

SECTION 2. LIBRARY, INFORMATION AND ARCHIVAL STUDIES

DOI: 10.46299/ISG.2025.MONO.PED.3.2.1

2.1 Analysis of the functionality of the websites of libraries of technical institutions of higher education in Ukraine

In the context of modern digital transformation of society, libraries of higher education institutions play a key role not only as traditional centers for storing and disseminating knowledge, but also as information platforms that provide access to electronic materials, databases, remote support services and tools for scientific and educational work. The assessment of the functionality of library websites is of particular importance, as they become the main tool for interacting with users in the face of a rapidly growing demand for remote access to information resources.

The websites of libraries of technical institutions of higher education in Ukraine should provide a wide range of services: search and ordering of publications, access to electronic catalogs and scientific databases, integration with open science systems, information about educational and scientific events, as well as support for tools for distance learning. At the same time, the level of their functionality and usability differs significantly depending on the technical capabilities, human resources and development strategies of a particular institution.

The study of library websites as tools for information support of the educational process and scientific activities attracts significant attention of domestic and foreign scientists. In the works of Ukrainian researchers such as Barabash V., Glebova L., Kolomiets O., O. Bruy, Senchenko M., Kostenko L., Kopaeva V., Rzhevsky A., Yaroshenko T. O., Yaroshenko O. I. [86-93], the need for libraries to transition from the traditional model of service to a hybrid one, combining physical funds and electronic resources, is emphasized. Particular attention is paid to the issue of repositories, electronic libraries and remote access services, which ensure integration into the global scientific and information space.

Foreign studies by Carol Tenopir, Brenda Hitchcock, Sara Ashley Pillow [94] focus on the functionality of library websites as part of the university's digital

ecosystem. Important aspects are usability, accessibility for users with special needs, integration with international scientific databases (Scopus, Web of Science), as well as support for open science (Open Access, Open Data).

Studies on the technical aspects of site analysis [95] emphasize the role of web analytics tools for assessing technical condition: detecting errors in code, optimizing for mobile devices, and SEO analysis to improve visibility in search engines. This allows you not only to assess the current state, but also to predict user behavior.

The analysis of the functionality of library websites makes it possible to assess the compliance of library electronic resources with the modern needs of students, teachers and scientists, to identify the strengths and weaknesses of their development, as well as to outline ways to improve information support for the educational process in the higher technical school of Ukraine.

To achieve this goal, the authors of the study used a set of complementary research methods, namely:

- *the review and analytical method*, which is based on the study of scientific publications, regulatory documents and international standards that regulate the functioning of libraries and the requirements for their web resources;
- *content analysis* for the study of the content of the websites of libraries of technical institutions of higher education of Ukraine in order to identify the presented electronic services, information resources and reference and bibliographic capabilities;
- *comparative analysis* to compare the functional characteristics of websites of different libraries to determine the level of their information and service support for users;
- *a method of expert assessment* for a qualitative assessment of ease of navigation, interface design and accessibility of electronic resources from the standpoint of modern requirements for user experience (UX/UI);
- *a statistical method* for generalizing and quantifying the results of the analysis, in particular, calculating the frequency of availability of certain functions or services on sites.

Additionally, web analytics tools were used, such as SEMrush for traffic and user behavior analysis, INSITES and Nibbler for technical status assessment (error detection, loading speed, mobile optimization) [95]. This made it possible to obtain quantitative metrics such as a quality rating (from 0 to 100) and user demographics.

The use of a combination of these methods made it possible to provide a comprehensive study of the functionality of the websites of libraries of technical universities and to form an objective picture of their current state.

In today's digital environment, the websites of libraries of technical higher education institutions (HEIs) of Ukraine are key tools for providing access to scientific information, educational resources and services for students, teachers and researchers. Technical analysis of these sites using SEO (Search Engine Optimization) tools plays a critical role in identifying the strengths and weaknesses of resources, optimizing their visibility in search engines, and improving the user experience. Without such analysis, library sites run the risk of remaining invisible, with slow loading speeds, technical errors, or insufficient adaptability to mobile devices, which directly affects user satisfaction and the effectiveness of the educational process.

