



Visibility of Moodle applications in Central Asia: analysis of SEO

Aizharkyn Sait Kyzy¹ · Rita Ismailova¹

Accepted: 23 September 2022 / Published online: 8 October 2022

© The Author(s), under exclusive licence to Springer-Verlag GmbH Germany, part of Springer Nature 2022

Abstract

Search engine optimization (SEO) is an important tool that can predict the number of website visits, and good SEO strategies can help increase the visibility of educational resources. In the current article, the relevance between Search engine optimization (SEO) characteristics and the number of Moodle users in four Central Asian countries was examined. The analysis of learning management systems covered 38 Moodle websites. Analysis was conducted using semi-automated tools. Results suggested that although there is no difference in general SEO scores of Moodle installations, page structures and link structures in websites of different countries were dissimilar. Also, server configuration practices were different. In addition, there was a positive correspondence between the number of visits to a website and the number of external factors; the duration of users' visits was correlated with page structure. As for the normalized number of visits, the analysis revealed that in Kazakh universities, students use the Moodle system more frequently in a day than in other countries, while visits to Tajik universities' Moodle platforms were the lowest; the difference was 53 users per day.

Keywords Search engine optimization · Learning management system · Moodle · Site rank · Central Asia

1 Introduction

As many companies and educational institutions choose to deliver their training online, special software for the management of online learning processes—learning management systems (LMS)—were developed. Although online education cannot be as effective as traditional classes, online training is more convenient as it allows one to conduct the learning process without meeting in person and thus, minimizing the challenges of traditional education [1]. Therefore LMSs are gaining popularity all over the world. As statistics services report, 249,969 websites are using Learning Management System technologies in the world [2]. Of them, 50% are Moodle platforms, an open-source software package for creating virtual learning environments. According to the Moodle official website report, this number is even higher—there are 202 000 registered sites in the world.

Although the use of LMS and, particularly Moodle platforms, started in the early 2000, in the countries of Central Asia they appeared after 2010 [3], and started being widely used during the Covid-19 pandemic. According to official statistics by Moodle, in Kyrgyzstan, there are 73 registered Moodle platforms, in Kazakhstan—409, in Uzbekistan—247, in Tajikistan—19 [4]. Yet, many of them are not in use or used with limited functionality. The analysis of the content of Moodle websites showed that most of them belong to higher education institutions. Thus, these websites have a certain number of users, consisting of students and teachers of these universities. Yet, as any software, learning management systems should follow usability and search engine optimization principles, since any educational resource, including learning management systems, should be discoverable [5]. In addition, it is important to know how many users have accessed these systems in a day or a month.

To measure the ease of finding a website, so-called Search engine optimization (SEO) characteristics are used. According to SemRush, “SEO is the art and science of persuading search engines such as Google, Bing, and Yahoo, to recommend your content to their users as the best solution to their problem” [6]. For search engines to find websites easily, the set of parameters should be arranged properly. That is, for a search engine to find a website, there should be flags

✉ Rita Ismailova
rita.ismailova@manas.edu.kg

Aizharkyn Sait Kyzy
aycarkin.sayit@manas.edu.kg

¹ Department of Computer Engineering, Kyrgyz-Turkish Manas University, Bishkek, Kyrgyzstan

and other website attributes (headings, titles, webs structure, etc.), which identify the web content. If these attributes are not arranged properly, it can be hard for search engines to match user requests and the website. In addition, a good SEO of a website enhances its usability and thus ensures user satisfaction [7]. Therefore, for an educational website, SEO is one of the most important characteristics, since the number of visits to educational websites can be one of the measures of the effectiveness of the system usage and the level of transition to online education.

As for the number of potential visitors to educational websites and learning management systems, in Uzbekistan, 440,991 students are studying in 119 HEIs [8]; in Kyrgyzstan, 214,157 students and 57 HEIs [9]; in Kazakhstan, 604,345 students in 125 HEIs [10]; in Tajikistan, 229,600 students in 39 HEIs [11]. Thus, the process of digitization of education involves many citizens. On the other hand, since Moodle is an open-source web application, its source code can be easily modified, which minimizes standardization and changes the optimization characteristics of the package [12]. Therefore, this study analyzes the extent to which Moodle learning management systems are used in countries of Central Asia: Kyrgyzstan, Kazakhstan, Uzbekistan, and Tajikistan, and measures the efficiency of usage based on SEO characteristics.

2 Literature review

Many works have been carried out to evaluate the performance of Moodle systems from many aspects. Coelho and Rocio tested Moodle package performance in several dimensions such as operating systems (Linux, Windows), supporting databases (MySQL, PostgreSQL, etc.), and hardware under different loads in order to define what should be changed in order to obtain the largest performance gain when the website load increases [13]. The results of this work showed that among aspects such as Moodle version, database type, architecture, and hardware/OS, the choice of hardware and small database size are the most important factors that contribute to performance. Another work that analyzed the configuration of underlying aspects was by Kroth [14]. The author evaluated and analyzed some of the different database and related configurations for application cache and user session data that Moodle currently supports with respect to their impact on scalability, reliability, security, and performance. The results of this work suggested that systems with relaxed durability can show as high performance as systems with no durability as the cost of network communication tends to outweigh the possible cost of background disk activity. Erjomina et al.

also showed that the performance of Moodle system, with different applications including video conferences, depends on the RAM of the server and showed that 512 MB RAM supports the work of up to 100 users, given the technical environments are Apache web server, PHP, MySQL [15]. However, they pointed out that during web-conferencing, there were delays due to conversation to.swf format. As a way out of this situation, the authors proposed to use a multi-core processor, which is able to handle the conversion of the document and avoid delays for users.

