

# Comparative Evaluation of a Universities' Websites Quality

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## Abstract

Methods of assessing the quality of websites of higher education institutions are considered. It is proposed to choose a model of quality assessment, which is based on the following attributes: quality of content, quality of design, ease of use of the site for applicants and students, reputation. Based on the analysis of existing models, the basic model was selected, which was modified. A quantitative, model-based methodology called QEM (Website Quality Assessment Methodology) was used. Within the modified model, changes were made to two attributes. Quantitative values of metrics, characteristics and quality attributes were obtained and the value of the overall quality assessment of the websites of Taras Shevchenko National University of Kyiv and Kyiv National University of Trade and Economics was calculated.

## Keywords <sup>1</sup>

Web page, internet, metrics, website accessibility, website usability, webquality

## 1. Introduction

The rapid development and spread of new information and software technologies has an impact on politics, economics, management, finance, science, culture and other spheres of society [1-3].

Software technologies have an increasing impact on all aspects of our lives:

- development and improvement of global networks [4-5], which open endless opportunities for obtaining information;
- cloud technologies provided by online services;
- development of the Internet of Things, which is reduced to the penetration of "smart" devices in all aspects of life [6];
- development of intelligent decision support systems, which allows to optimize many processes [6-7].

The development and improvement of global networks is closely linked to the rapid growth in the number and quality of websites. By 2021, there are more than 1.83 billion websites worldwide. To be successful among so much information you need to pay attention to the quality of the site.

The efficiency of higher education (HEI), in modern conditions, also requires the use of new information technologies and effective marketing communications in higher professional education and the market of educational services. An effective WEB-site guarantees the transparency of comprehensive educational and scientific activities of the university on the Internet. Proper evaluation of the effectiveness of the WEB-site will allow you to make the necessary changes in the work of existing resources, and understanding the evaluation parameters and their correct presentation - to avoid mistakes when creating a new Internet resource.

A modern website [8] is a system of software, information, and media that are logically interconnected. All this affects the effective operation of the site. To highlight strengths and eliminate weaknesses highlight a number of attributes. The most important among them are metrics, which are grouped into characteristics. These characteristics reflect the design or visual content, the functionality

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or technical content and the content or information content, the availability of adaptability and the reputation of the website.

This work describes an algorithm for selecting attributes and characteristics and calculating metrics that help determine the quality of a web application. The algorithm helps to analyze the factors of site quality assessment through structural properties. This article aims to explore tools for assessing the quality of web applications for empirically derived metrics. The rating approach is considered, which allows to carry out a comparative analysis of university sites, and the final quantitative measure of the rating shows how much better or worse the performance of the site compared to the leader of the rating.

Analysis of recent research and publications on this topic. Existing general methods of assessing the effectiveness of sites, as well as common approaches to calculating ROI (return on investment in WEB-resources) can not be used to assess university sites due to the characteristics of the product of higher education institutions (HEIs) - educational services. For example, in [9] a number of methods for evaluating the effectiveness of projects on the Internet (in particular, online stores) are considered. However, they cannot be used to assess the effectiveness of the sites of institutions that provide educational services, which require an assessment not of commercial but of communicative orientation of the WEB-resource. In this regard, of interest for the analysis of university sites are, above all, approaches related to assessing not the effectiveness but the quality of Internet resources.

A separate area in the analysis of WEB-resources is SEO-audit (search engine optimization - analysis of site promotion in search engines and directories) and analysis based on WEB-analytics (according to traffic statistics systems and log analyzers). You can get acquainted in more detail with the step-by-step analysis of sites and practical recommendations for improving the efficiency of the site in [10]. This area also includes techniques based on the analysis of user movements. Of particular interest is the technique presented in [11] "Spivak's Diagram", which on the basis of the analysis allows you to optimize the structure of the site and the navigation system to direct user streams on the desired traffic. To analyze the quality of marketing communications, it is important to assess, first of all, the degree of perception of the target audience of information content. In this regard, it is necessary to assess the content of sites and the usability of users with the information posted on the information resource.

