We have proposed a method for optimizing the loading speed of the site. The site is targeted at the local audience within one city or region. It is also taken into account that we can develop the site in a ready-made content management system. We have formed a list of criteria that affect the site loading speed. Experts in multimedia publishing have been involved in forming a list of criteria that affect the site loading speed. We have discovered the difficulties and shortcomings of certain criteria, which should be considered as analytical and theoretical data for an expert review of the complexity of criteria implementation.

The weighting factors of the criteria influence on the optimization degree of the website loading speed are determined. A pairwise comparison matrix of criteria is based on determining how much is one of the criteria influencing the optimization degree of the site loading speed more significant than the other. The calculation of the elements of the weighting matrix of the criteria is implemented. The most important and significant criteria that influence the optimization of the website loading speed have been discovered.

We have formed an order of the criteria list implementation to increase the site loading speed. The implementation of the developed methodology for optimizing the site loading speed was implemented as a prototype of a food photographer's site, which is based on the Joomla 3.9 content management system (USA). We have reviewed several alternatives for the implementation of image compression. The site loading speed has been tested before and after the implementation of the developed method. It has been determined that, on average, site loading speed indicators improved by 48 %. The development of a method for optimizing the site loading speed will create conditions for improving the site's position in search engine rankings

Keywords: loading speed, expert evaluation, pairwise comparison matrix, hierarchy analysis method

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DEVELOPMENT OF A METHOD FOR OPTIMIZING THE SITE LOADING SPEED

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1. Introduction

Modern websites contain a large amount of high-quality multimedia content (resolution, colors and clear sound) and many interactive elements. This increases the page size in kilobytes and the time of page loading.

The speed of page loading affects the site usability. The faster it loads, the more convenient it is. If the page is smaller, users use less traffic. This way, they will pay less for it. Furthermore, the loading speed of the site affects the bounce rate – a situation where the user did not wait for the page to load and closed it. This affects conversions – sales, filling out forms on the site and other important actions for site owners.

The loading speed affects the position of the site in search results. In the situation where all other things are equal, faster sites occupy higher positions in search engine rankings. This allows increasing the number of visitors and potential customers.

These aspects determine the relevance of the issue of optimizing the loading speed of the site.

Typically, site loading speed optimization is based on editing the source code of the CMS (Content Management System) or its extension. However, there is no way to maintain the compatibility of the CMS and various add-ons. In addition, deep CMS optimization is almost unrealistic due to the impossibility of code refactoring. This approach complicates the mechanism of transition from one version of the content management system to another. There are objective difficulties in trying to overcome these limitations for prompt CMS updates and extensions. These difficulties are due to the lack of tools that can optimize the process of site loading, in particular, improve the efficiency and quality of image compression.

Overcoming these difficulties should be done by developing a method of optimizing the loading speed of the site. The central element of this method is a pairwise comparison matrix of criteria based on determining how much one criterion affects the optimization degree of the site loading speed.

The creation of this methodology will provide existing tools for improving the information support of a multimedia publishing house. In addition, the development of methods for optimizing the site loading speed will create conditions for improving the site's position in search engine rankings and getting some effects from implementation in production. In particular, the growth of site visitors may be ensured due to the reduction of the user's time of working with the web page.

2. Literature review and problem statement

The practical need for prompt loading of web pages causes the emergence of relevant scientific interest in the issue of optimizing the site loading speed. Thus, [1] proposes a set of methods and algorithms that allow evaluating the code script in parallel when a user's browser loads a web page. It also outlines the components that must be included in the user's browser architecture to implement these methods. However, this paper does not take into account the specifics of the impact of various factors on the loading speed of the site.

The study [2] proposes a mathematical model of multi-project content optimization, which allows you to create a multi-project, taking into account the specifics of activities, resources and capabilities of the company. The basis for this study was a project-oriented approach. However, this study does not provide opportunities to consider the systematization of the site as an iterative process aimed at reducing the time to load the page completely.

The work [3] is devoted to the risk assessment of corporate infocommunication systems projects using Bayesian networks. The factor of low site performance is considered as the main risk factor for reducing the efficiency of the information service. However, this paper does not contain a description of the most important criteria that affect the optimization of the site loading speed.

The work [4] proposes an approach to the development of large-scale web systems based on a systematic and well-defined process to ensure the quality and measurability of these systems. The paper presents an example of application of the ADM web engineering method (Architecture Development Method). Nevertheless, in the structure of this approach, there is no focus on a specific local audience and the appropriate content management system.

Systematization of key variable determinants of various studies of the website optimization process is proposed in [5]. At the same time, consideration of the problem of optimizing the site loading speed is quite narrow in terms of the composition of the issues considered and intended mainly to increase the popularity of academic websites.

