviv Polytechnic National University (LPNU)	35700	33500	2200	
3	National Technical University "Kharkiv Polytechnic Institute" (NTU KhPI)	13400	12000	1400	1001-5000
4	Kharkiv National University of Radio Electronics (KNURE)	9150	8500	650	
5	National Technical University "Dnipro Polytechnic" (NTU DP)	8830	8200	630	1001-5000
6	National Aviation University (NAU)	26200	25000	1200	100001-+
7	Zhukovsky National Aerospace University "Kharkiv Aviation Institute" (KAI)	7399	6870	529	1001-5000
8	Vinnytsia National Technical University (VNTU)	6425	6000	425	
9	Ivan Puluj Ternopil National Technical University (TNTU)	1340	900	440	501-1000
10	Donetsk National Technical University (DonNTU)	1594	1469	125	1001-5000

Below, in Figure 4, Figure 5, Figure 6 and Figure 7, we present data related to the structure of the user audience of the selected resources, obtained using the SEMrush resource.

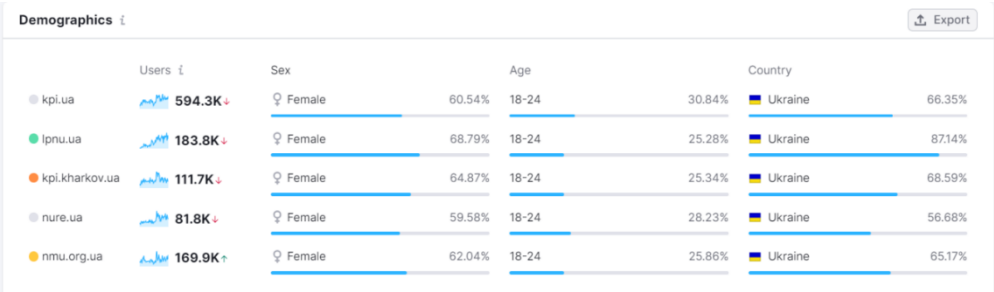

Figure 4: Demographic and gender structure of the user audience of selected resources, obtained using the SEMrush resource (NTUU KPI, LPNU, NTU KhPI, KHNURE, NTU DP)

Figure 4 shows that the main part of the users of these resources are women aged 18-24 who are in Ukraine.

Figure 5: Socioeconomic structure of the user audience of the selected resources, obtained using the SEMrush resource (NTUU KPI, LPNU, NTU KhPI, KHNURE, NTU DP)

From Figure 5 , it can be concluded that users of resources are female employees or students who work full-time, depending on age (see the previous figure).

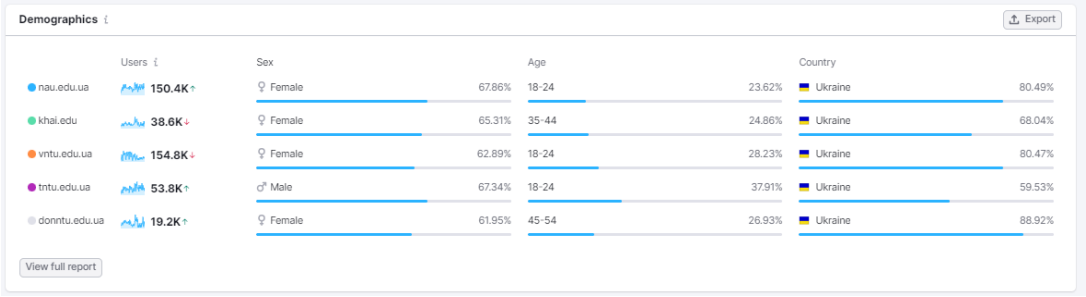

Figure 6: Demographic and gender structure of the user audience of the selected resources, obtained with the help of SEMrush (NAU, KHAI, VNTU, TNTU, DonNTU)

Figure 6 and Figure 7shows that the age of the user category is not as clear as in the previous case and is 18-54 years old.

Figure 7: Socioeconomic structure of the user audience of the selected resources, obtained using the SEMrush resource (NAU, KHAI, VNTU, TNTU, DonNTU)

It can be seen from this figure that it is similar to the previous drawing, users of resources are female employees or students who work full-time, depending on age (see the previous figure).