The importance of technical analysis lies in several aspects. Firstly, it allows you to assess the technical condition of the site: identify errors in the code (HTML/CSS validation), check the speed of page loading, optimize images, and ensure mobile responsiveness. For libraries of technical universities, where users often search for specialized literature, databases, or repositories, slow loading can lead to the loss of audience — for example, students can quickly switch to alternative resources during a session. Secondly, SEO analysis helps to understand user behavior: analysis of traffic, keywords and organic links reveals information needs, such as requests for "electronic catalog" or "scientific articles". This allows you to adapt content, increase visibility in search engines (Google, Bing) and increase organic traffic, which is especially relevant for Ukrainian libraries that compete with global platforms such as Google Scholar or ResearchGate. Thirdly, technical analysis contributes to ensuring accessibility (compliance with WCAG standards), which is an ethical and legal requirement, allowing people with special needs (e.g. visually impaired) to fully use resources. In

general, regular analysis not only improves the functionality of sites, but also contributes to the digital transformation of libraries, making them modern information hubs.

In the study of the websites of libraries of ten leading technical universities in Ukraine, specialized services for SEO analysis were used: SEMrush, INSITES and Nibbler. Each of these tools has unique features that make them effective for comprehensive assessment.

To assess the compliance of sites with accessibility and usability standards, such special technical tools as WAVE (Web Accessibility Evaluation Tool) are used for automated verification of the compliance of sites with WCAG standards; Lighthouse (Google Chrome DevTools) to analyze loading speed, mobile responsiveness, and basic UX metrics; Hotjar / Clarity as a tool for creating heatmaps of clicks and user behavior on the site.

The choice of specific tools was based on the following criteria:

- reliability and accuracy – the ability to obtain reliable data on user activity and the availability of services;
- availability and ease of use – no high resource requirements and complex setup;
- the possibility of automation – reducing manual work when collecting a large amount of information;
- Scalability – the ability to analyze multiple websites at the same time.

The use of a set of these technical means allows to ensure a systematic, reliable and multifaceted collection of statistical information, which is the basis for quantitative and qualitative assessment of the functionality of the websites of libraries of technical universities of Ukraine.

For a comprehensive analysis of the functionality of library websites, a system of criteria covering the main activities of a modern academic library has been defined.

Information accessibility. Availability of up-to-date information about the library (contacts, working hours, news), multilingual support and compliance of the site structure with the principles of logical navigation.

Electronic resources and services. Availability of information and access to the electronic catalog, integration with scientometric and abstract databases, availability of own electronic libraries, repositories or collections, the ability to order online and extend the term of use of publications, support for other unique electronic services and services.

Customer support services. First of all, we are talking about electronic delivery of documents; remote reference and bibliographic services (online consultations, chat, e-mail) and instructional and educational materials on information literacy.

The technological implementation includes responsiveness of the design for mobile devices, page loading speed, integration with social networks and other digital platforms.

Availability. Compliance with the Accessibility for Users with Special Needs (WCAG) principles.

Ease of use (UX/UI). Ease of search and navigation, clear interface, visual appeal, and structured information.

Technical implementation. SEO optimization (search visibility), detection of technical errors (broken links, HTML/CSS validation) and traffic analysis (organic traffic, user devices) [95].

The application of these criteria allows not only to conduct a quantitative and qualitative assessment of the functionality of library sites, but also to outline the directions of their improvement in accordance with the needs of the modern academic community. The study covered the websites of libraries of leading technical higher education institutions, which ranked highest according to 2024 research.