The work [6] focuses on the optimization of the graphical components of web applications in the loading process. Accordingly, this study proposes a visualizing information technique for use in multimedia applications. Nevertheless, this work does not take into account the criterion of image compression to correctly solve the problem of optimizing the web page loading speed.

The study [7] proposes a fractional-integral calculus, which allows you to describe nonlinear processes for estimating the site loading speed with high accuracy. These tools solve the problem of estimating the site loading speed using linear fractional-order transfer functions. However, the question of determining the criteria for optimizing the site loading speed in this study remains open.

The work [8] proposes an approach to use the Markov chain model and the hidden Markov model to optimize the Google Page Rank algorithm, but this work does not describe the main stages of optimizing the site loading speed.

The research [9] considers the possibility of optimizing the process of developing 3D advertising, in order to increase the speed of its loading on relevant web resources. Although, this study does not take into account the complex combination of different factors to optimize the loading speed of a web page in the process of creating appropriate advertising installations.

The technology of improving the visibility of web pages on the Internet through search engine optimization is presented in [10]. Nevertheless, this work does not contain recommendations for expert assessment of the criteria implementation complexity for assessing the quality of this optimization.

Thus, the performed analysis of scientific research on the issue of improving user interaction with web resources indicates the lack of a holistic scientifically sound method of optimizing the site loading speed in the considered works.

3. The aim and objectives of the study

The aim of this work is to develop a method of optimizing the site loading speed. This will make it possible to improve the information support of the multimedia publishing house by targeting the local audience. This takes into account the cost of optimization, the location of the target audience within one city or region, as well as the fact that the site can be developed on a ready-made content management system.

To achieve the aim, the following objectives were set:

– to study the essence of the criteria that affect the optimization of the site loading speed;

– to determine the degree of influence of the criteria on the degree of optimization of the site loading speed;

– to design the list and content of the basic stages of a method for optimizing the site loading speed focused on a local audience;

– to implement the developed method of optimizing the site loading speed focused on the local audience, a prototype of a food photographer's site has been chosen.

4. Materials and methods of research

We have used the following research methods to solve the set tasks. The expert approach has become the basis for forming a list of criteria that affect the site loading speed. The assessment of the criteria influence on the level of site loading speed optimization has been implemented using an expert approach and hierarchy analysis method. Methods of analysis and synthesis, as well as a systematic approach, have been used to fill the stages of the methodology of optimizing the loading speed of the site focused on the local audience.

The practical implementation of the proposed method in the form of developing a prototype of a food photographer's site is based on the use of the File Optimizer image compression program. The created page has been tested using the Google Page Speed Insights service.

5. Results of research on the development of a method for optimizing the site loading speed, focused on the local audience

5. 1. Research of the essence of criteria influencing the optimization of the site loading speed

Loading speed optimization is an iterative process aimed at reducing the time required to fully load a page. This time is calculated from the moment the site receives a request from the user's browser to the moment when the user can fully interact with the page in the browser. It is allowed to load not all the content, but only the minimum necessary part of it. For example, if there are several images

on a page, we consider it sufficient to quickly load those that are visible to the user.

Other images can be loaded in the background, or not loaded at all if the user does not access them. Reduction of the loading time is achieved by making changes to the settings of the site, its files, content files and changes in the server settings. All these actions should not harm the functionality of the site, its appearance and should not constantly increase the load on the server.

Experts in the field of multimedia publishing have been involved to form a list of criteria that affect the site loading speed. These are the specialists of "TessLab", "Karagez", "Artjoker" and "Sitepark" multimedia studios (Ukraine). Based on a survey of experts, the following list of criteria that affect the site loading speed has been formed:

1) loading time;
2) usage of the CDN content delivery network;
3) usage of the cookieless domain to transfer static files;
4) delayed image loading;
5) disabling unnecessary extensions of the content management system;
6) ability to cache static files in the user's browser;
7) ability to cache generated pages on the server;
8) CSS minimization (Cascading Style Sheets);
9) JavaScript minimization;
10) page size;
11) availability of Zend OPcache on the server;
12) availability of the Memcache database query caching module on the hosting (server);
13) availability of HTTP/2 support on the server;
14) combining several small images into one;
15) combining all JavaScript scripts into one file;
16) combining all CSS styles into one file;
17) merging spaces, removing extra quotation marks in tag attributes from the code;
18) CSS optimization in style attributes;
19) URL optimization (Uniform Resource Locator) in the href and src attributes;
20) moving external CSS files up to 1 KB in size inside HTML (HyperText Markup Language);
21 moving external JavaScript files up to 1 KB inside HTML;
22) moving CSS styles to the head section;
23) moving CSS styles in front of JavaScript scripts;
24) matching META tags with HTTP (HyperText Transfer Protocol) headers;
25) pre-resolving (resolving, domain verification) of the DNS (Domain Name System);
26) powerful server with a small number of sites on it;
27) availability of a server with SSD disks (Solid-State Drive);
28) image compression efficiency.