As for the Moodle site rankings, Hasan compared the result of eduroute and heuristic evaluation methods for examining the usability of universities' websites and their impact on universities' ranking. The heuristic method was performed for the investigation of the most frequently visited pages. Then the author developed a set of comprehensive heuristics specific to educational websites [16].

Giannakouloupoulos and Konstantinou investigated the relationship between the university's academic excellence and the quality of its web presence based on the website quality and search engine optimization (SEO) performance of the websites of the top 100 universities in the Academic Ranking of World Universities (ARWU) Shanghai list. The results of the research indicate that universities place particular emphasis on issues concerning website quality, while the utilization of SEO does not appear to be of equal importance, indicating possible room for improvement in this area [17]. Shayegan and Kouhzadi investigated the impact of SEO parameters on university web ranks. For that, they proposed to use a chart of two-variable dispersion distribution and then apply association rules based on these distributions. The results of the research show that some of the SEO metrics, such as the number of backlinks, Alexa Rank, and Pagerank have a direct and significant impact on the website rank of universities, and in this regard, interesting rules have been extracted [18].

Kabak et al. determined criteria and formed a model that identified criteria weight that was then used by TOPSIS to rank Turkish education websites by these criteria: system quality, information quality, service quality, and attractiveness. This work suggests the criteria groups according to their qualitative and quantitative characteristics [19].

However, few studies are available on the SEO of Moodle platforms. Africa [12] compared two open-source web applications—Moodle and WordPress [12]. In the work, they mention search engine-friendly plugins in WordPress, but not in Moodle. Zhang and Cabbage also noted the big number of SEO plugins in WordPress [20]. Therefore, the current work aims to analyze SEO characteristics of university

Moodle platforms to investigate the traffic and, thus, the extent to which universities utilize Moodle platforms. In addition, we compare the SEO implementations differences in four Central Asian countries on the example of Moodle web applications.

3 Method

3.1 Research questions

The research aims to analyze the usability of Moodle platforms in different countries. Research questions are formulated as follows:

1. Does the SEO score of Moodle depend on the HEI?
2. Is there a difference in usage in countries?
3. Does SEO affect the number of visitors to distance education websites?

3.2 Materials

3.2.1 University selection

The choice of Moodle LMS in Central Asia was identified using the Builtwith online platform. According to Builtwith.com, in Kyrgyzstan there are 61 registered Learning Management System technologies, 43 of them are Moodle platforms; in Uzbekistan 205 LMS, of them 159 are Moodle platforms; in Kazakhstan, of 464 registered LMS, 212 are Moodle platforms; and finally, in Tajikistan, there are 16 Moodle web applications. The list of Moodle platforms was collected using the BuiltWith service [21]. Next, the shortlist was withdrawn, taking the first 10 websites on the list. Selected universities are technical, humanities, law, and medical universities. Due to ethical issues, in the study, university names were encoded.

3.3 Tools

3.3.1 BuiltWith service

One of the popular tracking systems, BuiltWith, is a service that tracks used categories which include widgets, analytics, frameworks, content management systems, content delivery networks, web standards, and web servers. BuiltWith has 46,792+ technologies that were stored over 10 years. Thus, the service is an information profiler tool that finds out what a website is built with. This service was

used in many studies for different purposes. For example, Shteiman used BuiltWith to detect content management systems vulnerability [22]. Grill and Vij evaluated higher education institutions (HEI) G2C web portals' security vulnerability and ambiguity aspects via such tools as Whois.sc, Yougetsignal.com, Kali Linux, Builtwith.com, NMAP, and Google Hacking Database (GHDB) [23]. Galba investigates the differences in statistics of successful attacks on web applications by various programming languages that are found in the Builtwith system [24].

3.3.2 Seobility test service

SEO testing is popular nowadays. Seobility.net cloud service allows analyzing web pages by crawling completely all linked website pages. The seobility.net cloud testing services founded in 2013 as a free SEO checker. One of the SEO criteria the On-page optimization techniques focus on website content and structure that is meaningful to website performance. Gudivada specifies that website structure and web content SEO parameters are important for page optimization [25]. Lieke determines website accessibility and usability directly depends on on-page optimization [26]. However, few studies are using Seobility.net cloud testing services in HEI website testing.

3.4 Procedure

As mentioned, first, the links to Moodle platforms of Central Asian universities were located. Next, metadata of these platforms were collected using Seobility.net cloud testing SEO score metrics. These metrics are meta-information, page quality, page structure, link structure, server, and external factors. In general, each SEO metric has its parameters. Muntean monitored the download times of web pages from different websites, and to find out to what extent the images contained in these Web pages influence these times [27]. Image download time is important in the performance of a web server. Parameters of meta-information are title, meta description, crawlability, canonical URL, language alternative/Hreflang Link, domain, page URL, charset encoding, and Doctype. The next metric—page quality, depends on the content, frames, mobile optimization, bold and strong tags, image SEO, social networks, and HTTPS. Page structure metric contains H1 heading, Heading, and heading structure. Link structure parameters are those related to internal and external links. One of the most important metrics is Server configuration, which contains redirects, HTTP header, performance, and HTTP Response Header. External factors

Table 1 SEO and its components' scores (%) of Moodle deployments in Central Asian universities