It is also important to assess the age structure when researching user needs. The results are shown in Figure 8, Figure 9 and Figure 10.

Figure 8: Structure of users by age (NTUU KPI, LPNU, NTU KhPI, KHNURE, NTU DP)

It can be seen from this figure that the main group of interested users are people 18-24 and 35-44 years old. at least users aged 65+ years.

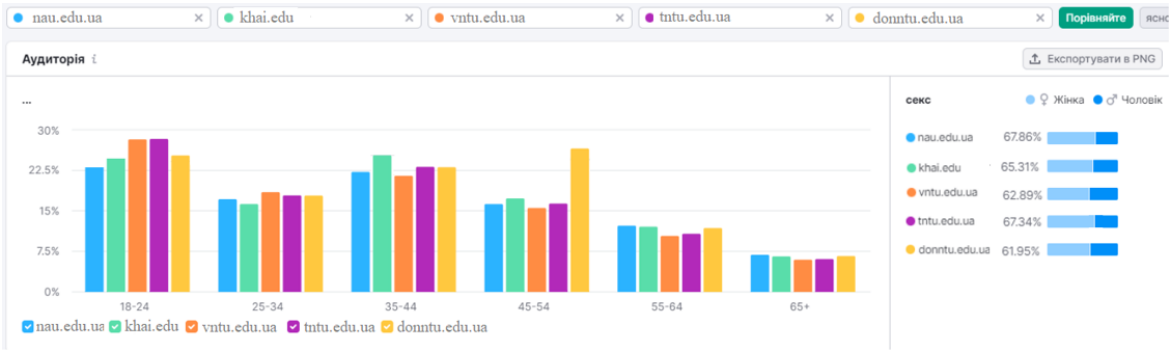

Figure 9: Structure of users by age (NAU, KHAI, VNTU, TNTU, DonNTU)

The above data shows that the main users of library websites of technical higher education institutions in Ukraine are women aged 18-24 and 35-44. This is due to the specifics of the functioning of the institutions themselves. It can be assumed that these are students who use library resources to complete individual assignments or young scientists to conduct research.

Figure 10 and Figure 11 show the distribution of devices most often used to access information.

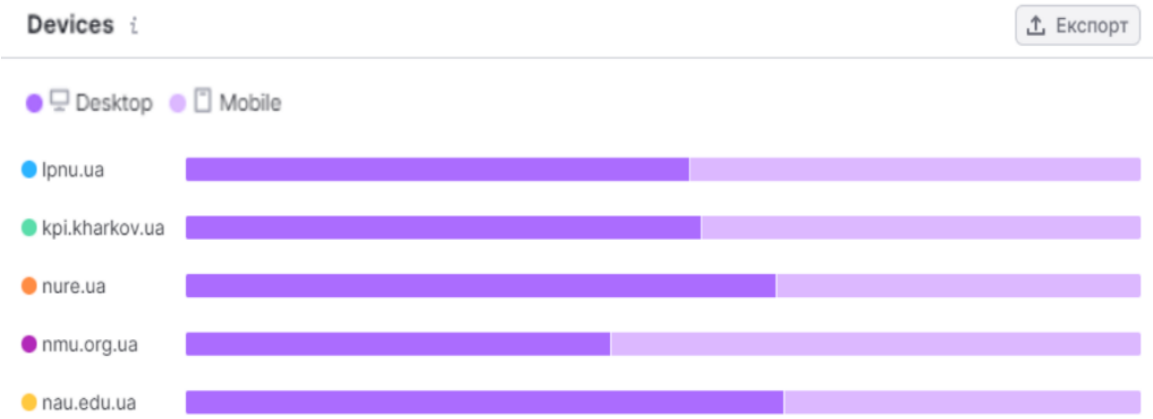

Figure 10: Modes of receiving information (NTUU KPI, LPNU, NTU KhPI, KHNURE, NTU DP)

If we are talking about the devices from which users visit these resources, then they prefer stationary computers to other means.