In the process of studying the essence of the criteria influencing the optimization of the loading speed, the inherent difficulties and shortcomings were identified, which rationally, in the future, will be regarded as analytical and theoretical data (*Di*, when $i=\overline{1,k}$). These data are necessary for an expert assessment of the complexity of criteria implementation.

5. 2. Determining the degree of the criteria influence on the degree of optimization of the site loading speed

Determining the degree of influence of the criteria on the level of optimization of the site loading speed begins with the processing of many influencing criteria F_V, when $v=\overline{1,28}$, using the hierarchy analysis method. As a result of processing, the weights of each of the influence criteria are defined. We exclude the criteria that have the lowest values of weights from further consideration as those that make little contribution to the process of optimizing the site loading speed.

Table 1 shows the criteria that affect the degree of optimization of the site loading speed and the corresponding weights that allow choosing only the most significant of the analyzed criteria. The values of the weights were obtained by interviewing experts from the "TessLab", "Karagez", "Artjoker" and "Sitepark" multimedia studios (Ukraine).

Given that the software market is evolving very rapidly, the list of criteria can be adjusted and supplemented with new data.

Table 1

Influence criteria for the degree of optimization of the site loading speed

Criteria		Weight $\mu_i^u(F_i)$
Mark	Name	
1	2	3
*f*1	Loading time	0.05
*f*2	Combining all JavaScript scripts in one file	0.05
*f*3	DNS pre-resolving	0.003
*f*4	Availability of Zend OPcache on the server	0.02
*f*5	Powerful server with a small number of sites on it	0.1
*f*6	Merging spaces, removing extra quotation marks in tag attributes from the code	0.01
*f*7	Combining all CSS styles into one file	0.25
*f*8	Combining several small images into one	0.026
*f*9	Ability to cache static files in the user's browser	0.1
*f*10	Delayed image loading	0.03
*f*11	Moving CSS styles to JavaScript scripts	0.003
*f*12	Server with SSD disks	0.046
*f*13	Matching META tags with HTTP headers	0.02
*f*14	Page size	0.05
*f*15	Availability of the Memcache database query caching module on the hosting (server)	0.01
*f*16	Using the Content Delivery Network (CDN)	0.002
*f*17	Moving external CSS files up to 1 Kb inside HTML	0.002
*f*18	Ability to cache generated pages on the server	0.09
*f*19	CSS minimization	0.05
*f*20	JavaScript minimization	0.05
*f*21	Availability of HTTP/2 support on the server	0.05
*f*22	Image compression	0.07
*f*23	Moving CSS styles to the head section	0.01
*f*24	URL optimization in href and src attributes	0.003
*f*25	Moving external JavaScript files up to 1 Kb inside HTML	0.002
*f*26	Use of subdomains/aliases (cookieless domain) to transfer static files	0.05
*f*27	Disabling unnecessary content management system extensions	0.05
*f*28	CSS optimization in style attributes	0.003

To determine the significant factors that will be involved in the ranking process, you need to perform the following steps:

1) construct a pairwise comparison matrix of criteria $F=\|f_{ij}\|$ (when $i,j=\overline{1,n}$) The comparison procedure is based on the question: "How much is one of the criteria

influencing the optimization degree of the site loading speed more significant than the other?" The construction process is as follows. A matrix is constructed, and the selected criteria are located in the headers of rows (i) and columns (j). The value "1" is placed diagonally, because each criterion is compared not only with all others, but also with itself. We use the scale of relativity (significance degree of actions scale) proposed by Saati to determine the numerical value of the importance degree of pairwise compared criteria.

The choice of the hierarchy analysis method is because this method allows taking into account a range of different expert opinions, which is very relevant for such a complex and multifaceted task as site optimization.

Thus, for example, when comparing criterion f5 (powerful server with a small number of sites on it) with criterion $f7$ (combining all CSS styles into one file), the following is determined. Criterion $f5$ is 2 times more important in optimizing the site loading speed than criterion $f7$, the significance of which is 0.25. A fragment of the calculation matrix is given below:

$$F=\left\|f_{ij}\right\|=\begin{pmatrix} & f_1 & f_2 & f_3 & ... & f_{28} \\ f_1 & 1 & 0.25 & 6 & ... & 0.12 \\ f_2 & 4 & 1 & 3 & ... & 4 \\ f_3 & 0.16 & 0.33 & 1 & ... & 0.25 \\ ... & ... & ... & ... & ... & ... \\ f_{28} & 8 & 0.25 & 4 & ... & 1 \end{pmatrix}; \quad (1)$$

2) calculate the elements of the weighting matrix (according to (2)):

$$\mu_i^u(F_i)=\frac{f_{ij}}{\sum_{i=1}^{n} f_{ij}}, \quad (2)$$

where $\mu_i^u(F_i)$ is the value of the weights of the "i" criteria within the "u" range, when $u\in\overline{0,1}$.