University	SEO score	Meta information	Page quality	Page structure	Link structure	Server	External factors	Visitors (norm.)	Bounce rate
<i>Kyrgyzstan</i>									
kg1	56	79	32	58	25	73	41	68.31	25.68
kg2	74	98	72	58	25	80	32	67.86	20.81
kg3	70	98	71	58	25	36	28	32.03	23.32
kg4	64	80	31	100	83	75	23	0.12	–
kg5	60	69	47	100	25	81	21	1.74	27.85
kg6	55	69	60	24	25	84	28	7.84	29.41
kg7	57	69	54	58	8	87	21	1.9	21.7
kg8	61	70	73	68	25	59	25	0.31	–
kg9	73	98	47	97	82	65	21	33	27.85
kg10	59	88	30	71	48	44	30	0.26	–
<i>Uzbekistan</i>									
uz1	63	80	66	58	25	62	23	–	15.82
uz2	54	79	33	71	60	21	25	13.85	17.17
uz3	68	100	54	58	25	56	30	18.05	24.28
uz4	59	79	43	75	25	59	27	4.61	50.23
uz5	54	79	33	71	60	21	25	13.85	17.17
uz6	64	90	52	58	25	70	23	–	–
uz7	64	98	33	71	25	80	23	0.7	50
uz8	63	79	39	100	25	87	30	2.57	5.88
uz9	64	79	68	58	25	67	25	2.28	15.63
uz10	67	98	57	58	7	64	27	0.07	–
<i>Kazakhstan</i>									
kz1	72	98	62	71	25	75	32	134.9	49.14
kz2	42	40	34	100	40	19	21	33.25	25.58
kz3	60	69	77	73	25	13	27	65.75	63.92
kz4	50	69	36	75	6	16	41	76	28.13
kz5	69	100	35	100	25	87	21	43.36	13.4
kz6	62	69	76	58	25	76	21	40.42	10.49
kz7	56	69	45	100	25	27	27	48.08	7.07
kz8	64	79	70	58	25	59	25	23.61	7.8
kz9	62	100	43	58	25	30	23	14.47	17.33
kz10	66	79	48	95	62	78	21	46.6	67.51
<i>Tajikistan</i>									
tj 1	75	80	87	90	25	73	38	0.22	–
tj 2	58	79	40	75	25	67	21	0.35	61.47
tj 3	56	80	44	50	30	56	25	0.43	28.18
tj 4	65	79	71	75	0	70	25	1.12	57.7
tj 5	70	79	47	100	82	91	36	–	–
tj6	61	79	33	95	25	81	27	1.13	56.28
tj7	53	80	37	68	0	38	23	–	–
tj8	46	77	47	58	0	0	23	3.65	–

contain backlinks, facebook popularity, listed on web wiki, and links from Wikipedia.

Finally, the SimilarWeb tool was used to get the websites' traffic information.

4 Results

4.1 SEO analysis of websites

In the current work, all SEO metrics were collected for 40 Moodle platforms of Central Asian universities. After that, comparative data analysis was carried out. Results were first considered at the country level.

4.1.1 Moodle platforms at Kyrgyz Universities

Among Kyrgyz universities that use Moodle websites, the maximum ranking was 74% for the e-learning platform of the university encoded as kg2, and the minimum was 55% for the platform of the university encoded as kg6 (Table 1). The difference can be due to the first parameter of the meta information score, which is a page title. By the specification on seobility.net, the image size should be less than 580 pixels or more than 250 pixels. The Page title length of kg2 is 345 pixels out of 580 max pixel length, while those of kg6 are 1781 pixels. Also, the length of the Meta description of kg2 is 283 pixels out of 1000 max pixel length, while in kg6 and kg6 the meta- description is missing (69%). The remaining meta specification parameters were similar in all analyzed websites.

As for the Page quality characteristics, the scores of websites ranged from 31 to 72. This characteristic depends on the content, frames, mobile optimization, bold and strong tags, image SEO, social networks, and HTTPS. Here, the page content of the websites scored higher was higher, which affects the load score of the site. For example, the page content of kg2 contains 6783 words, which is too large. Besides, compared to other websites, the number of javascript files was higher in kg2, which can affect mobile optimization. On many websites, there were problems with the use of bold and strong tags, as well as text alternatives for images.

The visibility of websites can also be increased if widgets of social networks are used. However, only a few social sharing widgets on the pages were found.

Finally, security issues were also encountered. Only kg1, kg3, kg4, kg5, and kg6 of the analyzed websites are working on HTTPS protocol for secure data transmission.

The page structure parameter ranged from 24 (kg6) to 100 (kg4 and kg5). The problems were mostly related to the specification of headings. In many cases, the heading was

missing, while in others some headings occurred twice on the page. Besides, there were cases where the structure of headings was missing one or more levels. The number of headings should be in proper relation to the amount of text. However, for most of the websites, the tool reported that there are too many heading for a relatively small amount of text.

Link structure parameters are those related to internal links and external links. This parameter ranged from 36 to 87%. The analysis of internal links showed that the maximal number was in the kg2—1884. Also, it was observed that in many websites, some internal links have dynamic parameters, and some anchor texts are used more than once. As for the external links, these numbers on the analyzed websites ranged from 1 to 13, yet, an outlier with 38 external links was observed in kg7.

Server configuration, which contains redirects, HTTP header, performance, and HTTP Response Header achieved 87% in kg7, but the lowest was as low as 34% (kg3).

The page response time of many websites is very slow (from 0.42 to 2.96 s), while for good performance, this time should not exceed 0.4 s. Slow websites are bad for search engine bots and also result in a bad user experience.

