ECONTECHMOD. AN INTERNATIONAL QUARTERLY JOURNAL – 2019, Vol. 08, No. 2, 9 – 16

Accessibility Analysis of Scientific Libraries Web Resources

V. Pasichnyk, T. Shestakevych, N. Kunanets, A. Rzheuskyi, V. Andrunyk

Information Systems and Networks Department, Lviv Polytechnic National University, UKRAINE, Lviv

vpasichnyk@gmail.com, Tetiana.V.Shestakevych@lpnu.ua, nek.lviv@gmail.com, antonii.v.rzheuskyi@lpnu.ua, Vasyl.A.Andrunyk@lpnu.ua

Received: March 29, 2019, accepted June 1, 2019

Abstract. A complex system of social and educational inclusion needs competent analysis to make it possible proper management and comprehensive improvement. To analyze one of the actual facets of such a system, namely, its ICT support, it is necessary to take into account the various needs of socially vulnerable people. A set of guidance to web accessibility is a convenient instrument, that provides various approaches in designing goods and technologies. Among other, such guidance helps to design websites with no access barriers, which is extremely important for people with special needs. To analyze the websites and different online resources, which might be of interest to a person with special needs during the social and educational inclusion, a list of characteristics was developed. It must be taken into account the classification and the structure of information materials, website`s structure, design, etc. The unification of the ICT for people, involved in educational and social inclusion, will improve informational and technological support of such process.

Keywords: educational and social inclusion, IT support, IT resources ergonomics, WCAG 2.0, social websites characteristics.

I. Introduction

In January 2018, the European Commission adopted new initiatives aimed at improving the key and digital competences of European citizens, promoting common values and inclusion. Specialists of the European Commission have been approved a number of documents that reflect the vision of the European Union's future ways of society development. The recommendations to Member Countries of the European Union (from January 2018) underlined, among other, the need to support the right to quality and inclusive education, together with a lifelong learning for all [1]. The importance of the inclusive society is also declared in the European Union's Horizon2020 Program, which states the need for innovative approaches to support individuals, facing social and digital exclusion [2]. The problems of the European Union countries are relevant also for Ukraine.

The system of social and educational inclusion (SEI) for people with special needs is a complex, multifactorial system, with a large number of components. One of its sub-processes is an inclusive education [3]. A system of SEI is a complex system [4-6], which is characterized by a large number of involved components and resources, self-organization, variability, diversity, dynamic and viable, adjustment to the environment, interaction, nonlinearity, selectivity, feedback, lack of central control, the hierarchy of the organization, emergence, and evolution.

The information and technological support is an important feature of a complex system of educational and social inclusion. One of the types of the information technology, that support social and educational inclusion, are online learning management systems and multimedia learning environments, information technologies applicable to the education of people with special needs, mobile applications, and online reference resources. In this paper, we shall discuss the accessibility of the online resources for people with special needs. Such an analysis will show the level of implementation of universal design ideas [7].

As suggested in [8], the first stage of the analysis of a complex system of educational and social inclusion, we shall the study the Web products, required by the inclusion participants.

II. State of the art

The problem of web accessibility on various online resources became even more actual with increasing the interest to ICT from researchers of inclusive and educational inclusion.

In [9], we analyzed the websites of the institutions, to which parents of the child with special needs originally apply. Such diagnostic and correctional facility is called *The psychological,* medical *and pedagogical consultations (PMPC).* We analyzed 17 websites to evaluate their compliance with the requirements of availability, completeness, and connection between components of an inclusive education system. We came into conclusion, that in the process of IT-support of the education of people with special needs, offered by PMPC, has no systemicity and does not fully cover stages of inclusive education. The design of PMPC websites definitely requires centralized management to unify the information, important for the education of people with special needs.

In [10], authors proposed an idea of evaluating the level of barrier-free web resources for users. In the paper, the analysis of accessibility, readability, and site-ranking government websites of India was presented.

The usability and the accessibility of websites of county-level emergency management agencies were described in [11]. The identified problems, among others, requests the need for promoting the use of usability guidelines to help lead website development, particularly when it comes into navigation.

In [8], it was analyzed the current state of compliance of web products, relevant to people with different needs, who are finishing school. Authors worked with a set of 578 web products, related to future education or a professional career. These were the websites of the higher education institutions all over the country. Authors are convinced that the most of these websites do not comply the web-accessibility demands.

For many decades, libraries served as a storage of information resources on various media. Nowadays, the library has turned into information institutions transmitting knowledge in the information society, provide information needs of specialists in various fields of knowledge. Libraries as socio-communicational institutions are equipped with a modern material and technical base, have access to information industry resources and databases, provide a wide range of information distance services. The staff of information workers able to work with information flows is formed, conducting its analytical and synthetic processing and providing users with relevant information.

The library as a nonprofit organization becomes a competitive institution in the market of information services. Increasing their roles by proposing traditional services in ICT mode, libraries became an instrument of gaining knowledge not only for students or pupils but for all people, involved in lifelong learning. That is extremely important for library users, who have special needs because these institutions became an important part of educational and social inclusion support.

With the development of information technology and the Internet, the web accessibility requirements were reflected in ISO standardized documents. The increasing level of socialization of people with special needs is supported and promoted with the opportunity of lifelong learning.