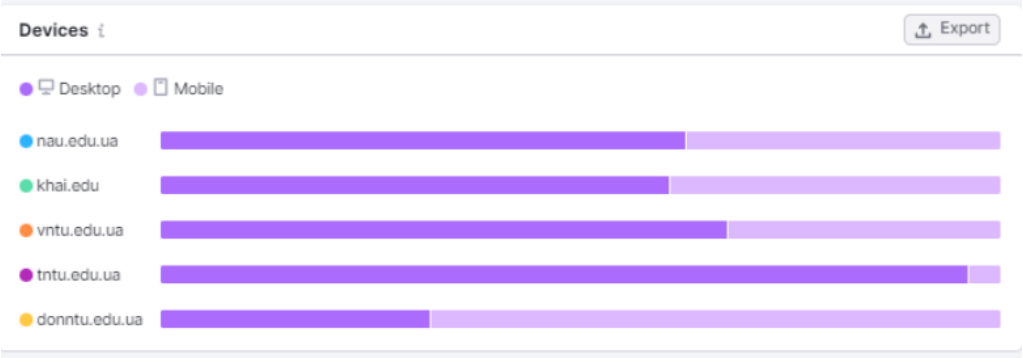

Figure 11: Modes of receiving information (NAU, KHAI, VNTU, TNTU, DonNTU)

These results confirm the assumption that the main use of information resources is to obtain educational materials for further study. For a wide range of users, computers (both home and library equipment) are an important means of providing access to information and resources, which facilitates their learning, research, and socio-cultural activity in general. It should be noted that the integration of mobile technologies allows libraries to provide faster, more convenient, and more accessible services to their users, contributing to their satisfaction and efficiency of using library resources. Mobile devices can be used to organize virtual tours, QR codes for additional information about publications or resources, mobile applications or mobile versions of websites can be used to book books, view the relevance of the book collection, and check the terms and conditions of use of materials.

4.5. Analysis of resource traffic

One of the most important stages of website analysis is traffic research - the number of visitors and visits to a website. This indicator is recorded every time a user visits the site.

Figure 12, Figure 13 and Figure 14 show data only for the last 6 months of operation, but information for 2 years of resource activity was taken into account.

Цільова	Відвідування	Унікальні відвідувачі	Конверсія покупки Обсяг результатів: коренев	Сторінки / відвідування	Середнє Тривалість відв...	Показник відмов
lib.vntu.edu.ua subdomain	225.5K	187.1K	n/a	1.52	08:10	68.57%
library.khai.edu subdomain	74.3K	64K	n/a	1.87	05:31	87.81%
library.khai.edu subdomain	74.3K	64K	n/a	1.87	05:31	87.81%
library.kpi.kharkov.ua subdomain	58.1K	63.2K	n/a	1.18	01:13	75.01%
lib.nmu.org.ua subdomain	21.2K	20.3K	n/a	1.11	01:27	94.13%
lib.nau.edu.ua subdomain	6.6K	2.9K	n/a	3.37	14:18	54.95%
library.tntu.edu.ua subdomain	4.8K	5.8K	n/a	2.12	01:49	39.23%
library.lpnu.ua subdomain	1.3K	1.9K	0.16%	2.70	03:29	46.58%
nure.ua/branch/naukova-biblioteka/ subfolder	n/a	n/a	n/a	n/a	n/a	n/a
kpi.ua/library/ subfolder	n/a	n/a	< 0.01%	n/a	n/a	n/a

Figure 12: Analytical data on website traffic of the surveyed institutions

Organic traffic refers to visitors who find a website using certain search engine queries. It depends on the visibility of the site by search engines.

Direct traffic is traffic to a website by entering the website URL into the address bar of a browser or through a bookmark. From the point of view of analytics systems, this is traffic without a source or data. Direct traffic does not account for much of the total number of visits, but it can indicate brand awareness or customer loyalty.

Backlinks are important for boosting search engine rankings, increasing the authority of your website, attracting more traffic, and improving your online visibility.

Figure 12 shows statistics on website traffic.

Pageviews is a parameter that can be useful when analyzing visitor activity on a website. In this case, the number of pages visited is important.

The average duration of a page visit is calculated as the ratio of the total duration of all visitors on the site to the sessions. It is important to note that sessions during which a person visited only one page of the site are not taken into account, and their duration is taken as zero. If this indicator is high, it may mean that users are interested in the content. Instead, a short presence on the page suggests that the resource did not meet the user's expectations or the information is not relevant.

Another important indicator is unique visitors, which indicates the number of people who have visited a website one or more times over a certain period of time.

For example, Figure 12 shows the average duration of visits to resources over a 6-month period.