4.1.2 Moodle platforms at Uzbek universities

Among Uzbek universities, which use moodle websites, the maximum ranking was 68% (uz3) for the e-learning platform of the university, and the minimum was 54% (uz2) for the Moodle platform (Table 1).

Meta information score of Uzbek universities' websites had the maximal score of 100% (uz3), and the minimum score was 79% (uz4, uz5, uz8,uz9). The page title length was mostly in a suitable range. As for the meta description, in more than half of websites meta description is missing.

The page quality of Moodle website score ranged from 33 to 68%. According to the seobility.net result, almost all Moodle site words provided in the page title are not used within the pages' content. In addition, the amount of useful information, which should be from 250 to 1000 words, in more than half of the website's content does not fit into this range. On some sites, no paragraph is detected and words from the H1 heading are not used in the page content. Websites for mobile optimization have 5–8 javascript files, which may affect the load time negatively. Bold and strong tags of the Moodle website are present in less than half of websites; some tags are either too long or empty, and either bold or strong. Half of the Moodle website uses HTTPS to protect the privacy and integrity of the exchanged data.

As for the Moodle web page structure of Uzbek universities, this score ranges from 58 (uz6, uz8, uz9, uz10) up to 100 (uz8). Almost all Moodle websites lack an H1 heading, and only on one website H1 heading was properly arranged. The structure of headings is missing one or more levels and some web pages have 43–74 headings. Moreover, some headings occur twice on the page.

As shown in Table 1, link structure scores ranged from 7 to 60. The worst case of link structure characteristics is that some internal links have dynamic parameters, some anchor texts are used more than once and some links don't have an anchor text. For example, on one of the websites, there were 36 links with trivial anchor text.

Server configuration of the Moodle site ranged from 21 to 87 scores, with case performance response time ranging from 0.71 to 0.84 s, which again exceeds the 0.4 s.

4.1.3 Moodle platforms at Kazakh universities

Among 10 Moodle websites of Kazakh universities, the maximum ranking was 72% (for the e-learning platform of the university encoded as kz1), and the minimum score was 42% (kz2) (Table 1).

The page title length in meta information ranged from 40% (kz2) to 100%. (kz5, kz9). The low scores were due to a lower (in three websites) or higher (in two websites) number of pixels in title length. Also, more than half of them are missing a meta description. Among those websites where meta description is present, some have too long (14,298 pixels in kz3) or short (5 pixels in kz6) meta descriptions.

The page quality range of the moodle website was 34% to 77%. Half of the websites have less than 500 words of

useful information. Besides, in most of the websites, the H1 heading was not used in page content, and no paragraphs were detected. Websites for mobile optimization have 3 to 10 javascript files, and as mentioned above the javascript negatively affects the server performance. Compared to websites in other countries, the percentage of websites using HTTPS was higher—eight Moodle websites work on HTTPS to protect the privacy and integrity of the exchanged data.

Page structure of Moodle site parameter score ranged from 58% (kz6, kz8, kz9) to 100% (kz5). That means that some developers do not pay attention to heading settings.

The link structure of Kazakh universities ranged from 6 (kz4) to 62 (kz10). Errors were due to not providing anchor texts for links (kz4), and most of the links have dynamic parameters and are not marked as no-follow.

Server configuration scores are from 13 to 78%. The worst server response time was 1.32 s.

4.1.4 Moodle platforms at Tajik universities

According to BuiltIn, in Tajikistan, there were 16 Moodle platforms. However, only 8 of them were found. The maximum SEO score was received for the e-learning platform of the university tj1-75%, and the minimum score of 46% was observed in the analysis of the tj8 university website (Table 1).

Meta information of Moodle websites scores ranged from 77% (tj8) to 80% (tj1, tj2, tj7). As in the cases of other countries' websites, issues related to the page title length were encountered.

Page quality of websites ranges from 33 to 87%. In almost all web pages, words from the page title or H1 headings are not used within the page's content. Also, the Seobility tool could not detect any paragraphs. Requirements for mobile

Table 2 Average of SEO characteristics by country

	SEO score	Meta information	Page quality	Page structure	Link structure	Server configuration	External factors
<i>Kyrgyzstan</i>							
Mean	62.90	81.80	51.70	69.20	37.10	68.40	27.00
S.Dev	7.06	12.77	17.14	24.08	25.75	17.30	6.32
<i>Uzbekistan</i>							
Mean	62.00	86.10	47.80	67.80	30.20	58.70	25.80
S.Dev	4.85	9.31	13.49	13.33	16.68	21.96	2.66
<i>Kazakhstan</i>							
Mean	60.30	77.20	52.60	78.80	28.30	48.00	25.90
S.Dev	8.97	18.65	17.12	18.31	14.32	29.65	6.44
<i>Tajikistan</i>							
Mean	60.50	79.13	50.75	76.38	23.38	59.50	27.25
S.Dev	9.37	0.99	18.58	17.72	27.07	28.83	6.30

optimization were also violated, with up to 11 JavaScript file loads. As for the secure transfer, only half of the websites use HTTPS.

Page structure parameter scores ranged from 50% (tj3) to 100% (tj5). Errors were similar to those in websites of other countries, that is, half of the website H1 headings were not specified. In those where headings were present, they appeared to be too short. Besides, cases where headings occur twice on the page or where headings do not have any content were detected.

As for the link structure, on some Tajik universities' websites, there were no links detected (tj4, tj7, tj8). The higher score was 82% (tj5). Errors were again due to dynamic parameters of internal links and anchor texts.

Besides, server configuration parameters in websites were also very low; in the e-learning platform of the university tj8, this parameter scored 0%. The higher server configuration parameter was 91% (tj5). Response time ranged from 0.48 to 33.6 s.