In [13], authors studied the needs of users with visual impairments to create accessible library website. Selected library sites were tested for convenience and accessibility by people with visual impairment. The results were analyzed in terms of available coding standards. The most common barriers to accessibility were the problems of information architecture and web design.

In [13], it was presented a methodology for investigating a wide range of information services, provided remotely by the USA university libraries. The methodology consists of the method of comparative analysis and the method of pair comparison on the basis of expert evaluations. As a result, a group of library leaders in providing quality information services was identified.

In the system of social and educational inclusion, inclusive education covers institution from pre-school and to higher education institutions, as well as organizations that provide and accompany such training (libraries, etc). We shall continue the research on the accessibility of the websites, which should deliver useful and safe information for all people, including people with special needs. As the next group of information and technological resources, suitable for people with special needs, we shall consider libraries websites, namely, the regional universal scientific libraries in Ukraine.

III. THE ANALYSIS OF STATISTICAL INDICATORS OF WEBSITES

There are 22 websites for the regional universal scientific libraries in Ukraine (Table 1).

TABLE I. THE LIST OF REGIONAL UNIVERSAL SCIENTIFIC LIBRARIES IN UKRAINE

Denot.	Regional universal scientific library
Lib.1	Vinnitsa regional universal scientific library named after Timiryazev
Lib.2	Volyn state regional universal scientific library named after Olena Pchilka
Lib.3	Zhytomyr regional universal scientific library named after Oleg Olzhich
Lib.4	Transcarpathian regional universal scientific library named after F. Potosnak
Lib.5	Zaporizhzhya regional universal scientific library
Lib.6	Ivano-Frankivsk regional universal scientific library named after I. Franko
Lib.7	Regional universal scientific library named after D. Chyzhevsky
Lib.8	Lviv regional universal scientific library
Lib.9	Mykolaiv regional universal scientific library
Lib.10	Poltava regional universal scientific library named after I. Kotlyarevsky
Lib.11	Rivne regional universal scientific library
Lib.12	Sumy regional universal scientific library
Lib.13	Kharkiv regional universal scientific library
Lib.14	Kherson regional universal scientific library named after Oles Honchar
Lib.15	Khmelnitsky regional universal scientific library
Lib.16	Cherkasy regional universal scientific library named after Taras Shevchenko
Lib.17	Chernihiv regional universal scientific library named after V. Korolenko
Lib.18	Chernivtsi regional universal scientific library named after Mykhailo Ivasiuk
Lib.19	Luhansk regional universal scientific library named after M. Gorky
Lib.20	Dnipropetrovsk regional universal scientific library named after the Saints Cyril and Methodius
Lib.21	Odessa Regional Universal Scientific Library. named after M. Hrushevsky
Lib.22	Ternopil regional universal scientific library

The analysis of the statistical indicators of the he activities of the website was carried out in [9] by using the *SimilarWeb Platform* [14]. This information technology processes the big data to collect, measure, and analyze the behavioral models of sites and users attract. The fig. 1 presents the results of Odessa Regional Universal Scientific Library, named after M. Hrushevsky (Lib.21) website evaluation.

Using *SimilarWeb*, we accumulated the following characteristics of the sites (in parentheses, we add denotation of such characteristic):

- Global worldwide rank according to traffic use (a_1).

- Country rank according to traffic use (a_2).
- Site category / rank in category (a_3).

Results for all universal scientific libraries websites are presented in Table 2.

From the results, presented in Table 2, we draw the following conclusions (as a remark we should say that the highest rank is 1, and it is the rank for the most popular site with the highest activity).

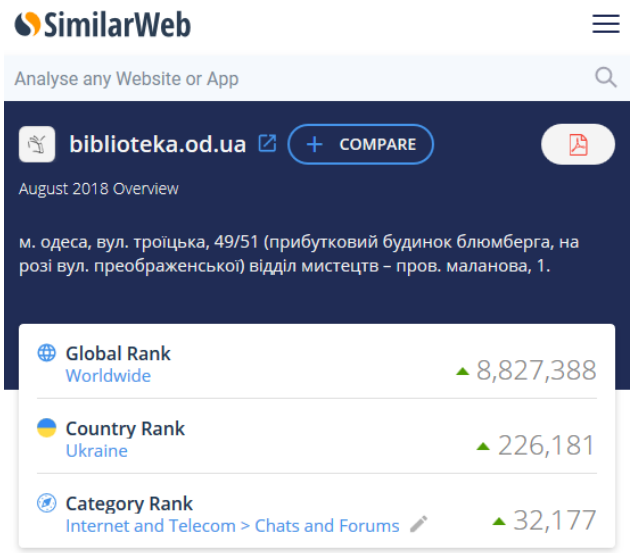

Fig. 1. The statistical characteristics of the Lib.21 website activity (by *SimilarWeb*)

Table 1. SUMMARY CHARACTERISTICS OF THE WEBSITES OF REGIONAL UNIVERSAL SCIENTIFIC LIBRARIES (ACCORDING TO THE SIMILARWEB)