## **2. Actuality of theme**

With the beginning of serious competition between universities, related to the reduction of the number of entrants, as well as the submission of documents for admission of applicants online, the quality of the university website becomes one of the most important components of successful recruitment. The problem of assessing the quality of websites is relevant around the world, because every day a large number of websites are created and launched, which in today's society can be used for various purposes: from business card sites to automated large portal sites in the direction of web commerce. The quality of a website can be assessed from two points of view: developers and end users. Developers focus on features such as support, security, functionality, and end users pay more attention to ease of use, efficiency, reliability, and more. Obviously, evaluating the quality of the website from the point of view of the user, who is primarily an applicant, is a priority for universities. From this point of view, determining the quality of a website shows how well it is designed and how well it meets the needs of the end user.

In general, the quality of a website tends to make it possible to compare the results of evaluating the quality of different websites. The evaluation process should be based on criteria that can be quantified and measured. This is possible only if the appropriate quality model and quality assessment methodology are formalized, within which the quality of the website is quantified.

## **3. Analysis of existing quality assessment methods**

The website is actually a specific software that is defined within a system of attributes of different levels, which together form a quality model [12]. The website quality model should define quality

requirements that are identified by a set of measurable attributes and that meet user expectations. To perform measurements within a single model, it is necessary to define the so-called metrics, which are a certain method and scale of measurement.

The first model for determining the quality of software was created in the mid-1970s. The International Organization for Standardization (ISO) together with the International Electrotechnical Commission (IEC) has completed the development of a new standard ISO 9126 "Information Technologies. Evaluation of software products. Qualitative characteristics and guidelines" [13]. It describes a quality model that can be applied to any software product or service. Two series were created during the standard review: the ISO 9126 series defined the quality model, and the ISO 14598 series described the quality assessment process. In this standard, quality is presented in the form of six main attributes: functionality, ease of use, efficiency, reliability, maintainability and portability. Within these attributes form a subset of characteristics of the second level, where each characteristic is divided into a set of sub-characteristics. These characteristics in turn are once again broken down into a set of metrics at the third level.

The model described above is fairly general and most researchers focus on developing quality models for a specific field. In particular, the authors have recently proposed narrower models that apply to websites in a particular direction. Subsequently, many website quality models have been developed [14-19], the main ones of which will be briefly discussed further.

Fitzpatrick R. with a team of authors [12] approached the creation of a quality model of the standards of human-computer interaction (Human Computer Interaction). They identified a total set of 12 external and five internal quality attributes. An additional five website quality attributes were later identified. For each of the attributes, the author identified a set of "tools" that reflect the presence and importance of this attribute.

Principles of development of the Human Computer Interaction method. According to the assessment of the current user interface or when developing a new interface, the basic principles of development should be identified, which focus on users and tasks. Early techniques interpreted the cognitive processes of users. These processes are predictable and quantifiable. The methodologies suggested that the developers consider the results of cognitive research in such areas as memory and attention when designing user interfaces. Modern models tend to focus on constant feedback and dialogue between users, developers and engineers. Currently, modern and widely applicable is user-oriented design. Users should be central to the development of any computer system.

Users, developers, and technicians work together to articulate desires, needs, and boundaries, and to create a system that meets those requirements. User-oriented projects often use research on the ethnographic tools in which users will work with the system. The principles of user interface development can be considered at any time during the entire development period.

In [13] the Quality Evaluation Model is described. The model contains a tree of quality requirements, which is formed from more than 100 characteristics related to different types of websites: e-commerce, academic sites, etc. This requirements tree is also based on ISO 9126. The purpose of the method is to classify and group individual elements. Then they must be divided into four main categories, namely: ease of use, functionality, reliability and efficiency of the site.

The WebQEM process includes four main technical steps:

- Definition and specification of requirements.
- Elementary assessment (stages of design and implementation).
- Global assessment (planning and implementation stages).
- Conclusion (recommendations).