4.2 Is there a difference in SEO by country?

To see if there is a difference in SEO characteristics of websites administered in different countries, the averages of all indicators were calculated. As presented in Table 2, the average SEO scores of university Moodle platforms are 60.3 for Kazakh and Tajik websites, and 62.0. On Kyrgyz and Uzbek websites. The differences were mostly observed in the page structures of websites, link structures, and server configurations.

4.3 Number of visits dependencies

4.3.1 SEO and number of visits

For the analysis, the number of visits was divided by the number of students at an HEI. This was done to normalize the number of visits since some universities have more students than others. Data on the number of students was taken from open data sources provided by Ministries of education and statistics services of countries [28, 29]. However, since no open data on the number of students was available for Tajik universities, this data was taken

from university websites, and in some cases, approximate numbers are given.

To examine the relationship between the number of visits and SEO characteristics, a correlation analysis was carried out. According to the results, the number of visits is correlated with external factors, meaning that the more a website is presented on other resources, the more visitors it gets. Although the correlation was 0.395, however, it was found to be statistically significant, with $p=0.021$ (Table 3).

On the other hand, visit durations are correlated with a page structure; the better the page structure, the longer a user stays at the website; the correlation was 0.339 and $p=0.05$.

4.3.2 Number of visits by countries

At this stage, the normalized number of website visits was compared by country to analyze the dependence of the number of websites' users on the SEO indicators of these sites. As can be seen in Fig. 1, the SEO rates of Moodle systems in Kazakhstan's universities and the number of users accessing these sites were the highest. It should be noted that the number of users visiting the website is normalized, i.e., the average number of times each student visited the site in the last month was calculated. Moodle systems, which belong to the universities of Kyrgyzstan, are in the second position when evaluated by the number of visitors; despite the fact that the SEO score is relatively higher than in Kazakhstan, the number of users is relatively small. Figure 1 also shows that Moodle systems, which are owned by Uzbek universities, rank third in terms of traffic and have the lowest SEO scores among websites in four countries.

Also, as we can see from the visualization in Fig. 1, we can see that the number of users of Moodle systems, which belong to Tajik universities, is small, despite the relatively high SEO scores.

Next, to compare the normalized number of website visits by country, the ANOVA was carried out. According to the results, the significance of mean differences was 0.001. The Post-Hoc results showed that the most visited websites are those of Kazakh universities; on average, every user visits the website 52.64 times in a month. The lowest number of visits was observed among Tajik websites—each user visits a website 1.15 times in a month (Table 4).

The biggest difference was between the average number of Kazakh and Tajik university websites, 51.49 visits difference. The average number of visits difference between Kazakh and Kyrgyz university websites was the lowest—31.31. These differences in visits to Kazakh websites with websites of the other three countries were found to be statistically significant.

Table 3 Correlation of SEO characteristics with the number of visitors and visit duration

Correlated items	Pearson correlation	Sig
Number of visits (normalized)— External factors	0.395	0.021
Visit duration—Page structure	0.339	0.05