Next, based on the calculation of the sum of $\sum_{j=1}^{n}\mu_i^u(F_i)$ type for each F_i, we determine the weights of the criteria. This makes it possible to make an informed choice when comparing several criteria influencing the optimization of the site loading speed. For example, the value of the weight of criterion $f1$ is $\mu_1^u(F_1)=0.05$. The weights calculated for each criterion are given above (Table 1).

We should note that the estimated sum of all weights must be equal to "1":

$$\sum_{i=1}^{n}\mu_i^u(F_i)=1; \quad (3)$$

3) identifying the most important (significant) criteria that affect the optimization of the site loading speed. It is proposed to determine the appropriateness of including criteria in the selection process, because 90 % of the total set of criteria is sufficient for further consideration, analysis and forming of relevant conclusions. This allows forming the following relationships:

a) criteria $f4$, $f13$, $f6$, $f15$, $f23$, $f3$, $f11$, $f24$, $f28$, $f16$, $f17$, $f25$ in total gained less than 10 %. Therefore, they can be excluded from the review process;

b) criteria $f5$, $f9$, $f18$, $f22$, $f1$, $f2$, $f7$, $f14$, $f19$, $f20$, $f21$, $f26$, $f27$, $f12$, $f10$, $f8$ in total gained more than 90 %. They should be used to optimize the loading speed of the site.

5. 3. List and content of the basic stages of the site loading speed optimization method

We offer the method of optimizing the loading speed of the site, which is targeted at the local audience, taking into account the fact that the site is developed on a ready-made content management system.

Stage 1 – preliminary assessment. Testing the site loading speed in several services to obtain information on the site loading speed.

Stage 2 – preparation of the site for optimization. Searching for extensions to optimize the site loading speed for a specific content management system based on a list of essential optimization criteria.

Stage 3 – hosting verification. Checking the site hosting according to the following criteria:

1) powerful server with a small number of sites on it;

2) page size;

3) availability of HTTP/2 support on the server;

4) server with SSD disks.

Stage 4 – optimization of the site loading speed. Introduction of a list of criteria to increase the loading speed of the site. The sequence of implementation may depend on the characteristics of the selected component to optimize the loading speed:

1) disabling unnecessary extensions of the content management system;

2) combining several small images into one;

3) loading time;

4) CSS minimization;

5) JavaScript minimization;

6) merging all CSS styles into one file;

7) merging all JavaScript scripts into one file;

8) delayed image loading;

9) using subdomains/aliases (cookieless domain) to transfer static files;

10) page size;

11) ability to cache static files in the user's browser;

12) ability to cache generated pages on the server.

Stage 5 – site verification. Checking the appearance and functioning of all standard pages of the site in different browsers and devices. If any errors are detected, you should change the settings of the site optimization component and the server. Then repeat step 4.

Stage 6 – final assessment. Testing the site loading speed in several services to obtain information about the site loading speed. If most of the indicators have worsened, you should return to stage 2 and go through all the stages again.

5. 4. Implementation of the developed method of optimizing the site loading speed focused on the local audience

Let us consider the results of the proposed method on the example of image optimization.

To implement the developed method of optimizing the site loading speed targeted at the local audience, we have chosen a prototype of a food photographer's site. It is based on the Joomla 3.9 content management system. The features of the site are a large number of images with high resolution and a large palette of colors. The target audience of the site is located within one city. We should also note that the owner cannot pay a large amount of money for hosting. Prior to the optimization, we have considered several tariffs from different hosting providers. During the review, we have paid attention to the following criteria:

1) powerful server with a small number of sites on it;
2) page size;
3) loading time;
4) server with SSD disks.

There have also been restrictions on the cost of the tariff per year (no more than $ 71.18) and location of servers. You should consider creating three subdomains or aliases to implement a cookieless domain. As a result, three alternatives have been identified:

1) U.ua. The "Best SSD" tariff is $ 49.61 per year;
2) Uh.ua. The "Optimal" tariff is $ 52.63 per year;
3) Bitte.net.ua. The "Master" tariff is $ 33.7 per year.