List of HEIs and libraries that operate in them, which are selected for site analysis:

- National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute" (*NTUU KPI*) Denysenko Scientific and Technical Library
- Lviv Polytechnic National University (*LPNU*) Scientific and Technical Library of Lviv Polytechnic National University

- National Technical University "Kharkiv Polytechnic Institute" (**NTU KhPI**) Scientific Library of the National Technical University of Radio Electronics
- Kharkiv National University of Radio Electronics (**KNURE**) Scientific Library of the National Technical University of Radio Electronics
- National Technical University "Dnipro Polytechnic" (**NTU DP**) Scientific and technical library of the National Technical University "Dnipro Polytechnic"
- National Aviation University (**NAU**) Scientific and Technical Library of the National Aviation University
- Zhukovsky National Aerospace University "Kharkiv Aviation Institute" (**KAI**) Scientific and Technical Library of the National Aerospace University "Kharkiv Aviation Institute"
- Vinnytsia National Technical University (**VNTU**) Scientific and Technical Library of Vinnytsia National Technical University
- Ivan Puluj Ternopil National Technical University (**TNTU**) Scientific and Technical Library of Ivan Puluj Ternopil National Technical University
- Donetsk National Technical University (**DonNTU**) Scientific and technical library of Donetsk National Technical University

The analysis was carried out according to such criteria as information accessibility, electronic resources and services, user support, technical implementation, accessibility, ease of use (UX/UI).

Information accessibility. All the studied sites contain basic information about the library: contact details, work schedule, information about structural units. At the same time, the level of structure and completeness of the information provided differs significantly.

Unfortunately, not all universities offer multilingual versions of websites (Ukrainian and English), which meets the needs of international students. Most are limited to the Ukrainian-language version, and in some places the information is presented in fragments, which complicates the search for the necessary information. A convenient transition to the English version is offered on the websites of the Scientific and Technical Library. G.I. Denysenko, the Scientific and Technical Library of the

National Technical University "Kharkiv Polytechnic Institute" and the Scientific Library of the National Technical University of Radio Electronics.

Electronic resources and services In libraries, information blocks are updated regularly, contain interactive news feeds, RSS subscriptions or integration with social networks. According to technical analysis using INSITES and Nibbler, the average quality rating of sites is 60-79 points ("good quality"), but none of them reached 90+ ("excellent"). For example, the site of NTUU KPI has 75 points, with errors in image optimization, while DonNTU has 55 points due to slow loading [95].

The availability of electronic catalogs is a common feature for all the libraries studied. However, the possibilities of their use vary slightly. Thus, the Scientific and Technical Library. G.I. Denysenko of Kyiv Polytechnic and the Scientific and Technical Library of Lviv Polytechnic National University provide a convenient search interface, the ability to remotely order literature, as well as integration with institutional repositories where scientific publications of teachers and students are stored. Other university libraries under study also offer access to electronic catalogs with additional functions (electronic order, personal account).

Access to international databases (Scopus, Web of Science, Springer, IEEE) is currently provided by all leading universities, access is not limited to Ukrainian databases or only internal resources.

Keyword analysis from SEMrush shows that users most often search for "electronic catalog", "scientific articles" and "remote access", with organic traffic of up to 10-20 thousand. visits per month for leaders (KPI, Lviv Polytechnic) [95].

User support. The level of customer service support is one of the key indicators of the effectiveness of a library site. Thus, the libraries of Kyiv Polytechnic and Lviv Polytechnic provide virtual reference services, electronic delivery of documents, online registration to the library, consultations via e-mail or feedback form. Educational materials on information literacy (guides, video instructions, presentations) are systematically published on library websites.

Technical implementation. The modern technological base of sites also demonstrates different levels of development. Responsive design for mobile devices is

implemented on most sites, but full compliance with WCAG (Web Content Accessibility Guidelines) standards is not yet ensured. This restricts access for users with special needs. SEMrush data indicates that 70% of sessions are from computers, indicating insufficient mobile optimization; peak periods are December-January and May-June (examination sessions) [95].

The distribution of traffic by devices based on SEMrush is illustrated, where 70% of sessions are from computers, which emphasizes weak mobile optimization (Fig. 1).