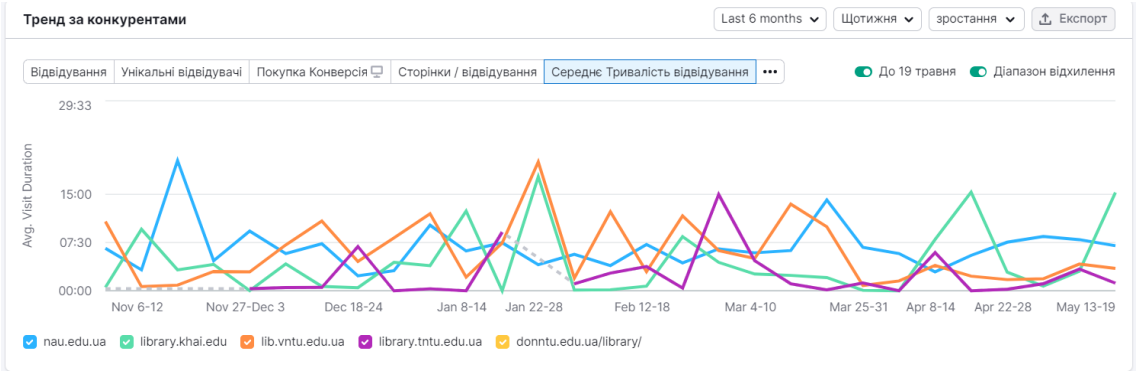

Figure 13: Statistics on the duration of visits to resources (NTUU KPI, LPNU, NTU KhPI, KHNURE, NTU DP)

As can be seen, at least three of the institutions featured have materials that are of particular interest to users, as the duration of their viewing is about 20 minutes. It can be assumed that these are some materials for performing tasks that are allowed to be used only in screen viewing mode.

The traffic analysis revealed that there are two peak periods of website visits: December-January and May-June. It can be assumed that it is during this period that the exam session falls and users need library materials to complete individual tasks and prepare for it. All other periods show approximately the same number of visits to the resources. The results are shown in Figure 13.

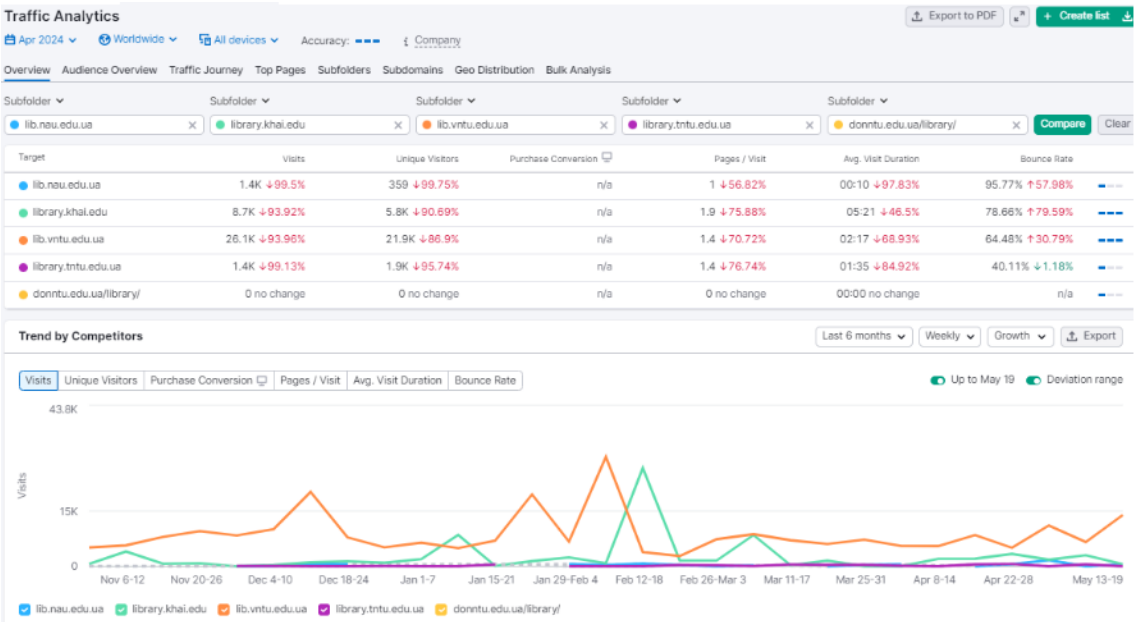

Figure 14: Traffic analytics of the studied resources (NTUU KPI, LPNU, NTU KhPI, KHNURE, NTU DP).