Which of these services to choose will be decided by the site owner. To test the method of optimizing the loading speed of the site, a prototype of the site has been posted on a temporary U.ua hosting account using the "Best SSD" tariff.

In order to increase the loading speed of the site according to the developed methodology, the following criteria have been introduced:

1) disabling unnecessary extensions of the content management system;
2) combining several small images into one;
3) loading time;
4) CSS minimization;
5) JavaScript minimization;
6) merging all CSS styles into one file;
7) merging all JavaScript scripts into one file;
8) delayed image loading;
9) using subdomains/aliases (cookieless domain) to transfer static files;
10) page size;
11) ability to cache static files in the user's browser;
12) ability to cache generated pages on the server.

We have considered several alternatives to implement the image compression criterion.

The Caesium toolkit contains open source code for compressing files in PNG, JPG and BMP formats.

FileOptimizer, in addition to compressing JPG, GIF and PNG images, allows processing executable files.

Due to a clear and understandable interface, the RIOT toolkit quickly compresses GIF, PNG or JPG images and compares the results.

The TinyPNG online service allows you to optimize images in PNG and JPG formats. Furthermore, this service supports JPG and PNG formats and allows you to upload up to 20 images and if the file size of each image is less than 5 MB.

Optimizilla is an online service, which allows controlling the degree of compression and is quite convenient for mobile devices.

Table 2 provides information on the results of compression testing of five JPEG images and five PNG images.

As a result, we have chosen FileOptimizer to compress the images. The program has processed 740 files in 95 territories. Including 731 JPEG files:

– the total size of all files before compression – 73.1 MB;
– the total size of all files after compression – 30.3 MB.

The volume of all files has reduced by 58.55 % without significant loss of quality. Fig. 1 shows an example of a FileOptimizer window after compressing JPEG images.

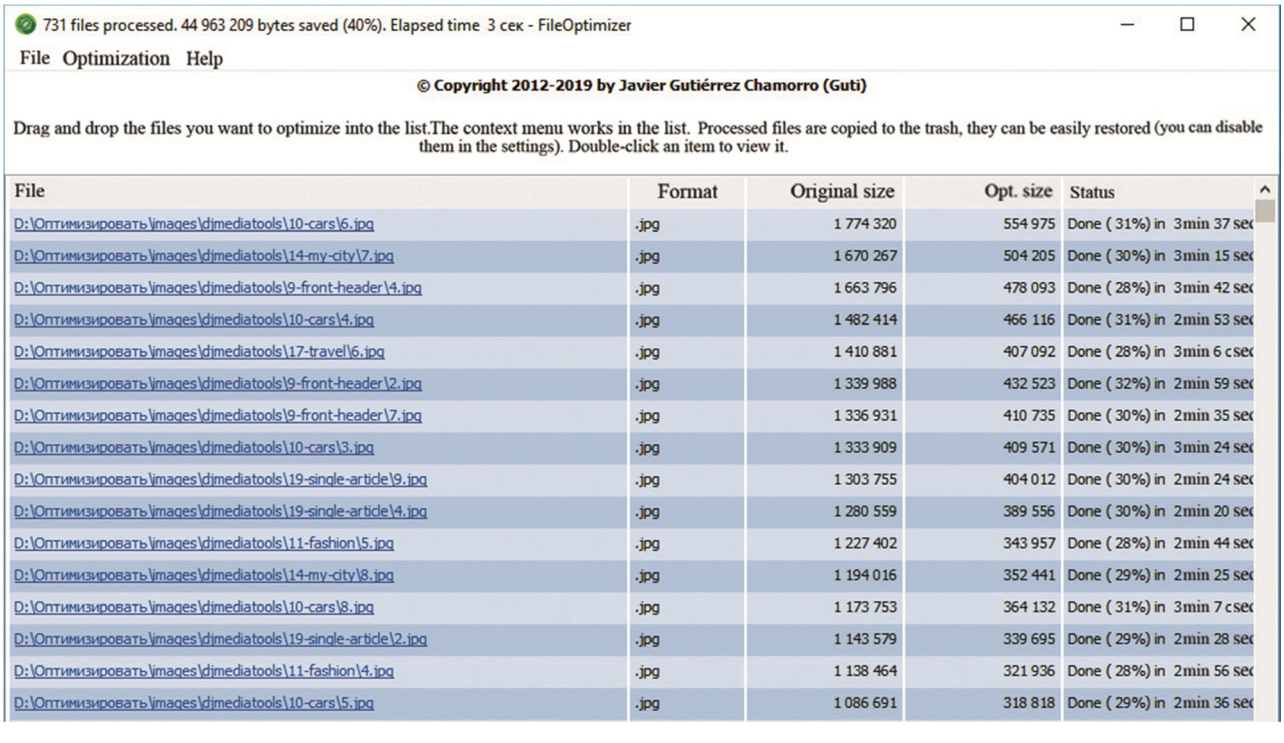
To assess the degree of site loading speed optimization before implementing the list of criteria, we have selected the following services:

– Google PageSpeed Insights;
– WebPagetest;
– Gtmetrix;
– Pingdom.