Library	a_1	a_2	a_3
Lib.1	2031905	48453	9835
Lib.2	13124650	321127	13422
Lib.3	3064942	81751	8885
Lib.4	5578400	134680	15565
Lib.5	1535066	36787	4324
Lib.6	2054906	50206	271586
Lib.7	1345937	38120	2022
Lib.8	10756025	254498	199479
Lib.9	5105883	149595	6600
Lib.10	4709868	116163	13300
Lib.11	4483473	106751	5909
Lib.12	8354140	204637	20915
Lib.13	2580247	65114	7449
Lib.14	897360	21323	2478
Lib.15	2449689	57444	3479
Lib.16	6361217	150715	17367
Lib.17	2044257	48676	5865
Lib.18	4141546	100858	11899
Lib.19	7094364	170969	8597
Lib.20	1864628	46512	2733
Lib.21	8827388	226181	32177
Lib.22	2884280	71023	8378

- The top-five websites with the highest global worldwide rank according to traffic use belong to Kherson, Kirovograd, Zaporizhzhya, Dnipropetrovsk, and Vinnytsya regional universal scientific libraries. The five sites with the lowest global worldwide rank are websites of Luhansk, Sumy, Odesa, Lviv, and Volyn region libraries.
- The top-five websites with the highest global country rank according to traffic use belong to Kherson, Zaporizhzhya, Kirovograd, Dnipropetrovsk, and Vinnytsya regional universal scientific libraries. The five sites with the lowest country rank are websites of Luhansk, Sumy, Odesa, Lviv, and Volyn region (see fig. 2) libraries.
- The top-five websites with the highest rank in a category according to traffic use belong to Kirovograd, Kherson, Dnipropetrovsk, Khmelnytskyy, and Zaporizhzhya regional universal scientific libraries. The five sites with the lowest rank in a category, are websites of Cherkasy, Sumy, Odesa, Lviv, and Ivano-Frankivsk region libraries.

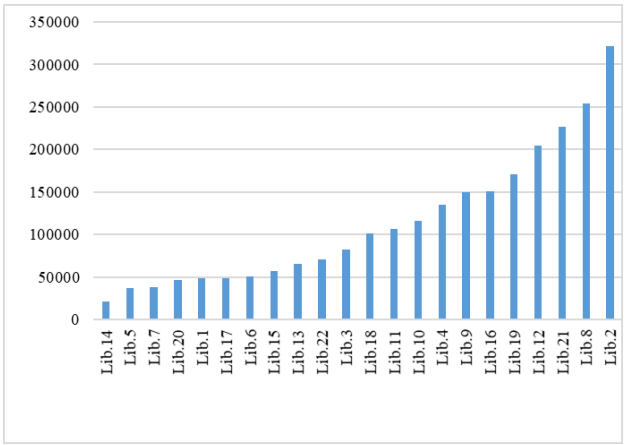

Fig. 2. The country ranks of websites of the regional universal scientific libraries

IV. WEB ACCESSIBILITY REQUIREMENTS

In 2008, the W3C released a set of Web Content Accessibility Guidelines WCAG 2.0. This document consists of a number of recommendations to any technology development so that the needs of vulnerable people were taken into account. This Guideline reminds of the importance of the perceivability, the operability, the understandability, and the robustness of the websites, which might be used by people with special needs. WCAG 2.0 is now the basis for accessibility laws in a number of countries the European Union, the United Kingdom, and Japan [11]. The current version of WCAG 2.0 became an ISO/IEC 40500:2012 standard in October 2012 [15].

4.1 The model of WCAG 2.0

The model of WCAG 2.0 guidance in [9] is given as a tuple M [8]. One of its components is a set of principles of web content accessibility. Such set $P=\{p_1, p_2, p_3, p_4\}$ presents the perceivability (p_1), operability (p_2), understandability (p_3), and robustness (p_4). The elements of the set of guidelines of web content accessibility $G=\{g_1, \ldots g_{12}\}$ are text alternatives ($g_{1.1}$), time-based media ($g_{1.2}$), adaptability ($g_{1.3}$), distinguishability ($g_{1.4}$), keyboard accessibility ($g_{2.1}$),

enough time ($g_{2.2}$), seizures ($g_{2.3}$), navigability ($g_{2.4}$), readability ($g_{3.1}$), predictability ($g_{3.2}$), input assistance ($g_{3.3}$), and compatibility ($g_{4.1}$).

The set C of success criteria of web content accessibility consists of four subsets, described in [8]:

$$C_1=\{c_{1.1.1}, c_{1.2.1}, c_{1.2.2}, c_{1.2.3}, c_{1.3.1}, c_{1.3,2}, c_{1.3.3}, c_{1.4.1}, c_{1.4.2}, c_{2.1.1}, c_{2.1.2}, c_{2.2.1}, c_{2.2.2}, c_{2.3.1}, c_{2.4.1}, c_{2.4.2}, c_{2.4.3}, c_{2.4.4}, c_{2.4.5}, c_{3.1.1}, c_{3.2.1}, c_{3.2.2}, c_{3.3.1}, c_{3.3,2}, c_{3.3.4}, c_{4.1.1}, c_{4.1.2}\};$$

$$C_2=C_1U\{ c_{1.2.4}, c_{1.2.5}, c_{1.4.3}, c_{1.4.4}, c_{1.4.5}, c_{2.4.6}, c_{2.4.7}, c_{3.1.2}, c_{3.2.3}, c_{3.2.4}, c_{3.3.3}\};$$

$$C=C_2\,U\{ c_{1.2.6}, c_{1.2.7}, c_{1.2.8}, c_{1.2.9}, c_{1.4,6}, c_{1.4.7}, c_{1.4.8}, c_{1.4.9}, c_{2.1.3}, c_{2.2.3}, c_{2.2.4}, c_{2.2.5}, c_{2.3.2}, c_{2.4.8}, c_{2.4.9}, c_{2.4.10}, c_{3.1.3}, c_{3.1.4}, c_{3.1.5}, c_{3.1.6}, c_{3.2,5}, c_{3.3.5}, c_{3.3.6}\}.$$

Such a model can be conceptually presented as a tree (fig. 3).