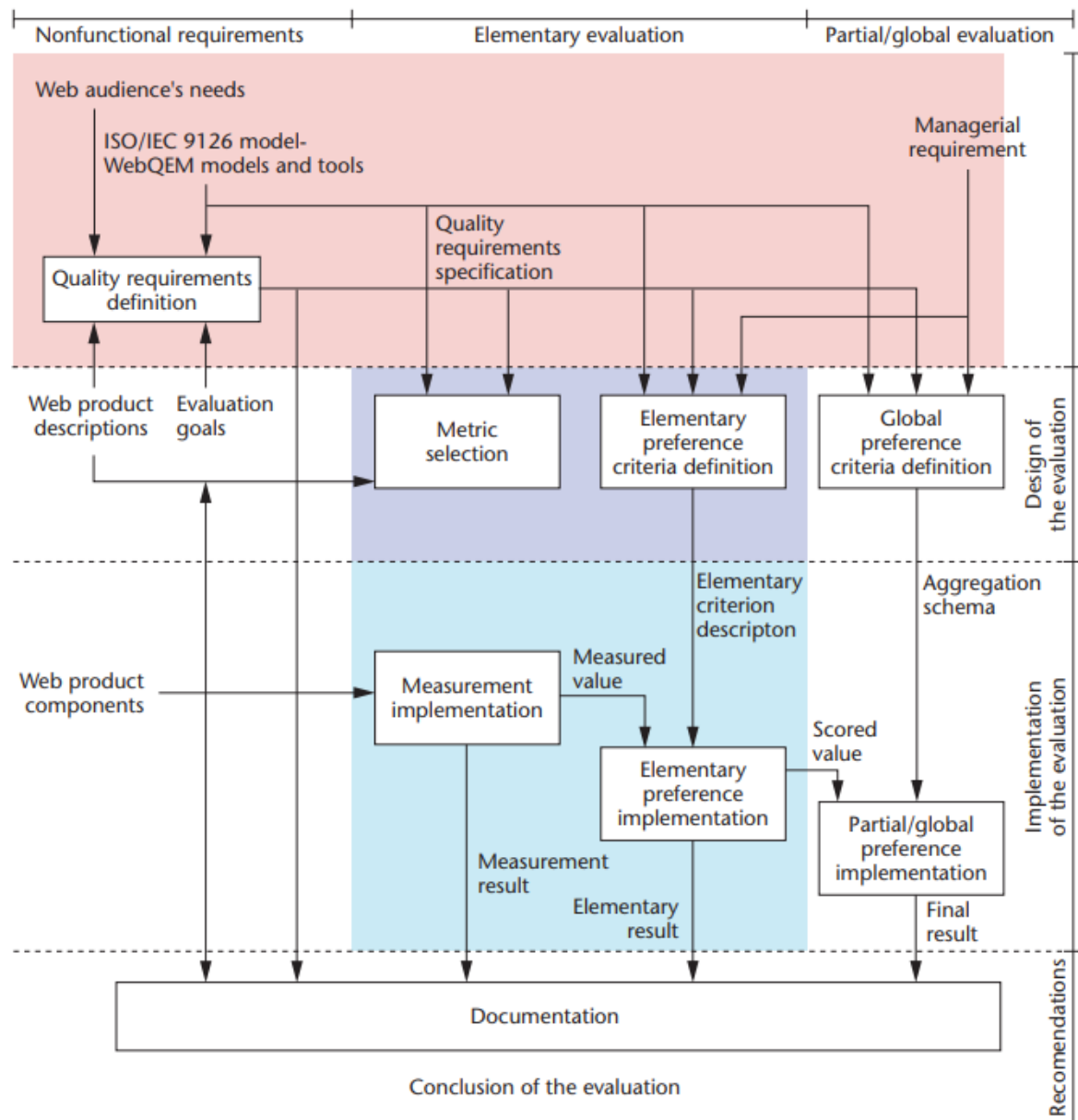
Figure 1 shows the basic process of evaluating the use of the methodology. It includes phases, stages, basic steps, inputs and outputs.