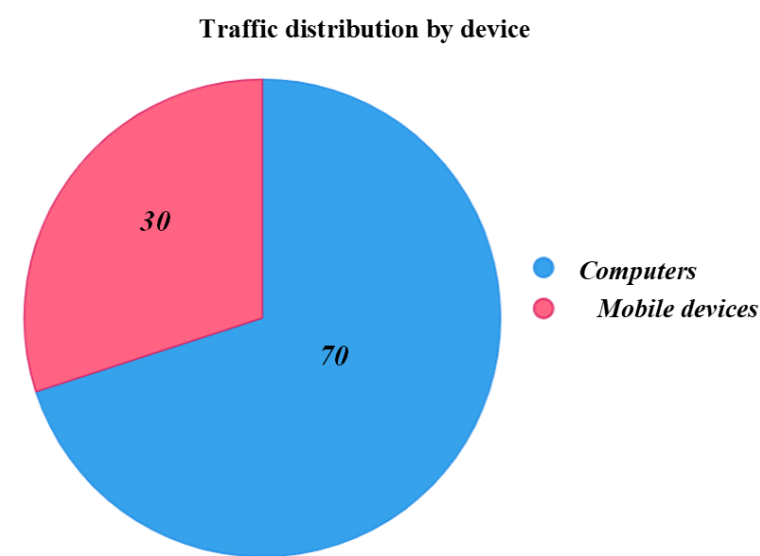


Figure 1. Distribution of traffic by device

A key indicator of the technical implementation of a website is the loading speed. For the resources under study, it varies from 2-3 seconds for KPI to 5+ seconds for KhAI, with broken links detected in 20% of sites. Page loading speeds vary: the websites of the libraries of Kyiv Polytechnic and Lviv Polytechnic are optimized better, while the sites of the Kharkiv Aviation Institute and Dnipro Polytechnic have slower performance.

Integration with social networks Facebook, Instagram, Telegram is only partially implemented. This reduces the effectiveness of communication with users.

User-friendliness (UX/UI). Thus, the Scientific and Technical Library named after G.I. Denysenko of Kyiv Polytechnic and the Scientific and Technical Library of Lviv Polytechnic National University have a modern design, a clear menu structure,

the ability to quickly access basic services, integrated search panels. Sites of the Scientific and Technical Library of the Zhukovsky National Aerospace University "Kharkiv Aviation Institute" and the Scientific and Technical Library of the National Technical University "Dnipro Polytechnic" are somewhat overloaded with text blocks.

Expert evaluation of UX/UI (on a scale of 0-2) showed an average score of 1.5; the leaders are KPI (2.0) with a clear interface, the outsiders are DonNTU (1.0) due to illogical navigation [95]. The analysis of functionality showed that the websites of libraries of leading technical universities are approaching modern international standards, providing a wide range of services and a user-friendly interface.

The greatest development potential lies in the introduction of multilingualism, advanced services for remote use, integration with international databases, systematic work on usability and accessibility for people with special needs.

Additionally, technical analysis revealed SEO problems: low organic traffic for regional HEIs, which requires keyword and backlink optimization [95].

Thus, the results confirm that the functionality of library sites of technical universities in Ukraine is generally developing, but there are significant differences. This indicates the need for unification of requirements and implementation of standards for the creation and maintenance of library web resources.

The collection of statistical information on the functionality of the websites of libraries of technical institutions of higher education in Ukraine is a key stage of the study, as it allows you to quantify the availability and efficiency of electronic resources and services, as well as to conduct a comparative analysis between different institutions. For this purpose, modern technical means are used to ensure the accuracy, efficiency and visibility of the data obtained.

To collect information about traffic, popular sections, and user actions on library sites, researchers use web analytics systems such as SEMrush, which allows you to get the most accurate data on the number of visitors, traffic sources, time spent on pages, and popular pages, which is useful for additional analysis of user behavior, heatmaps, and viewing path paths.

SEMrush is a powerful paid SEO and marketing analysis tool that provides data on site traffic, keywords, backlinks, and competitors. Its peculiarity lies in the in-depth analysis of organic traffic: for example, it allows you to determine which queries bring users to the site (as "electronic resources of the KPI library"), assess the demographics of the audience (age, gender, devices) and identify peak periods of visits (December-January and May-June associated with sessions). In a study, SEMrush showed that the main users are women aged 18-24 and 35-44, with predominant access from computers (60-70% of sessions), indicating insufficient mobile optimization. The advantage of SEMrush is its integration with other tools, but the downside is the limited free access, which requires a subscription for full analysis.