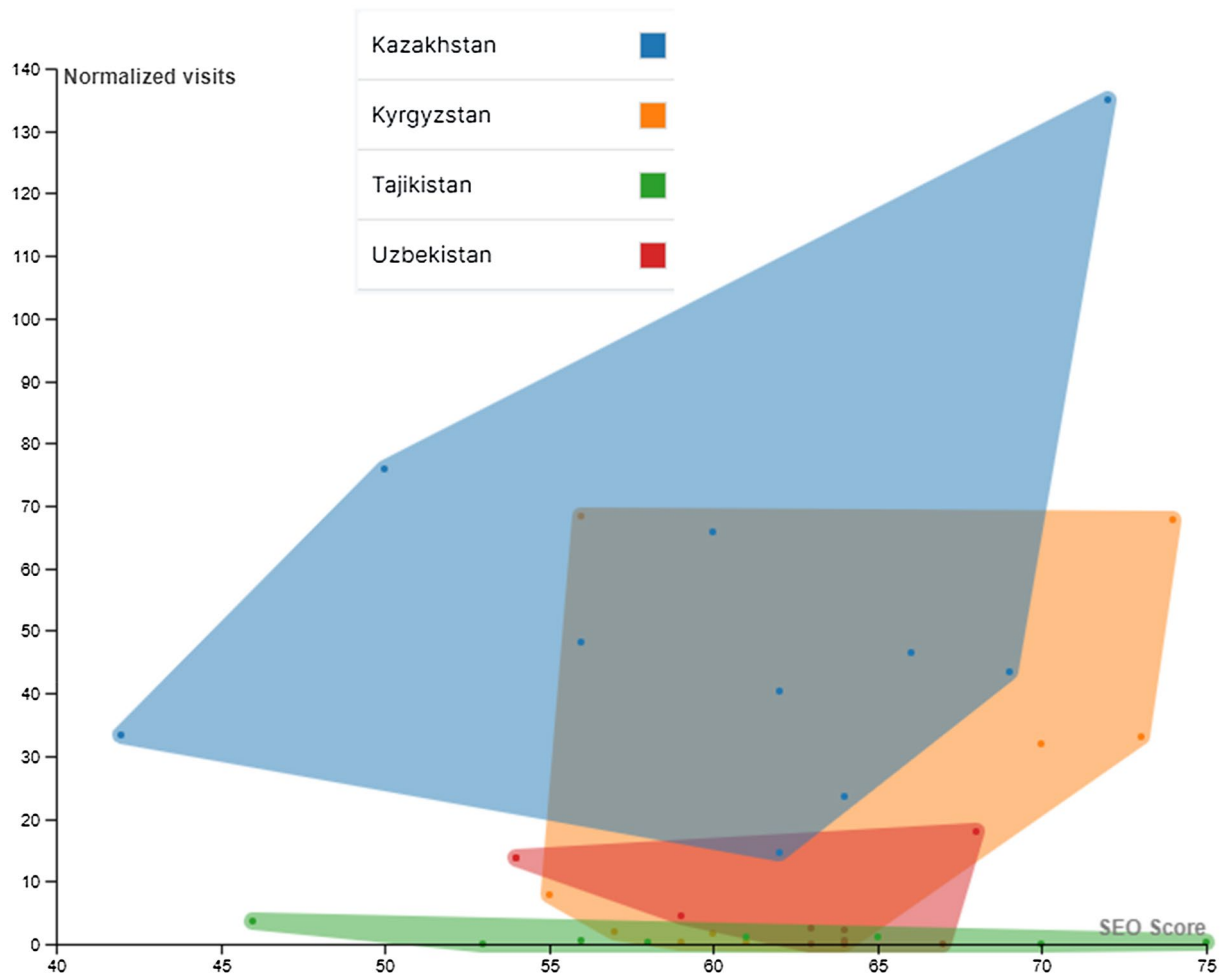


Fig. 1 The ratio of the normalized number of users in Central Asian websites and SEO scores by country

Table 4 Results of ANOVA on the normalized number of visitors by country

(I) Country	Mean	St.d	(J) Country	Mean difference (I–J)	Std. Error	Sig
Kyrgyzstan	21.34	27.69	Uzbekistan	14.34	11.53	0.605
			Kazakhstan	– 31.31*	10.87	0.035
			Tajikistan	20.19	12.55	0.389
Uzbekistan	7.00	7.08	Kyrgyzstan	– 14.34	11.53	0.605
			Kazakhstan	– 45.65*	11.53	0.002
			Tajikistan	5.85	13.12	0.970
Kazakhstan	52.64	34.08	Kyrgyzstan	31.31*	10.87	0.035
			Uzbekistan	45.65*	11.53	0.002
			Tajikistan	51.49*	12.55	0.002
Tajikistan	1.15	1.29	Kyrgyzstan	– 20.19	12.55	0.389
			Uzbekistan	– 5.85	13.12	0.970
			Kazakhstan	– 51.49*	12.55	0.002

*The mean difference is significant at the 0.05 level

5 Discussion and conclusion

The wide range of SEO optimization techniques, in general, can be divided into on-page and off-page techniques [30]. Although off-page techniques are those which cannot be controlled by administrators and programmers, they can use on-page techniques such as meta- information, page quality, page structure, link structure, and server configurations.

As the results of the study showed, although the difference in website SEO scores and its components from different countries slightly differ, yet, page structures and link structures in websites of different countries differ, as well as server configuration practices. For example, developers or Moodle administrators in Kazakhstan do not pay attention to meta description; in six websites out of 10 (kz2, kz4, kz6, kz7, kz8, kz10), this information was not provided. On some websites, indexing was turned off. Another error in the meta- description that was observed in the analysis—the size is too big—was 4298 pixels on the kz3 website and 6657 pixels on the uz9 website. Besides, developers in all four counties do not set the language of a website, in many cases, the language was set to English (en), while the detected language was Russian (ru). This error was observed in four Kazakh websites (kz3, kz4, kz6, kz7), one Uzbek (uz6), and eight Kyrgyz websites (kg5, kg6, kg7, kg8, kg10). According to Seobility net, usage of a top-level domain is for better SEO results [31], however many websites were hosted on subdomains. That is, 8 out of 10 Kazakh websites (kz1, kz2, kz3, kz4, kz6, kz7, kz8, kz10), 6 out of 10 Uzbek websites (uz2, uz4, uz5, uz7, uz8, uz9, uz10), 7 out of 10 Kyrgyz websites (kg1, kg2, kg3, kg5, kg6, kg7, kg9, kg10), and 4 out of 8 Tajik websites (tj2, tj4, tj5, tj6) were located on subdomains.

Although the information in the meta—description is not seen by users, errors related to meta descriptions can affect the search results in search engines. Yet, as results showed, developers or site administrators in countries covered in the study paid little attention to meta descriptions.

In addition, there are issues related to the size of HTTP, CSS files, and images. These page quality issues can affect the load scores, while users mostly navigate away from websites that load for more than 10 s [32].

On many sites, analyzed during the study, there were issues related to page structures, which are organized using so-called Headers. According to the results, in the vast majority of websites, there were no headings set. Conversely, the first level heading <h1> was encountered twice on the page, which also negatively affects the structure of the web page. In addition, there have been cases where one or more level headings were missing in the heading structure. Another rule that developers must follow is that the number of headings on the site should correspond to the volume

of the text. However, on most websites, too many headings have been set for a relatively small amount of text. Thus, on the websites of universities uz1, uz3, uz6, uz9, uz 10, kz6, kz8, kz9, kg1, kg2, kg3, kg7, kg8, kg9, tj8, there was a high number of heading, and the maximal number of heading was detected on the website of university kg7, 203 headings.

Link structure parameters can be divided into Internal links and external links. Issues related to link structures are mostly those of external links. According to the SeoClarity service (SEO Clarity, 2020), external links are one of the most important metrics for ranking websites. However, results showed that in analyzed websites, the number of external links is very low—it ranges from 0 to 13, with the highest outlier being 40 (kz4).