There are three methods for selecting metrics for software properties:

- model of the responsible person;
- standardized metrics;
- Goal-question-metric.

The method of the responsible person involves the selection of the necessary metrics directly by the responsible person. The selection of metrics in this case is associated with the tasks to be solved and the decisions to be made when solving these problems. Decisions on metric measurement are made based on the experience of the responsible person or on the recommendations of experts.

The method of using standardized metrics involves the use of recommendations or standards of some organizations engaged in research in the field of software development. This method is based on empirical research. Its use is limited to the scope of research, recommendations for the selection of metrics are general. The most common method of selecting metrics for software properties is "goal-question-metric" [14]. This method is based on setting goals and questions in the selection of metric software for the characteristic.



**Figure 1:** The evaluation processes underlying the WebQEM methodology

The method consists of three key steps:

- formulate goals that should be achieved by evaluating the properties of the software;
- questions are formulated for each goal that needs to be answered, to determine whether the goals have been achieved;
- identifies metrics that can be used to answer the questions that were asked in the second stage.

- The application of the method "goal-question-metric" includes the processes of planning, defining goals, questions and metrics, data collection and data analysis (Fig. 2). An important aspect in using this method is the experience and competence of the expert. At the same time, this method is not formalized, which gives a certain share of the probability of inadequate selection of metrics. In addition, this method does not allow you to select the metric software that is best suited to characterize the property. Therefore, to solve this problem, it is proposed to formalize the problem by using a subject-oriented method of constructing relationships between software metrics.

The user-oriented software quality assessment model [16] allows you to assess the quality of the site in relation to the assessment of different groups of end users. This designed a generalized assessment of the process that can be applied to different end-user domains.

In [17] a method of software quality assessment through analysis of websites and applications is proposed. It also helps to disable missing features or poorly implemented website requirements. This method is based on ISO9126-1 standards.

Liburne and others [18] proposed a methodology that defines the main attributes, characteristics and sub-characteristics of the site quality of different levels and measuring indicators (metrics). To assess the quality of the university site metrics are grouped into the following attributes: usability, design, multimedia, content and reputation. The model [18] was modified in accordance with the required metrics when assessing the quality of university sites.

Most of these models focus mainly on the technical and functional aspects of web design, but do not take into account aesthetic and reputational aspects. Therefore, Zhou Z. in [19] took into account the model Thorlacius L. [17] for the analysis of visual, aesthetic and communication information of all media products. This model analyzes the main factors of communication, such as context, addressee, addressee, sequence and environment of visual communication. There is a shortcoming in the general nature of the quality model and the quality assessment model proposed in [19], which was acknowledged by the authors themselves: for each specific type of website these models need to be customized, as not all metrics and weights absolutely every website without additional rules for their consideration. After analyzing the models of site quality assessment and taking into account that university sites should be focused primarily on applicants, we concluded that among the methods considered, the method Liburne B. [18] is more suitable for analyzing university sites. This method is simply adapted to the requirements and implemented in the study. This method of attributes and metrics is simply adapted to the requirements and implemented in the study. To do this, we used a quantitative, model-based methodology, the so-called QEM (Website Quality Assessment Methodology).

#### **4. Quality assessment of the university website**

An effective quality control mechanism for web applications is the use of web metrics. Due to the rapid growth of web resources, there is a need for up-to-date metrics that can have a big impact on the resource as a whole and on individual sites from different courses. The quality of the site (or quality web applications) can be assessed from two points of view: programmers and end users. Aspects of website quality are focused by programmers on the degree of maintainability, security, functionality, etc. Although end users are interested in usability, efficiency, security issues.

Extending these concepts, the assessment of website quality may depend on:

1. Task-related factors that affect the end result for quality and content assessment.
2. Factors related to performance, namely: efficiency and technology of web applications. For example: response time, transaction output and reliability.
3. Development factors that are crucial for web application developers and maintainers.

Therefore, the parameters of the website that can be implemented as a tool to ensure comprehensive results are identified.