The "About me" page has been the subject of testing, because it is the most "difficult": gallery, static images, scripts, styles.

Fig. 2 shows the result of page testing in Google PageSpeed Insights (for mobile devices).

Fig. 3 shows the result of page testing in Google PageSpeed Insights (for computers).



File	Format	Original size	Opt. size	Status
D:\Оптимизировать\images\djmediatools\10-cars\6.jpg	.jpg	1 774 320	554 975	Done (31%) in 3min 37 sec
D:\Оптимизировать\images\djmediatools\14-my-city\7.jpg	.jpg	1 670 267	504 205	Done (30%) in 3min 15 sec
D:\Оптимизировать\images\djmediatools\9-front-header\4.jpg	.jpg	1 663 796	478 093	Done (28%) in 3min 42 sec
D:\Оптимизировать\images\djmediatools\10-cars\4.jpg	.jpg	1 482 414	466 116	Done (31%) in 2min 53 sec
D:\Оптимизировать\images\djmediatools\17-travel\6.jpg	.jpg	1 410 881	407 092	Done (28%) in 3min 6 csec
D:\Оптимизировать\images\djmediatools\9-front-header\2.jpg	.jpg	1 339 988	432 523	Done (32%) in 2min 59 sec
D:\Оптимизировать\images\djmediatools\9-front-header\7.jpg	.jpg	1 336 931	410 735	Done (30%) in 2min 35 sec
D:\Оптимизировать\images\djmediatools\10-cars\3.jpg	.jpg	1 333 909	409 571	Done (30%) in 3min 24 sec
D:\Оптимизировать\images\djmediatools\19-single-article\9.jpg	.jpg	1 303 755	404 012	Done (30%) in 2min 24 sec
D:\Оптимизировать\images\djmediatools\19-single-article\4.jpg	.jpg	1 280 559	389 556	Done (30%) in 2min 20 sec
D:\Оптимизировать\images\djmediatools\11-fashion\5.jpg	.jpg	1 227 402	343 957	Done (28%) in 2min 44 sec
D:\Оптимизировать\images\djmediatools\14-my-city\8.jpg	.jpg	1 194 016	352 441	Done (29%) in 2min 25 sec
D:\Оптимизировать\images\djmediatools\10-cars\8.jpg	.jpg	1 173 753	364 132	Done (31%) in 3min 7 csec
D:\Оптимизировать\images\djmediatools\19-single-article\2.jpg	.jpg	1 143 579	339 695	Done (29%) in 2min 28 sec
D:\Оптимизировать\images\djmediatools\11-fashion\4.jpg	.jpg	1 138 464	321 936	Done (28%) in 2min 56 sec
D:\Оптимизировать\images\djmediatools\10-cars\5.jpg	.jpg	1 086 691	318 818	Done (29%) in 2min 36 sec