We used different colors to underline that to fulfill the higher level of the conformance, one should beforehand cover the demands of the lower level.

Let us consider the evaluations of the above-mentioned websites to find out the level of its conformance to WCAG 2.0 criteria. To do so, we used a Web accessibility evaluation tool *www.achecker.ca* (fig. 3) [11, 16].

4.2 Web content accessibility evaluation (Level AA)

We evaluated all the websites of the libraries, listed in Table 1 to check them on compliance to AA level of WCAG 2.0. There was no possibility to evaluate the Lib.21 and Lib.22 websites by *AChecker*. As the diagram (Fig. 4) shows, the most errors in the analysis of regional universal scientific libraries websites of Ukraine at the secondary level (AA) were found on the website of a regional universal scientific library named after. D. Chizhevsky (Lib. 7) – 8 errors, Volyn state regional universal scientific library named after Olena Pchilka (Lib.2) and Dnipropetrovsk regional universal scientific library named after the Saints Cyril and Methodius – 10 errors.

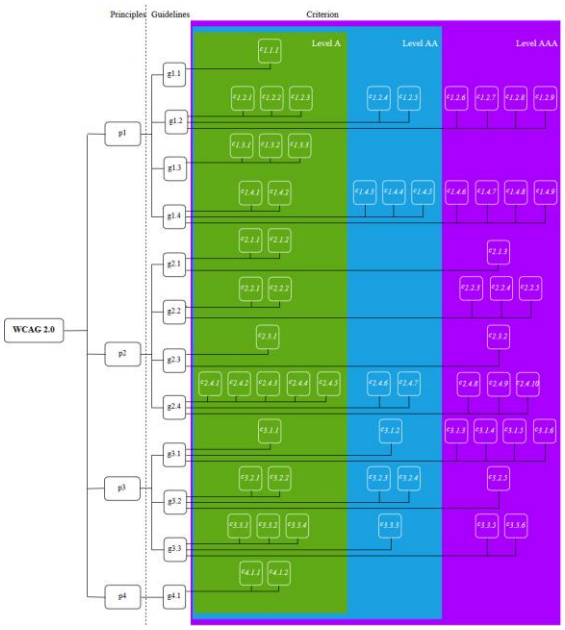

Fig. 3. The Conceptual Model of the WCAG 2.0 Guideline

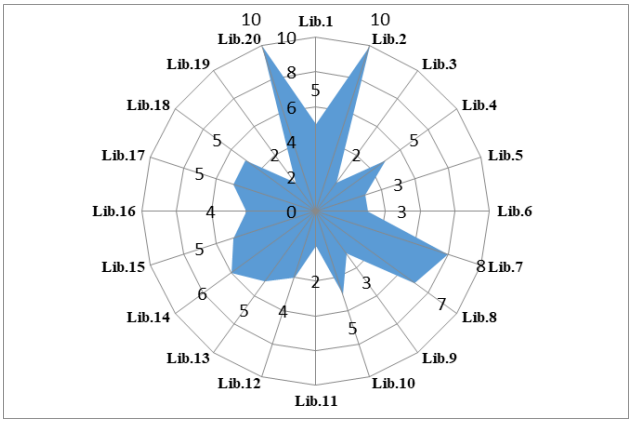

Fig. 4. The number of errors in the analysis of the level AA compliance (by AChecker)

The lowest error rate was recorded on the website of Zhytomyr regional universal scientific library named after Oleg Olzhich (Lib.3), Rivne regional universal scientific library (Lib.11) and Luhansk regional universal scientific library named after M. Gorky (Lib.19), two errors each.

Let us consider the most common errors (Table 3) and their level (Fig. 5).

The most common error c1.1.1. means that in 90% of the evaluated websites there were paid not enough attention to presenting a text alternative to visual information on the site.

In Fig. 6 we presented the schematic presentation of the found incompliance to the WCAG 2.0 AA level (compare with Fig. 4). The criteria which do not meet success are marked in white.