To assess the quality of the university in the structure of this work is based on the quality model of the website, using the methodology of quality assessment recommended by Liburn B. A hierarchical three-tier tree model consisting of five attributes of the model represents this model: design, usability, multimedia, content, reputation.

Each attribute has its own weights. The attributes of design, usability and multimedia have the greatest impact on the quality of user perception, while content and reputation are mostly seen from the point of view of administrators.

The quality assessment system provides a simple scale of compliance. This scale starts at 0% and ends at 100%. On this scale, 0% shows a low quality score, and on a scale of 100% shows excellent quality scores. This is the QCF (Quality Compliance Framework) for web applications.

**Quality Evaluation:**

$$\text{Quality Evaluation} = \frac{\sum \text{characteristics 's QCF}}{\text{Number of characteristics}} \quad (1)$$

**Quality compliance framework score for characteristics and sub characteristics:**

$$\text{Quality characteristics QCF score} = \frac{\sum \text{metrics 's QCF}}{\text{Number of metrics}} \quad (2)$$

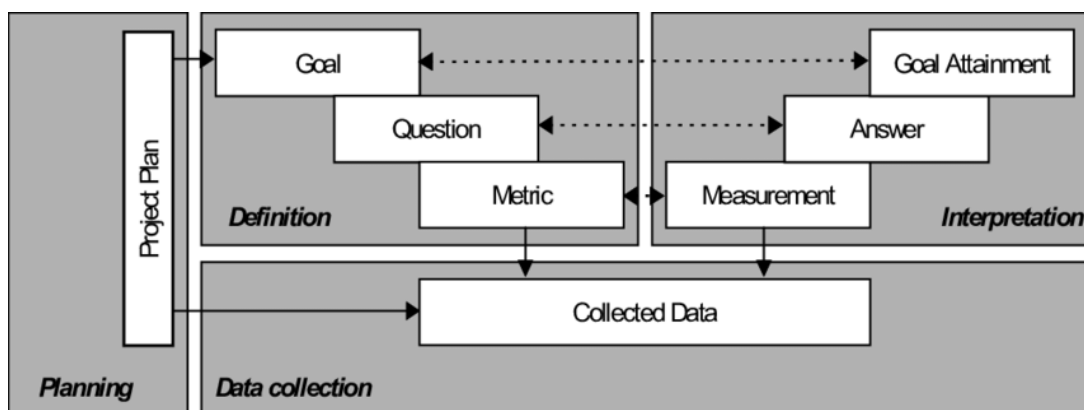
**Attribute Quality compliance framework score:**

$$\text{Quality Indicator} = \frac{\text{Earned score} * 100\%}{\text{Possible error}} \quad (3)$$

After selecting the attributes, each of them is broken down into key characteristics. The "goal-question-metric" method selects metrics that are assigned to each characteristic. Then for each characteristic, with the method of "goal-question-metric", a set of metrics is selected for each characteristic. At the next stage in the quality assessment model determine the weights for each characteristic. The structure of the model of quality assessment of universities, presented in this work, is presented in table 1.

As it was mentioned, the above model is aimed at generalizing the assessment of website quality for all industries, which in practice cannot be achieved due to certain specifics of a particular industry. In particular, to assess the quality of the university's website, it is proposed to change the values of the weights of individual attributes.

In particular, given that the university website is used by applicants, usually as an online guide to the information required for admission, so the weights of the attributes "Content" and "Reputation" should be greater than other weights (Table 2).



**Figure 2:** Goal - Question-Metric Method

## 5. Results of the evaluation of the quality of the university website

When assessing the quality of the university website, the sites of two universities were evaluated and the metrics of the first pages of the sites were determined (Fig. 3, Fig. 4). Detailed results of the site quality assessment of the Taras Shevchenko National University of Kyiv and the Kyiv National University of Trade and Economics are presented in Table 3.