4.6. Identification of users' information needs based on the results of keyword and organic link analysis

Another important criterion is keyword analysis. Keywords are words or phrases that people enter into search engines when they are looking for products, services, or information. Keyword research is important for several reasons. Let's consider them.

Understanding the audience of the resource. Keyword research allows you to establish the language used by the audience to find resources; and identify the most relevant keywords for a given resource, which helps you create content that targets the target audience and meets their needs and interests.

Content creation. By identifying the keywords that the target audience searches for, you can structure the resource in such a way that it meets the needs and interests of the audience, which will help increase website traffic and the number of users.

Of course, other indicators can be used in the general analysis of website keywords, but in the context of the objects under study, their study is not advisable for several reasons:

In this case, the objects under study are library pages and their resources, which contain specific content that cannot be modified with information alone or structured. Limited variety of information.

User restrictions. Access to resources in scientific and technical libraries is usually limited and only employees and students of the institution have this opportunity. It is almost impossible to attract other users to visit due to the limited resources available to unauthorized users, who mostly have only general information at their disposal.

The analysis of keywords and organic links shows that the main areas of user interest are educational and scientific materials, which is logical based on the purpose of these resources (Figure 15).

Keyword	Intent	kpi.ua	lpnu.ua	kpi.kharkov.ua	nure.ua	nmu.org.ua	Volume	KD%	CPC	Com.	Results
університет	C	64	85	79	99	84	27.1K	74	0.05	0.06	181M
університет	C	70	30	50	96	18	27.1K	72	0.05	0.06	55.9M
вступ інфо	I	29	17	86	51	59	8.1K	48	0.00	0	65.6K
бакалавр це	I	26	50	15	76	88	5.4K	17	0.00	0	2.2M
віртуальний університет	I N	13	49	67	40	96	4.4K	25	0.00	0	169K
дискретна математика	I	4	46	81	95	79	3.6K	24	0.05	0.05	77.9K
національний	I T	63	6	41	58	28	3.6K	56	0.13	0.01	30.2M
телекомунікації	I	28	65	17	10	59	3.6K	30	0.00	0	2.9M
комп ютерна інженерія	I	9	20	21	3	40	2.9K	30	0.00	0	491K
компютерна інженерія	I	7	15	16	4	33	2.9K	32	0.00	0	565K

Figure 15: Analysis of keywords

Keyword overlap between library sites reflects the level of commonality or similarity between keywords used by different libraries on their websites (Figure 16, Figure 17).

Analysis of the keywords of the studied resources made it possible to establish that, given the approximately identical structure of the resources for which the research was conducted,

their information provision is approximately the same, which is why the means and methods of information search overlap accordingly (Figure 16, Figure 17).

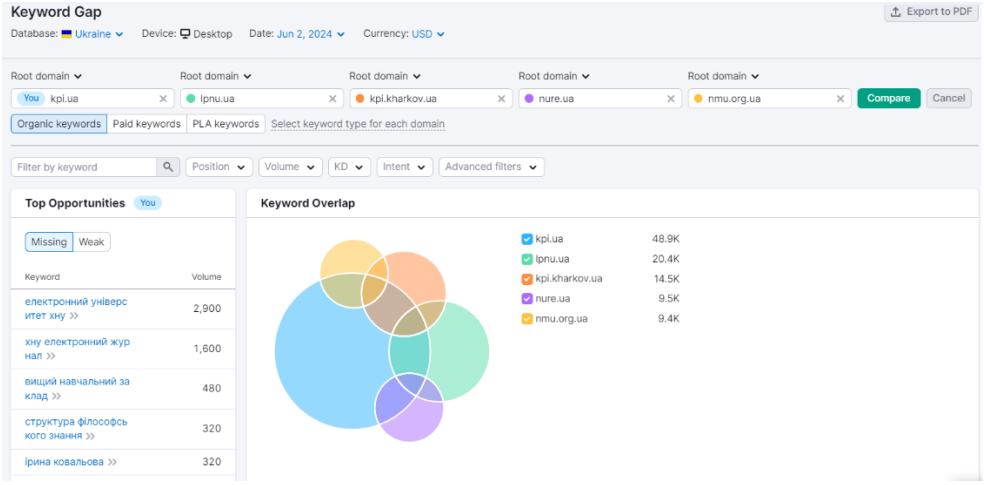

Figure 16: Overlapping keywords of the studied resources (NTUU KPI, LPNU, NTU KhPI, KHNURE, NTU DP)