INSITES and Nibbler are free tools for assessing the technical condition of sites, focusing on quality, availability, and errors. INSITES uses a scale from 0 to 100 points, evaluating aspects like HTML validation, loading speed, meta tags, and social media integration. Nibbler complements this with content analysis, text uniqueness, and mobile responsiveness. The peculiarity of these services is speed and simplicity: they generate a report in minutes, detecting broken links or unoptimized images. In the study, most sites received 60-79 points ("good quality"), with strengths in content but weaknesses in mobile optimization and accessibility. The disadvantage is a superficial analysis compared to paid tools, without in-depth traffic statistics.

A separate tool for technical analysis is Lighthouse, an open tool from Google, integrated into Chrome DevTools, which audits sites in four categories: Performance, Accessibility, Best Practices, and SEO. Lighthouse generates reports with metrics such as Time to Interactive, Largest Contentful Paint, and WCAG Compliance Score. Its feature is automated analysis with recommendations for improvement, for example, image compression or elimination of JavaScript blocks. In the study, Lighthouse was applied to selected sites, showing average results: Performance – 55-70 (due to slow loading, average 3-5 seconds for the main page); Accessibility – 70-85 (the presence of alt texts for images, but the lack of color contrast); Best Practices – 75-90 (good code, but problems with HTTPS); SEO – 80-95 (good meta tags, but low mobile friendliness). For example, the website of the library of NTUU "KPI" received

Performance 68, with recommendations to optimize the image, while the site of DonNTU - 52, due to numerous errors in the code. These results highlight the need for modernization, especially for mobile users, and confirm that no site has achieved "excellent" quality (90+ points).

Overall, technical analysis using these tools not only identifies problems but also provides recommendations for improvement, contributing to the efficiency of library resources in the digital age. Regular application of such methods will allow Ukrainian technical libraries to compete at the global level, providing fast, accessible and relevant access to knowledge.

To visualize the results of technical analysis of Ukrainian library sites, diagrams built on the basis of data from INSITES, Lighthouse and SEMrush were used. The analysis of the quality rating of sites according to INSITES shows leaders (NTUU KPI with 75 points) and outsiders (DonNTU with 55 points), which illustrates the unevenness of technical development (Fig. 2).