**Table 1**

General structure of the quality assessment model

Metrics	Characteristic	Weight factors for characteristic	Attribute
Modern image formats	Image	0,5	Design
Compressed images			
ALT text			
Image-link			
The same size of indents	Composition	0.2	
Symmetrical display of elements			
Use multiple colors	Color	0.3	
Enough white			
Observance of color scale			
Mobile version	Adaptability	0.5	
Navigation bar(menu)	Navigation	0,3	
Homepage link			
Fixed menu			
Button to top of the site			
Availability of search on the site	Search	0.1	
Multilanguage	Language	0.1	
The presence of the logo	Logotype	0.2	Multimedia
Multimedia components	Multimedia components	0,5	
Using icons	Icons	0.1	
Using sliders	Using sliders	0.2	
Calendar of events	Calendar of events	0.2	Content
Information guide	Informative directory	0.2	
Information about International Relations of the HEI	International Relations of the HEI	0.4	
Latest news	Latest news page	0.2	
Feedback and users	Feedback and users	0.3	Reputation
SEO optimization	SEO optimization	0.3	
Domain name	Domain name	0.2	
Availability of SSL- certificate	Security	0.2	

**Table 2**

Comparison of original and proposed weights of quality attributes

Attribute	Attribute weighting according to original model	Attribute weighting
Design	0,2	0.2
Usability	0.3	0.2
Multimedia	0.3	0.1
Content	0.1	0.3
Reputation	0.1	0.2

The general results of quality assessment of Taras Shevchenko National University and KNUTE sites are given in Table 4. You can see that the KNUTE website has lower performance values than the Taras Shevchenko National University website, in terms of all quality characteristics except the third. The final assessment of the quality of the websites of the selected universities differs by 0.32, according

to Table 4. The KNUTE website has the worst indicators in terms of usability and content attributes, which led to such a big difference in the overall assessment.

To improve the quality of the site of the second university it is necessary to: develop a mobile version of the site (to increase adaptability); to carry out search engine optimization (SEO-optimization); significantly expand the content of international relations of universities, as their presence demonstrates the position and competitiveness of the institution in the international arena, as well as affects the level of quality of educational services.

**Table 3**

The obtained values of metrics and quality characteristics for sites of KNU and KNUTE

Metrics	KNU	KNUTE	Characteristic	Value of characteristics (KNU )	Value of characteristics (KNUTE)
Modern image formats	1	1	Image	0,37	0.25
Compressed images	1	0			
ALT text	0	0			
Image-link	1	1			
The same size of indents	1	1	Composition	0.2	0.1
Symmetrical display of elements	1	0			
Use multiple colors	1	1	Color	0,3	0,3
Enough white	1	1			
Observance of color scale	1	1			
Mobile version	1	0	Adaptability	0,5	0
Navigation bar (menu)	1	1	Navigation	0.22	0.15
Link to home page	1	1			
Fixed menu	1	0			
Back to the top of the site button	0	0			
Availability of search on the site	1	1	Search	0.1	0.1
Multilanguage	1	1	Language	0.1	0.1
The presence of the logo	1	1	Logotype	0.2	0.2
Multimedia components	1	1	Multimedia components	0.5	0,5
Using icons	0	0	Icons	0	0
Using sliders	1	1	Using sliders	0.2	0,2
Calendar of events	1	1	Calendar of events	0.2	0.2
Information guide	1	1	Information guide	0,2	0,2
Information about International relations of the HEI	1	0	International relations of the HEI	0,4	0
Latest news	1	1	Latest news page	0.2	0.2
Feedback and users	1	1	Feedback and users	0.3	0.3
SEO optimization	1	0	SEO optimization	0.3	0
Domain name	1	1	Domain name	0.2	0.2
Availability of SSL- certificate	1	1	Security	0.2	0.2