Fig. 1. FileOptimizer window

Fig. 2. Testing the page in Google PageSpeed Insights for mobile devices

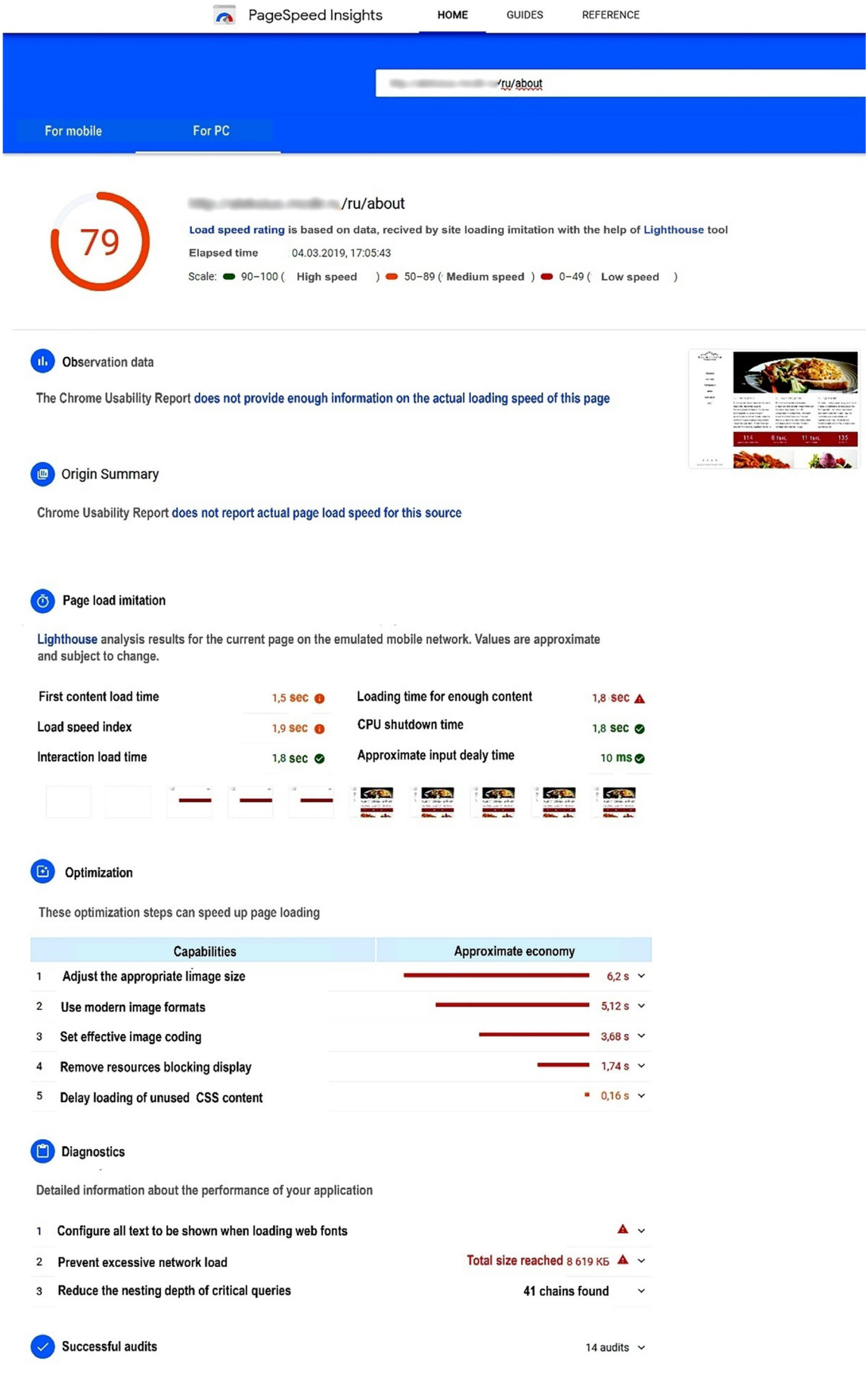


Fig. 3. Testing the page in Google PageSpeed Insights for computers

Table 2

Image compression results

Results of compression Services	JPEG reduced by	PNG reduced by
Caesium	5 %	1,2 %
FileOptimizer	17.7 %	42.2 %
RIOT	15.9 %	20.3 %
TinyPNG	17.2 %	38.3 %
Optimizilla	17.4 %	41.9 %

Table 3 shows the results of testing before and after the implementation of the developed methodology.

Table 3

Analysis of site loading speed indicators before and after optimization

Site loading speed indicator	Before optimi-zation	After optimi-zation	Improve-ment of the indicator
Google PageSpeed Insights (for mobile devices)			
Overall rating (100 % max)	54	97	43 %
First content loading time (sec.)	4.5	1.6	35.55 %
Loading speed index (sec.)	5.6	2.2	39.28 %
Interaction loading time (sec.)	5.8	3.3	56.89 %
Loading time for enough content (sec.)	5.7	1.6	28.07 %
CPU shutdown time (sec.)	5.7	2.9	50.87 %
Approximate input delay time (ms.)	10	10	0
Google PageSpeed Insights (for PC)			
Overall rating (100 % max)	79	100	21 %
First content loading time (sec.)	1.5	0.5	33.33 %
Loading speed index (sec.)	1.9	0.7	36.84 %
Interaction loading time (sec.)	1.8	0.5	27.77 %
Loading time for enough content (sec.)	1.8	0.5	27.77 %
CPU shutdown time (sec.)	1.8	0.5	27.77 %
Approximate input delay time (ms.)	10	10	0
GTmetrix			
PageSpeed (100 % max)	0	95	100 %
YSlow (100 % max)	70	90	20 %
Full page loading time (sec.)	5.5	3.5	63.63 %
Total page size (MB)	8.62	0.745	91.35 %
Number of requests	66	30	45.45 %
WebPagetest			
Loading time (sec.)	16.467	0.934	94.33 %
Time of receiving the first byte (sec.)	0.426	0.196	79.67 %
Start of grinding (sec.)	1.9	0.8	42.1 %
Speed index (sec.)	6.764	1.301	80.77 %
Number of requests	67	30	44.77 %
Total page size (MB)	8.916	0.722	91.9 %

By calculating the average percentage of improvement, we can assume that the average speed of site loading has improved by 48 %.