As for server configurations, the biggest difference was observed among websites of Kyrgyz and Kazakh universities: the average server configuration score of Kyrgyz university Moodle websites was 68, while that of Kazakh websites was 48. The issues were related to outdated PHP versions used in Kazakh websites (for example, in kz2, the version of PHP was 7.0.32, which no longer has security support and could be exposed to unpatched security vulnerabilities). Another issue is that HTML files are very large (as in the case of kz4), which affects the website load speed. Besides, in some of the servers, the clock was not set correctly (kz9). Another security threat can be due to X-powered HTTP headers (in kz2, kz3, kz7, kz9, kz10), which expose server-side technology, such as an outdated (and possibly vulnerable) version of PHP. Although there is no direct security risk, this is a bad practice in server configuration. Another issue is related to the redirect of URLs with www and non-www subdomain, which were not properly configured in all sites of the country. These issues resulted in a low score on the server configuration of Kazakh university websites.

At the time of data collection, many universities conduct educational content delivery to their students via online services, including the Moodle system. Based on the results, it was found that the number of students who visited the learning management website was directly related to the extent to which links to this site, known as external factors, were provided from other sources. The same results were obtained by Giomelakis and Veglis [33] who investigated media websites. In addition, we can see from the results of the analysis that the duration of the visit to the site (Visit duration) depends on the structure of the web page, which means that the better the page organization, the more users are engaged, which was also highlighted by Egri and Bayrak [34].

Moreover, the highest number of visits to Moodle platform was observed among Kazakh universities. Yet, the SEO score of these websites was lower than those of other countries websites. As the results of the current study show,

the highest SEO was 75 (the score of the tj1 university website). Some experts suggest that any website with a good SEO score is 80 and above. Search engines use XML data from semantic networks, however, their usage in the educational sector is low [35]. This can explain the relatively low SEO scores of Moodle web applications in Central Asian universities.

As mentioned above, the successful use of any software is known to be measured by the number of requests for that application. We can say that the high quality of the site's affirmations and the content will increase students' interest in the Moodle systems used by universities. If website usage is inconvenient for users, teachers and students will be forced to share training materials through other technologies (for example, via instant messaging services such as WhatsApp, Telegram, or emails). This was the case during the COVID-19 pandemics. Based on the results of this study, we can see that the most successful implementations of online education through the management system are conducted at Kazakh universities. However, looking at the websites of Tajik universities, we can say that marketing strategies and access to information and communication infrastructure for faculty and students also need to be taken into account.

As a limitation of the study, data on information and communication infrastructure in the countries covered by the study were not taken into account in the analysis, and this type of analysis is planned to be carried out as a follow-up study.

Data availability The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Conflict of interest No potential conflict of interest was reported by the authors.

References

1. Ukata, P.F., Onuekwa, F.A.: Application of ICT towards minimizing traditional classroom challenges of teaching and learning during Covid-19 pandemic in rivers state tertiary institutions. *Int. J. Educ. Eval.* **6**(5), 24–39 (2020)
2. BuiltWith, Learning Management System Usage Distribution in the Top 1 Million Sites. <https://trends.builtwith.com/cms/learning-management-system>, 2021 Accessed 13 April 2021
3. Berikkhanova, G., Gainullina, F., Berikkhanova, A., Mukhazhanova, R., Abisheva, S.: Distance e-learning experience in the Republic of Kazakhstan (by the example of the Shakarim State University of Semey). *Revista ESPACIOS* **38**(50), 34–46 (2017)
4. Moodle: Moodle Statistics. <https://stats.moodle.org/>, (2020). Accessed 15 Dec 2020
5. Yergler, R.N.: Search and Discovery: OER's Open Loop, In: Open Ed 2010 Proceedings, pp. 1–10. Barselona, (2010). <http://hdl.handle.net/10609/4852>
6. Barnard, J.: What Is SEO? A Beginner's Guide to Search Engine Optimization. Semrush Blog. https://www.semrush.com/blog/what-is-seo/?kw=&cmp=WW_SRCH_DSA_Blog_Core_BU_EN&label=dsa_pagefeed&Network=g&Device=c&utm_content=484277117729&kwid=aud-973005361823:dsa-1053501802787&cmpid=11776868584&agpid=117384932354&BU=Core&extid=167369085461&adpos=&gclid=Cj0KCQjwktKFBhCkARIsAJeDT0g-j9N_W6PtH9j105QHqPqFT0wnAH18osfgX744EVLIdtb2qkO9EHAaAlGyEALw_wcB (2021). Accessed 20 April 2021
7. Nielsen, J.: SEO and Usability. Nielsen Norman Group. <https://www.nngroup.com/articles/seo-and-usability/#:~:text=SEO%20is%20about%20attracting%20people,to%20increase%20the%20conversion%20rate> (2012). Accessed 12 May 2021
8. State Committee of the Republic of Uzbekistan on Statistics, Higher educational institutions, 2020. Open Data. <https://api.stat.uz/api/v1.0/data/oliy-talim-muassasalari?lang=ru&format=pdf> (2020). Accessed 2 May 2021
9. National Statistical Committee of the Kyrgyz Republic, Number of student organizations of higher professional education in the territory. National Statistical Committee of the Kyrgyz Republic. <http://www.stat.kg/ru/opendata/category/342/> (2021). Accessed 2 May 2021
10. Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan, Higher Education. Education Statistics. <https://stat.gov.kz/api/getFile/?docId=ESTAT099839> (2020). Accessed 2 May 2021
11. Statistics Agency under the President of the Republic of Tajikistan, or Higher Education Institutions. Socio-demographic sect. http://stat.wv.tj/library/ru/higher_education.xls (2020). Accessed 2 May 2021
12. Africa, A.D.M.: A logic scoring of preference algorithm using ISO/IEC 25010: 2011 for open source web applications moodle and wordpress. *ARPN J. Eng. Appl. Sci.* **13**(15), 4567–4571 (2018)
13. Coelho, J., Rocio, V.: A Study on Moodle's performance, In: Proceedings of EDEN Annual Conference, Eden, Lisbon (2008)
14. Kroth, B.: Adventures in Moodle Performance Analysis, CS764 Project Report. http://pages.cs.wisc.edu/~bpkroth/cs764/bpkroth_cs764_project_report.pdf (2014). Accessed 15 May 2021
15. Erjomina, I., Rozentsvaig, A., Ziatdinov, R.: Server component installation and testing of the university information and educational environment on the Moodle LMS platform. <http://arxiv.org/abs/1505.00422> (2015)
16. Hasan, L.: Using university ranking systems to predict usability of university websites. *JISTEM-J. Inf. Syst. Technol. Manag.* **10**(2), 235–250 (2013). <https://doi.org/10.4301/S1807-17752013000200003>
17. Giannakouloupoulos, A., Konstantinou, N., Koutsompolis, D., Pergantis, M., Varlamis, I.: Academic excellence, website quality, SEO performance: Is there a Correlation? *Future Internet* **11**(11), 242 (2019). <https://doi.org/10.3390/fi11110242>
18. Shayegan, J.M., Kouhzadi, M.: An Analysis of the Impact of SEO on University Website Ranking. arXiv preprint arXiv: 12417 (2020)
19. Kabak, M., Özceylan, E., Dağdeviren, M., Genc, T.: Evaluation of distance education websites: a hybrid multicriteria approach. *Turk. J. Electr. Eng. Comput. Sci.* **25**(4), 2809–2819 (2017)
20. Zhang, S., Cabbage, N.: Does SEO Matter? Increasing classroom blog visibility through search engine optimization. In 2013 46th Hawaii International Conference on System Sciences, pp.