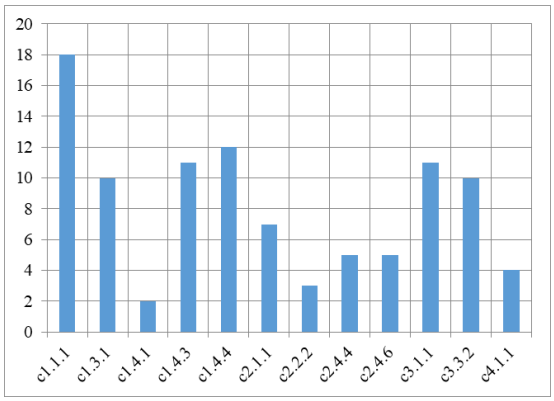

Fig. 5. The level of the most common criteria that do not meet success

Let us compare these results, achieved in [8], where the current state of compliance of web products, relevant to people with special needs was analyzed. In [8] we analyzed the websites, connected to after-school education, meaning, the 613 websites of the higher education institutions of the I-II levels of accreditation, including technical schools, colleges, and other institutions of higher education equivalent to them. The web products were tested to evaluate whether they conform to level AA of WCAG 2.0 demands.

Table 2. The MOST COMMON CRITERIA THAT DO NOT MEET SUCCESS

Criterion denotation (Web access. criterion)	Explanation
$c_{1.1.1}$ (Non-text Content)	All non-text content that is presented to the user has a text alternative that serves the equivalent purpose, except for the situations listed below
$c_{1.3.1}$ (Info and Relationships)	Information, structure, and relationships conveyed through presentation can be programmatically determined or are available in text
$c_{1.4.1}$ (Use of Color)	Color is not used as the only visual means of conveying information, indicating an action, prompting a response, or distinguishing a visual element
$c_{1.4.3}$ (Contrast (Minimum))	The visual presentation of text and images of text has a contrast ratio of at least 4.5:1
$c_{1.4.4}$ (Resize text)	Except for captions and images of text, text can be resized without assistive technology up to 200 percent without loss of content or functionality
$c_{2.1.1}$ (Keyboard)	All functionality of the content is operable through a keyboard interface without requiring specific timings for individual keystrokes
$c_{2.2.2}$ (Pause, top, hide)	For moving, blinking, scrolling, or autoupdating information, there is a mechanism for the user to pause, stop, or hide it unless the movement, blinking, or scrolling is part of an activity where it is essential; and there is a mechanism for the user to pause, stop, or hide it or to control the frequency of the update unless the auto-updating is part of an activity where it is essential
$c_{2.4.4}$ (Link Purpose (In Context))	The purpose of each link can be determined from the link text alone or from the link text together with its programmatically determined link context, except where the purpose of the link would be ambiguous to users in general
$c_{2.4.6}$ (Headings and Labels)	Headings or labels describe topic or purpose
$c_{3.1.1}$ (Language of Page)	The default human language of each Web page can be programmatically determined
$c_{3.3.2}$ (Labels or Instructions)	Labels or instructions are provided when content requires user input
$c_{4.1.1}$ (Parsing)	In content implemented using markup languages, elements have complete start and end tags, elements are nested according to their specifications, elements do not contain duplicate attributes, and any IDs are unique

Of 61 criteria in WCAG 2.0, 38 are conforming web accessibility of the AA level (not to forget that conforming AA level means conforming an A level, as well). Out of 38 accessibility criteria, 30 were fully realized in all of 613 analyzed websites. Fig. 7 visually compares the results of regional universal scientific libraries websites and the higher education institutions of the I-II levels of accreditation websites.

The most common mistakes (after both analysis) was the was the c1.1.1. According to numerical results, this error takes 18 % of all errors in regional universal scientific libraries websites research and over 25 % of all errors in higher education institutions of the I-II levels of accreditation websites research.

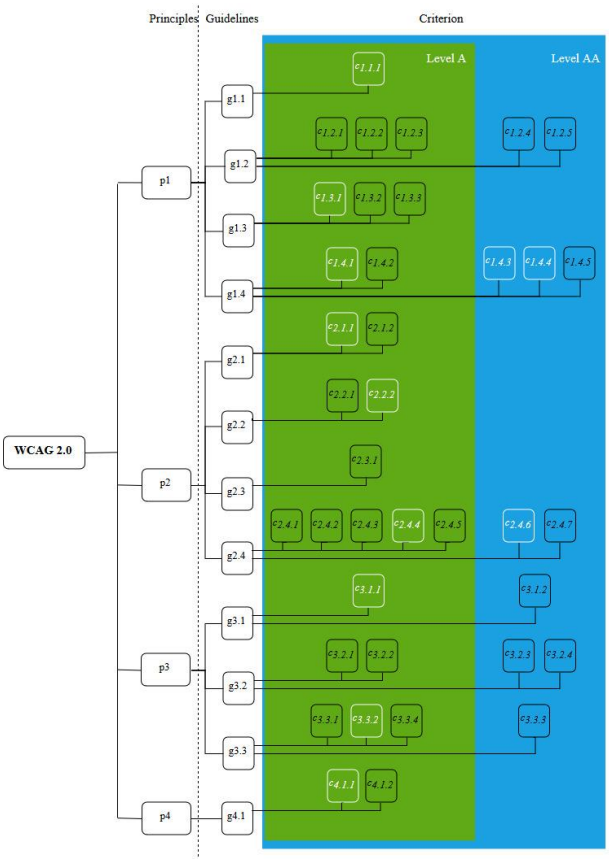

Fig. 6. The most common criteria that do not meet success

4.3 Web content accessibility evaluation (known, likely, and potential problems)

Let us evaluated all the websites of the libraries, listed in Table 1, to compare the number of errors, proposed by *AChecker* for A, AA and AAA level of compliance to WCAG 2.0 demands (fig. 8).