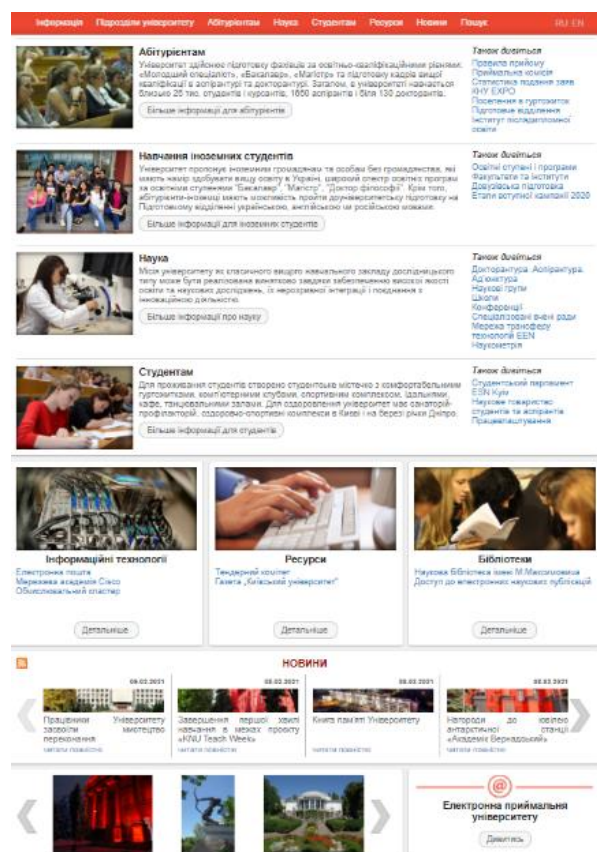
## 6. Conclusions

After analyzing each of the algorithms and comparing the results, we can say that in this study, among all the proposed methods of machine learning to solve problems of binary classification, the algorithm of decision-making trees best coped. Evaluating it according to the selected metrics and comparing the results with other algorithms, we can talk about its most significant effectiveness in DSS.

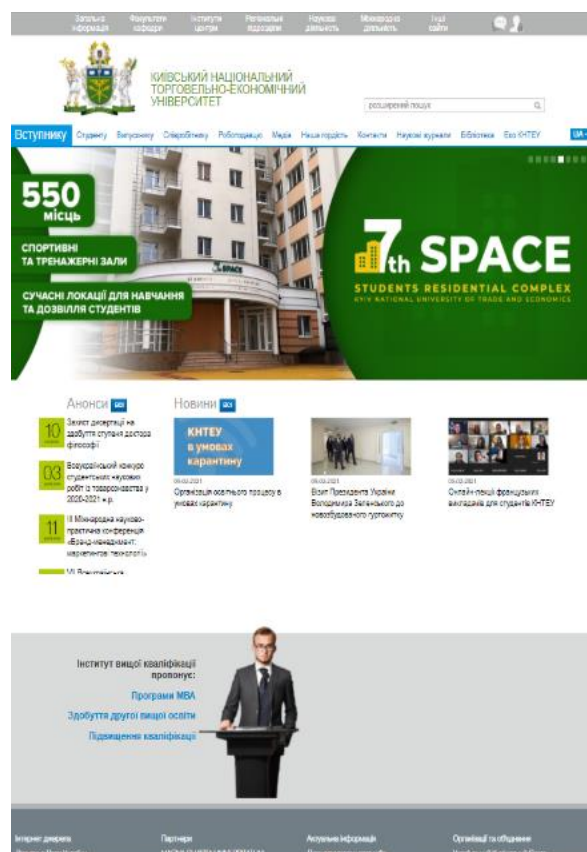
The developed classifier and its application in DSS can help hospitals and health facilities decide who needs attention in the first place when the system is overcrowded, as well as eliminate delays in providing the necessary care. This study could be scaled up to other diseases to help the health care system respond more effectively to an outbreak or pandemic.

**Table 4**  
Final assessment of the quality of KNU KNUTE websites

Attribute HEI	Design	Usability	Multimedia	Content	Reputation	General rating
KNU	0,87	0,9	0,9	1	1	0,94
KNUTE	0,65	0.35	0,9	0,6	0,8	0,62



a



b

**Figure 3:** Appearance of the KNU main page (a) and KNUTE main page (b)

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