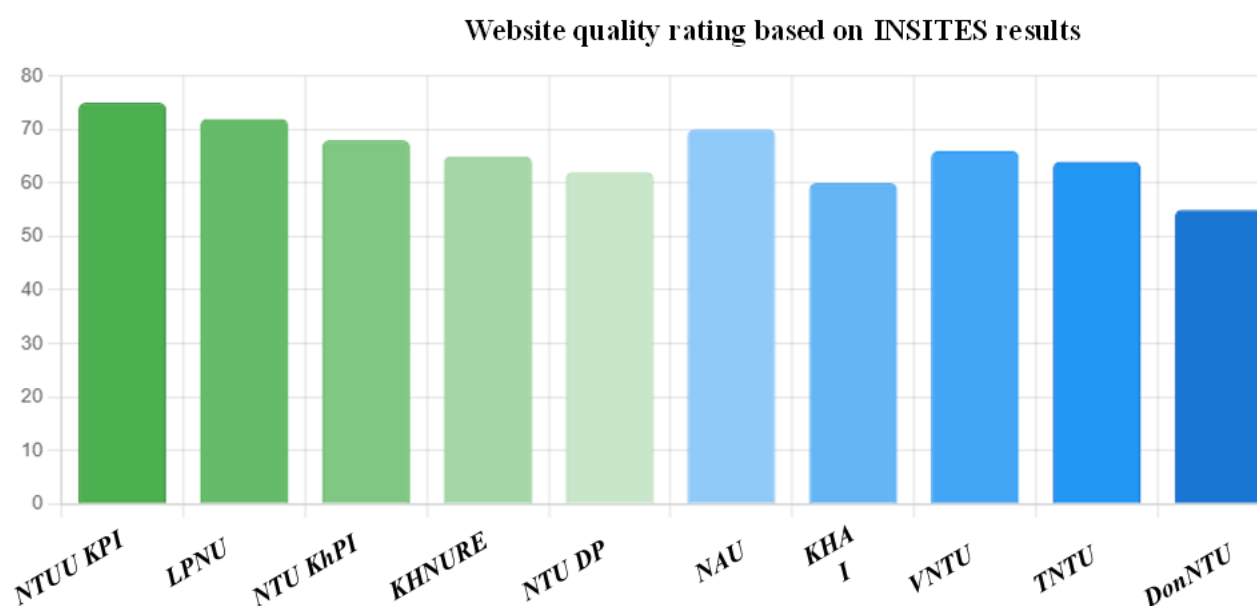


Figure 2. Chart of the rating of technical quality of websites of libraries of higher education institutions of Ukraine

The results of the analysis can be used to improve the efficiency of library websites, optimize navigation and user experience, plan the introduction of new electronic services and develop recommendations for the unification of standards and accessibility. The functionality of the websites of libraries of technical institutions of

higher education in Ukraine is gradually increasing, but there are significant differences between the leading universities. Further development of the digital infrastructure of libraries should be based on the integration of modern electronic services, accessibility standards, as well as on the unification of functionality in order to provide full information support for the educational and scientific process.

Ukrainian websites of libraries of technical universities (like KPI, Lviv Polytechnic) demonstrate a solid baseline level (77.5% WCAG, 50 SEO index, 30% mobile), but lag behind European ones by 5-25% in key metrics, due to limited resources and focus on desktop. European (especially UK/DE top universities) benefit from regulations (EAA 2025), investment in subdomains, and brand traffic, achieving higher visibility and accessibility (85% WCAG, 65 SEO, 55% mobile). However, global trends (94.8% WCAG failures) show that the problems are universal, with an improvement in education (~7% fewer errors). For UA, recommendations: Lighthouse/SEMrush integration for annual audit, focus on mobile-first (goal of 50% traffic) and SEO-keywords for +20% visibility. This will bring us closer to EU standards, improving user satisfaction and competitiveness in digital education.

Despite this scale (UAs are larger), European libraries have 4-5 times higher traffic and engagement due to better digital infrastructure. For UA, the recommendation is to improve SEO and mobility so that the index grows to 1000+, approaching the EU level.

The development of websites of libraries of technical institutions of higher education is of key importance in the era of digitalization, as they are becoming the central hub for access to information resources, educational materials, and services necessary for modern scientific and educational activities. In a digital society, information is a strategic resource, and the efficiency of its acquisition directly affects the quality of education, research, and professional training of future specialists. That is why the modernization and constant improvement of library websites is becoming not just a desirable, but an extremely necessary component of the development of a higher technical school.

First, the library's modern website provides 24/7 access to electronic catalogs, scientific databases, digital collections, textbooks, and teaching materials. This is especially important for technical specialties, where training is based on constant updating of knowledge, working with current research, standards, and patent information. A high-quality web resource allows students and teachers to quickly find the necessary data, use time rationally, and work with information regardless of location. Secondly, library websites perform an important communication function. They become a platform for informing users about new arrivals, changes in operating hours, educational events, information literacy trainings, webinars, and other initiatives. This contributes to the formation of an active academic community, supports interaction between students, teachers, and librarians, and strengthens the role of the library as a center of educational services. Third, the development of library websites is an important tool for integrating the institution into the global scientific and educational space. Modern digital platforms provide the opportunity to participate in international projects, exchange electronic resources, provide access to global scientific databases, and promote the results of one's own research. For technical universities, where innovation and technological progress are the main guidelines, such integration is of paramount importance. Fourth, library websites contribute to the development of users' digital competence. They teach students to work with electronic sources, critically evaluate information, and use modern search and data management tools. This builds skills that are essential in the digital economy and high-tech manufacturing.

Therefore, the development of library websites of technical institutions of higher education is a strategic direction that ensures the accessibility of knowledge, supports scientific research, improves the quality of the educational process, and contributes to the digital transformation of universities. In the modern era, when information technologies determine the pace of social development, such web resources are becoming not just information portals, but an integral infrastructure for the intellectual and professional development of future engineers and scientists.