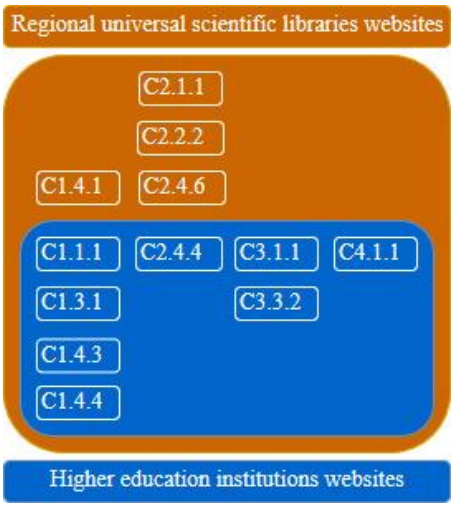

Fig. 7. The most common WCAG 2.0 criteria that do not meet success

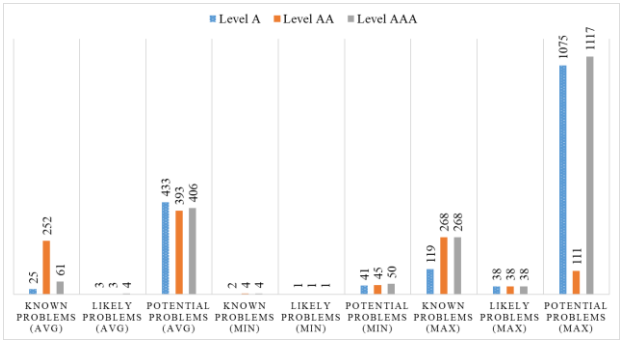

Fig. 8. The number of known, likely, and potential problems for A, AA and AAA level of WCAG 2.0

The highest rate if known problems was detected for the website of Dnipropetrovsk regional universal scientific library named after the Saints Cyril and Methodius (Lib.20) – 268, and the least level have websites Ivano-Frankivsk regional universal scientific library named after I. Franko (Lib.6) and Rivne regional universal scientific library (Lib.11) – 4 errors each.

The highest number of likely problems (38) was detected on the website of a regional universal scientific library named after D.I. Chyzhevsky (Lib.7).

The potential problems analysis states that the largest number of such problems (1111) was detected on the website of Mykolaiv regional universal scientific library (Lib. 9), and the least number (45) was detected for Ivano-Frankivsk regional universal scientific library named after I. Franko (Lib.6), fig. 9.

V. REQUIREMENTS TO THE SOCIAL WEBSITES CHARACTERISTICS

In 2015, the State Decree of Ukraine [17], which regulates the functioning of the executive authorities' websites since 2002, was updated in order to comply with actual demands and needs of citizens. This updated decree in seven sections describes the main characteristics of the websites, following which allows to standardizing:

- the classification of information materials, presented at the website,
- the structure of information materials,
- the information structure of the website,
- the design of the website,
- the efficiency of the information (in the state and other languages),
- the availability of information for users with visual and hearing impairment [22; 23] on the main or alternative (if any) version of the official website [24].

Such detailed demands, listed and described in the Decree, are to fulfill the needs and demands of Ukraine's citizens and guests, who want or need to contact the executive authorities. Such needs and demands are also inherent for people, who seek help or information from different institutions, both social and governmental. That is why, the authors analyzed the demands, proposed in the Decree and in [8, 18-20], to outline those characteristics of the websites, which will be suitable for institutions of PMPCs websites, as well as libraries websites. We propose a set of characteristics, which social institutions, such as PMPC and libraries websites [21] should accord, and presented it in Table 4 (with appropriate denotations). Note, that ergonomic of the websites we evaluated in [9] according to six characteristics, entered this classification, as well (M4.1-M4.6 in Table 4).

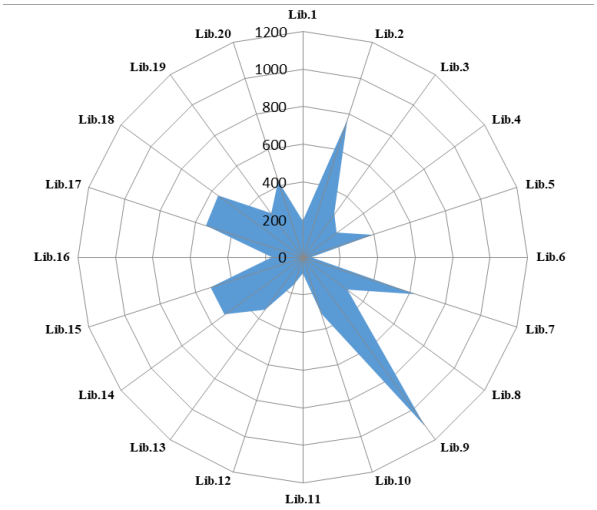

Fig. 9. The number potential problems for regional universal scientific libraries

The conception of such website characteristic list can be also presented in a graphical form, as at fig. 10.

In our future researches, these characteristics will become a basis to the research of websites and different online resources, which might be of interest to the person with special needs during the social and educational inclusion. After conducting such research, it will be possible to standardize demands to social-connected websites. Such demands should become well-known and widely applied, and that will support the idea of universal design in information and communication technologies.