- 1610–1619, IEEE. <https://www.computer.org/csdl/pds/api/csdl/proceedings/download-article/12OmNvEyR8l/pdf> (2013)
21. BuiltWith, Moodle Usage Statistics. <https://trends.builtwith.com/cms/Moodle> (2021). Accessed 13 April 2021
 22. Shteiman, B.: Why CMS platforms are breeding security vulnerabilities. *Netw. Secur.* **1**, 7–9 (2014)
 23. Gill, S., Vij, P.: Security ambiguity and vulnerability in G2C eGovernance system: Empirical evidences from Indian higher education. *Indian J. Sci. Technol.* **13**(34), 3515–3520 (2020)
 24. Galba, A.R.: Web application security: audit tools & languages. In: *System Approaches'15: Interaction of Soft and Hard Systems*, pp. 74–76 (2015) <https://doi.org/10.18267/pr.2015.pav.2125.13>
 25. Gudivada, N.V., Paris, J.: Understanding search-engine optimization. *Computer* **48**(10), 43–52 (2015)
 26. Lieke, K.: Accessibility, usability and SEO: a study on social inclusiveness. (-), pp 1–148 (2020)
 27. Muntean, H.C., Murphy, J.: The influence of Web page images on the performance of Web servers. In: *International Conference on Networking*, -(-) 821–828 (2001)
 28. State Committee of the Republic of Uzbekistan on Statistics. (2019, 02 28). 16–1599 Contingent of students in higher educational institutions of the Republic of Uzbekistan. Open Data Portal of the Republic of Uzbekistan. <https://opendata.gov.uz/ru/datasets/1599?DataSetSearch%5BG1%5D=&DataSetSearch%5BG2%5D=&DataSetSearch%5BG3%5D=&DataSetSearch%5BG4%5D=&DataSetSearch%5BG5%5D=&DataSetSearch%5BG6%5D=&DataSetSearch%5BG7%5D=&dp-1-page=1>. Accessed 05 Feb 2021
 29. Ministry of Education and Science of the Kyrgyz Republic. (2020). Universities. Ministry of Education and Science of the Kyrgyz Republic. <http://www.university.edu.gov.kg/ru/university/list>. Accessed 05 Feb 2021
 30. Dhole, M., Kharade, S., Jadhav, S.: Review on search engine optimization. *Int. J. Sci. Res. Comput. Sci. Eng. Inf. Technol.* **2**(6), 1290–1294 (2017)
 31. Seobility, Domain for SEO. Search Engine Optimization. https://www.seobility.net/en/wiki/Domain_for_SEO, n/a, Accessed 30 May 2021
 32. Shaw, J.: Web application performance testing: a case study of an on-line learning application. *BT Technol. J.* **18**(2), 79–86 (2000). <https://doi.org/10.1023/A:1026732502654>
 33. Giomelakis, D., Veglis, A.: Investigating search engine optimization factors in media websites. *Digit. Journal.* **4**(3), 379–400 (2016). <https://doi.org/10.1080/21670811.2015.1046992>
 34. Egri, G., Bayrak, C.: The Role of search engine optimization on keeping the user on the site. *Proc. Comput. Sci.* **36**, 335–342 (2014)
 35. Ermalai, I., Drăgulescu, B.: Inserting microformats into moodle. *Bull. Polytech. Inst. Iași.* **57**(6), 243–251 (2011)

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.