6. Discussion of the results of developing a method for optimizing the site loading speed

During the research, we were developing a method for optimizing the loading speed of a site, which is focused on a local audience. In the process of creating the method (in stages 5, 6), the following points were taken into account:

– cost of optimization;

– the target audience is located within one city or region;

– the site can be developed on a ready-made content management system.

The proposed method is a continuation of research on the development of a method for multimedia publishing information support. These are possible areas of practical usage of the proposed method:

– management of search engine optimization processes;

– Internet and social networks marketing;

– multimedia publishing house information support.

Based on the results of the development, we can draw the following conclusions about the possible practical application of the site loading speed optimization method:

1) the final loading speed (given in Table 3) of each specific site page may differ for each specific user at a certain point. The loading speed even for the same user may be different in a few seconds, even if the user just refreshed the same page. Above all, the site loading speed depends on a large number of criteria (Table 1): loading the connection between the user and the server, server load, caching, etc.;

2) gzip-compression can also be applied in case of highly loaded servers with dynamic HTML files (Table 2). It is necessary to focus on the minimum degree of compression, because the CPU costs increase linearly, but the size decreases only logarithmically;

3) both the client and the server approach must be applied during the creation of high-performance web applications. When it comes to client-server interaction, both aspects of optimization require changing. This applies to step 3 of the proposed method;

4) when using the proposed method of optimizing the site loading speed, do not forget that the loading speed consists of various components. Such components are, for example, the speed of searching for DNS information by the user's browser, the speed of connection of the user's browser to the server or the speed of generating the requested page by the server. This is relevant for testing the site on mobile devices (Fig. 2) and on a computer (Fig. 3).

The advantages of the proposed method of optimizing the site loading speed are:

– the views of leading experts in multimedia studios on the list and specific weight of the criteria that affect the site loading speed are taken into account;

– the proposed method is focused on the local audience, which allows effective application for marketing on the Internet and social networks;

– practical approbation and testing on both desktop computers and mobile devices.

The disadvantages of the created method of optimizing the site loading speed include the fact that it is impossible to implement some of the criteria selected in the method on a local server. It is also not possible to test the site on a local server using various services.

Throughout the time of using the proposed results, the following subjective restrictions may be imposed:

– to implement all the criteria of the developed methodology, the usage of specialized software for the content management system is required;

– the implementation sequence of the proposed criteria list may depend on the characteristics of the selected component to optimize the site loading speed.

Further research areas may be:

– evaluation of the SEO site optimization effectiveness;

– development of risk management techniques for SEO site promotion;

– development of a methodology for assessing the quality of search traffic.

When implementing these further areas of research, the following difficulties may arise:

– during the evaluation of the effectiveness of SEO site optimization, there may be difficulties in determining the integrated indicator of such effectiveness and quantification of each component of this indicator;

– when developing risk management techniques, SEO site promotion may face the problem of selecting acceptable risks;

– in the process of developing a methodology for assessing the quality of search traffic, it may be difficult to identify the usefulness of various tools and variations to improve traffic quality.

7. Conclusions

1. We have implemented the research of the essence of the criteria influencing the optimization of the site loading speed. Accordingly, a list of the main criteria for optimizing the site loading speed was formed. Characteristic features of the proposed criteria were chosen in such a way that they should not harm the site functionality, its appearance and should not constantly increase the load on the server.

2. The degree of the criteria influence on the degree of site loading speed optimization is determined. This made it possible to exclude the criteria that have the lowest values of weights from further consideration, as those that make a small contribution to the process of optimizing the site loading speed. The appropriateness of including criteria in the selection process is determined on the basis of the conclusion that 90 % of the total set of criteria is sufficient for further consideration, analysis and formation of relevant conclusions.

3. We have formed a list and content of the basic stages of the site loading speed optimization method. This method aims at the local audience, taking into account the possibility of site development on a ready-made content management system. The result of this method is the final estimate of the site loading speed, which is determined by testing. Testing the loading speed should take place in several services in order to obtain detailed information.

4. We have made the implementation of the developed method of optimizing the site loading speed on the example of a prototype of a food photographer's site. The specified site is based on the Joomla 3.9 content management system. To test the method of optimizing the site loading speed, the prototype is posted on a temporary U.ua hosting account. The "Best SSD" tariff is chosen. The analysis of site loading speed indicators before and after optimization is implemented. By calculating the average percentage of improvement, it was determined that the average loading speed has improved by 48 %.

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