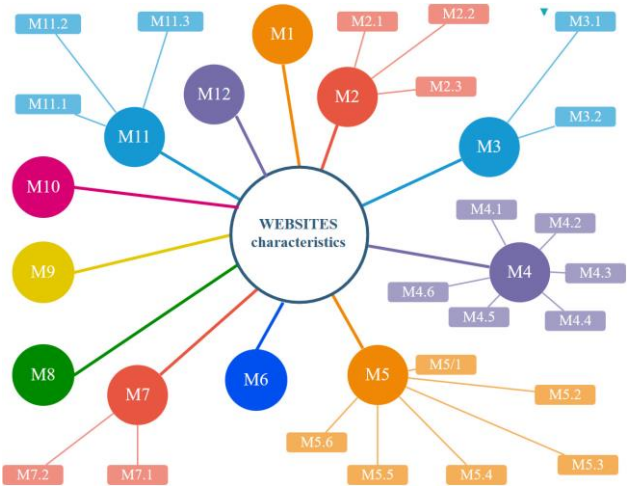

Fig. 10. Graphical representation of the set of characteristics for social institutions websites

Table 3. ESSENTIAL CHARACTERISTICS OF THE WEBSITES FOR SOCIAL INSTITUTIONS

Denot.	Website characteristics
M1	Availability of information on the institution's website for viewing through various browsers
M2.1	Availability of static information materials, which should keep their relevance over a long period of time, such as legislative acts, international standards, etc.
M2.2	Availability of dynamic information materials, the relevance of which is kept only for a limited time, such as an events calendar
M2.3	Availability of stream information materials, which lose relevance during a short period of time (several days, and sometimes hours), such as news
M3.1	Representation of the information according to the competence of the institution (directions of activity, a review of modern methods, etc.)
M3.2	Representation of the information about the institution (the legal basis of the institution, the structure of the institution, etc.)
M4.1	General composite rules for websites creation, that are basic for UI / UX (modular content positioning system Modular Grid pattern, Golden Section rule and Fibonacci proportion), which allows focusing on the main and contributes to the perception of content
M4.2	Infographic (information graphics) filling of particular sections of the site with the graphical visual representation of information, data or knowledge intended for the quick and accurate display of complex information
M4.3	The presence of interactive animation and video content
M4.4	A harmonious combination of color schemes (color schemes & palette) that must be presented so as not to violate the basic patterns of color influence on the psychological response of the user
M4.5	Responsive web design, that provides optimal mapping and interaction with the user regardless of the resolution and format of the device, the page is viewed at (tablet, smartphone, etc.)
M4.6	Availability of convenient and intuitive forms of feedback, support for thematic forums.
M5.1	The presence on the site of links to official sites of the authorities under the authority of which the institution is located;
M5.2	The presence on the site of links to web resources of the structural divisions of the institution
M5.3	The presence on the site of links to web resources of local and sectoral institutions, enterprises, organizations, which are within the competence of the institution
M5.4	The presence on the site of links to sites of international organizations with which the institution co-operates
M5.5	The presence on the site of links to resources, the profile of which is within the competence of the institution
M5.6	The presence on the site of links to sites of associations of citizens who exercise public control over the activities of the institution or have a common focus on activities
M6	Availability of the search engine.
M7.1	Availability of digital services, such as an entry to the specialist of the institution traffic information
M7.2	Availability of digital services, such as traffic information
M8	The contact information of structural subdivisions and/or officials responsible for software, technical and information support of websites
M9	Availability of website content in different languages
M10	Presence of a sitemap
M11.1	Availability of special interactive features, such as the opportunity to ask questions and get answers to it in real time
M11.2	Availability of special interactive features, such as the possibility of commenting
M11.3	Availability of special interactive features, such as the possibility of data personalization (personal cabinet);
M12	An absence of advertising (except the social one) and no access to paid services

VI. CONCLUSIONS

People with special needs are part of a modern informational society, which is mentioned in plans for future European development. The social and educational inclusion became a complex system, with, among other, large number of components and diverse resources, involved in the processes of the system. Make all the components of such a system friendly for people with special needs is a task of universal design. The demands of such design, applied to ICT, are generalized in *Web Content Accessibility Guidelines.*

To evaluate the website, which can be useful for a person with special needs, we used the SimilarWeb online tool to measure and analyze the behavioral models of sites. To check whether the websites are designed according to web accessibility demands, we used the AChecker online tool. Such evaluation was conducted for the set of universal scientific libraries websites of Ukraine sites. It appeared, that none of the sites was designed according to WCAG 2.0 demands. The most common problem of the analyzed websites (over 90%) was the lack of presenting a text alternative to visual information on the site.

In Ukraine, we have official demands to the executive authorities' websites. Authors suggested almost 30 characteristics of the websites for social institutions, according to the demands and needs of socially vulnerable people. Such characteristics will be used to assess websites, which are interesting and necessary for people, involved in social and educational inclusion.

VII. REFERENCES

1. **Annex to the proposal for a council recommendation on key competences for lifelong learning**. 2019. Available at: https://ec.europa.eu/education/sites/education/files/annex-recommendation-key-competences-lifelong-learning.pdf.