Analysis of the keywords of the studied resources made it possible to establish that, given the approximately identical structure of the resources for which the research was conducted, their information provision is approximately the same, which is why the means and methods of information search overlap accordingly (Figure 16, Figure 17).

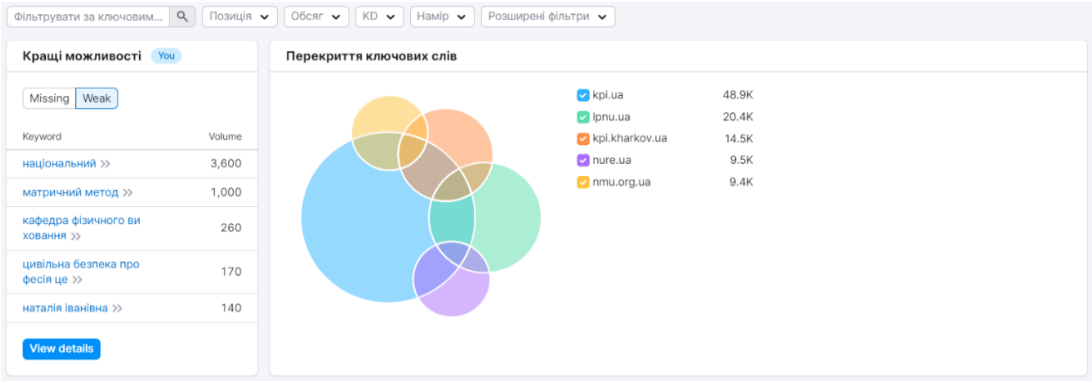

Figure 17: Overlap of keywords of the studied resources (NAU, KHAI, VNTU, TNTU, DonNTU)

4.7. Analysis of the results

The study made it possible to identify the main areas of interest of university library users.

Based on the data obtained from SEMrush, you can also study user behavior on web resources. By analyzing the data, you can find out what the most popular keywords are in queries, the period of stay, as well as movement within the resource, the elements that were of the greatest interest, and which users most often paid attention to. You can also find out where

users most often come from and where they go when they leave the resource (Figure 18, Figure 19).

Figure 18: The path before and after the visit to the sites (NTUU KPI, LPNU, NTU KhPI, KHNURE, NTU DP)

Figure 19: The path before and after the visit to the site (NAU, KHAI, VNTU, TNTU, DonNTU)

By processing the data, we were able to identify the ways users navigate the resources and the sections of greatest interest. Since this information is contained in large data sets, there is no point in presenting it here. Figure 20 below summarizes the most popular sections on library websites.

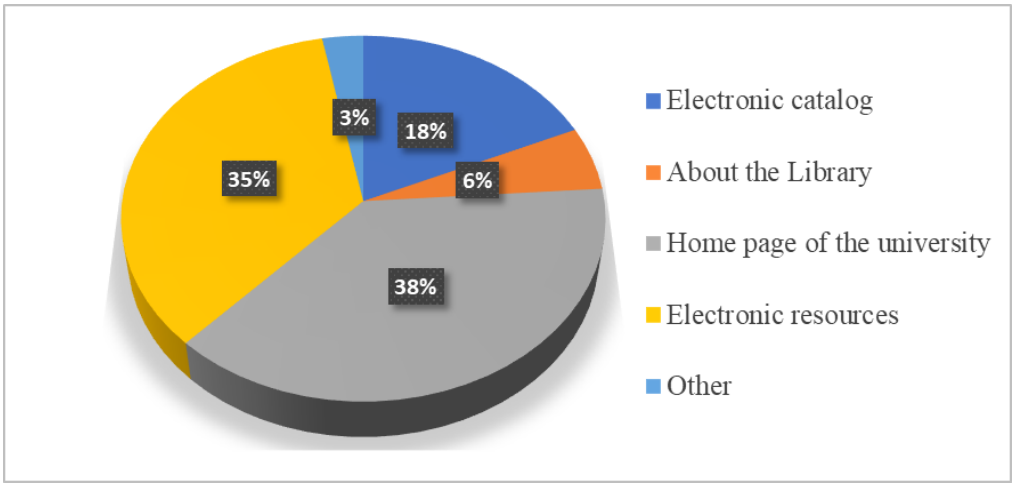

Figure 20: Generalized information about the most populist sections on library websites