2. **Horizon 2020 work programme 2014-2015**. Available at: http://ec.europa.eu/research/participants/data/ref/h2020/wp/2014_2015/main/h2020-wp1415-societies_en.pdf.
3. **Pasichnyk V. Shestakevych T.** 2016. The model of data analysis of the psychophysiological survey results. Advances in Intelligent Systems and Computing, vol.512: 271-281.
4. **Campean F. and Yildirim U. 2017.** Enhanced sequence diagram for function modelling of complex systems. In: Procedia CIRP, vol. 60: 273-278. Available at: http://www.sciencedirect.com/science/article/pii/S2212827117300549.
5. **Kożuch B., Sienkiewicz-Małyjurek K. 2015**. Information sharing in complex systems: a case study on public safety management. In: Procedia – Social and Behavioral Sciences, vol. 213: 722-727.
6. **Luis E.C. Rocha. 2017.** Dynamics of air transport networks: a review from a complex systems perspective. Chinese Journal of Aeronautics, vol. 30(2): 469-478.
7. BS 7000-6:2005 Design management systems, Part 6: Managing inclusive design guide.

Available at: https://www.researchgate.net/publication/240989498_BS_7000-62005_Design_management_systems_Part_6_Managing_inclusive_design_guide_Book_review.

8. **Shestakevych T., Pasichnyk V., Kunanets N., Medykovskyy M., and Antonyuk N. 2018.** Web-products, actual for inclusive school graduates: evaluating the accessibility. In: XIIIth International Scientific and Technical Conference Computer Sciences and Information Technologies (CSIT): XXVII-XXXII.
9. **Pasichnyk V., Shestakevych T., Kunanets N., Andrunyk V. 2018.** Analysis of completeness, diversity and ergonomics of information online resources of diagnostic and correction facilities in Ukraine. In: 14th International Conference on ICT in Education, Research and Industrial Applications. Integration, Harmonization and Knowledge Transfer (ICTERI), vol. I: 193-208.
10. **Abid Ismail, K.S. Kuppusamy, Ajit Kumar, Pawan Kumar Ojha 2017.** Connect the dots: accessibility, readability and site ranking – an investigation with reference to top ranked websites of Government of India, Journal of King Saud University. In: Computer and Information Sciences. Available at: http://www.sciencedirect.com/science/article/pii/S1319157816301550, last accessed 2018/04/27.
11. **Youngblood S., Youngblood N. 2018.** Usability, content, and connections: how county-level Alabama emergency management agencies communicate with their online public. Government Information Quarterly, vol. 35, iss. 1: 50-60.
12. **Yoon K., Dols R., Hulscher L., Newberry T. 2016.** An exploratory study of library website accessibility for visually impaired users. Library & Information Science Research, vol. 38, iss. 3: 250-258.
13. **Rzheuskyi A., Kunanets N., Kut V.** 2017. Methodology of research the library information services: the case of USA university libraries. Advances in Intelligent Systems and Computing II, 2017, vol. 689: 450–460.
14. SimilarWeb. Available at: https://www.similarweb.com/.
15. Information technology - W3C Web Content Accessibility Guidelines (WCAG) 2.0. Available at: https://www.iso.org/standard/58625.html.
16. **Andrunyk V., Shestakevych T., Pasichnyk V. 2018.** The technology of augmented and virtual reality in teaching children with ASD. Econtechmod. Vol 7, no 4: 59-64.
17. On approval of changes to the procedure for the functioning of web-sites of bodies of executive power, Ukraine stare decree, 16.02.2015 № 24/26. Available at: http://zakon.rada.gov.ua/laws/show/z0240-15.
18. **Müller-Brockmann J. 2008.** Grid systems in graphic design: a visual communication manual for graphic designers, typographers, and three dimensional designers, Zurich: Verlag Niggli AG.
19. **Marcotte E. 2011.** Responsive web design. A Book Apart LLC, New York.
20. Designing autism-friendly websites. The National Autistic Society. Available at: http://www.autism.org.uk/professionals/others/website-design.aspx.
21. **Rzheuskiy A., Veretennikova N., Kunanets N., Kut V. 2018.** The Information Support of Virtual Research Teams by Means of Cloud Managers. International Journal of Intelligent Systems and Applications(IJISA), Vol.10, No.2: 37-46.
22. **Lytvyn V., Vysotska V., Peleshchak I., Rishnyak I., Peleshchak R. 2018.** Time Dependence of the Output Signal Morphology for Nonlinear Oscillator Neuron Based on Van der Pol Model. International Journal of Intelligent Systems and Applications(IJISA), Vol.10, No.4: 8-17.
23. **Izonin I., Trostianchyn A., Duriagina Z., Tkachenko R., Tepla T., Lotoshynska N. 2018.** The Combined Use of the Wiener Polynomial and SVM for Material Classification Task in Medical Implants Production. International Journal of Intelligent Systems and Applications(IJISA), Vol.10, No.9: 40-47.
24. **Peleshko D., Rak T., Izonin I. 2016.** Image Superresolution via Divergence Matrix and Automatic Detection of Crossover. International Journal of Intelligent Systems and Applications (IJISA), Vol.8, No.12: 1-8.