Thus, the ways users move through the resources of scientific and technical libraries may include various aspects that contribute to the convenience and efficiency of using information resources. The main page has the most visitors, so it should be presentable, interesting, understandable, and convenient. In terms of percentage, the second place is taken by the category "Electronic resources". Libraries provide access to a variety of scientific databases where users can find up-to-date scientific information, scientific articles, conference materials, etc. Scientific and technical libraries have subscriptions to electronic versions of scientific journals and books, which allows users to quickly find and access the necessary literature. The third place is taken by the category "Electronic catalog". This is the main tool for searching for literature and other resources in the library. Users can search for books, journals, and scientific articles by author, title, keywords, etc. Taking into account modern technologies, libraries provide access to their resources remotely via the Internet, which allows users to obtain the necessary information without a direct visit to the library.

Libraries often organize training seminars and courses on the use of scientific resources to help users better understand how to search for and use scientific information and provide consulting support to users on how to search for and use scientific resources, which greatly facilitates their work. These ways help to make the use of scientific and technical resources more efficient and convenient for library users.

It should also be noted that the proposed method, which consists in the use of SEO analysis, technical analysis, expert evaluation of web resources, is sufficiently flexible and adaptive. These properties make it possible to apply the obtained approach for comprehensive assessment also for non-academic library resources.

5. Conclusions

The findings of the study provide important information about the interests and behavior of users of technical library websites at Ukrainian universities. The results of the study show that users most often use the sites to access library catalogs and educational and scientific content,

such as textbooks, articles, information about library services, and news. Resources in pdf and doc formats are of particular interest. They tend to spend more time on library websites during academic periods, such as the beginning of the academic year and exam sessions. Most of the sessions on the websites were conducted using computers, which indicates that library websites are not always optimized for use on mobile devices such as smartphones or tablets. In addition, there are some limitations related to the methodology and data processing, including the inability to accurately determine some indicators, such as the geographic distribution of users, as well as limitations in the amount and accuracy of the data. As for the accuracy of the data, the problems are related to the specifics of the software used to collect the information. Experts believe that more accurate information can be obtained by using, for example, Google Analytics or other systems that work directly with website data and require direct access to the administrative part of resources. The same tools were used for all the resources in this study, so we can assume that the data is sufficient.

We analyzed the interaction of users with the web resources of university libraries in Ukraine, in particular, we studied the elements with which users can interact on the site, such as the logo of the institution, the main menu, electronic resources, etc. The use of appropriate analysis tools allowed us to understand the impact of the importance of these elements on user behavior and the satisfaction of information needs. The study showed that there are certain trends in the use of different elements of the website. For example, the main menu items leading to the main catalog and electronic resources have the highest interaction activity. In addition, changing the website language to English is also a popular element.

Different groups of users have different information needs. For example, students may be looking for learning resources, while researchers may be interested in scientific publications and databases.

A study was conducted on the technical condition and quality of library websites. Although a significant number of them fall within the range of "good quality", none of them received the "excellent quality" rating.

The study reveals some problems and directions for further research and improvement of the system. In the form of recommendations for university libraries, they can be formulated as follows: it is necessary to modernize information resources of the above-mentioned caliber; update and expand the collection of documents; improve access to international databases; develop new services aimed at different user groups; optimize the structure and navigation of websites; select content adapted to the needs of users, which will significantly improve the user experience.

The results of the study confirm that the combination of SEO analysis and peer review is an effective approach for studying the information needs of users of library websites. The applied multi-criteria assessment methodology allows library specialists not only to assess the current state of web resources, but also to identify ways for their further improvement. Practical recommendations based on research results contribute to improving access to information and meeting user needs.

The proposed methodology can be used by librarians to regularly evaluate websites, which will ensure their compliance with modern user requirements and optimize information availability for different categories of users.

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