Methodology for the implementation of web standards to the activities of academic libraries

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Abstract: Information technology has already been introduced in almost all human activities, allowing them to significantly improve their performances. Libraries are actively introducing modern information technologies into their work through digital transformation, which allows them to offer more opportunities and knowledge to readers. Information technologies certainly help to increase the level and quality of library services, increase labor productivity, and optimize many work processes. All these arguments will make any library more efficient in business processes. Despite the huge amount of different information on the Internet, all of it is disordered and not always users can independently find the necessary material on necessary topic, even spending a lot of his time on it. That is why, at the moment, there is a huge need to prove to students that the library is an indispensable place through a modern approach, for high-quality training and the provision of necessary and useful materials. The implementation of information technology and the gradual transition to the Library 3.0 and Smart Library standards have a positive effect on library attendance, rapidly increasing it. Attracting social networks and web resources allows to popularize the library among users and is also a huge factor in improving overall statistics.

Keywords: computing information technology, project management, libraries, web standards, cloud technologies, library standards.

1. Introduction

The concept of benchmarking or comparative analysis became very popular and needed not only in private institutions, but also in public, especially in the academic library sector. Scientific organizations, centers, libraries are the starting point of research and must follow modern and relevant requirements and trends. Investigation of the experience of other countries that have implemented benchmarking results in the past help to understand main points in order to solve the problem. It became clear that there are specific principles and practices of quality management that improve the quality of effective services and reporting.

“Rank Xerox” company is most often associated with successful testing methods. For the first time, “Rank Xerox” began to purposefully use benchmarking at the time of the severe crisis in 1979 to analyze the costs and quality of its own products in comparison with Japanese ones. Comparative analysis is now widely used and is considered one of the main factors influencing the improvement of the company (DiGiovanni, 2020). Therefore, it is not surprising that the methodologies currently used are based on their approach.

Information today can be seen as a commodity, this is due to the huge demand, which is focused on research ratings and the number of students. If the library staff wants to improve the quality of existing services, focus on internal processes, eliminate and identify procedures that have no value, reduce the amount of unnecessary paperwork - benchmarking is an ideal tool for these tasks (Cai, 2018).

Given that there is competition between libraries, the analysis will allow the library to compare its level and performance with other similar institutions. In the process of analysis, can be found weaknesses that need to be refined and studied to improve the quality of service. Most of these weaknesses require a very small budget, and efforts to adjust, but without comparative analysis they can be detected only with time.

In 2021 libraries will need to intensify their efforts to maintain users, because they will take advantage streaming and virtual data from competing organizations. Efforts at building relationships with clients, which attracts members of the library during their journey, will be the key to saving readers. The main advantage of personalized marketing is the control over targeted

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and selective readers of libraries of all kinds. By collecting user data from these lists in Customer Relation Management (CRM), person get more opportunities to create more relevant and effective companies based on the habits, interests and behavior of customers.

Omnichannel library marketing is a marketing practice that uses multiple platforms to communicate, including participant email, newsletter, applications, social networks, and ads on your website. This approach allows libraries to communicate with members in several digital endpoints, effectively offering the best experience for the participants (Kinnell & Garrod, 1995).

Undoubtedly, the work of libraries is influenced by the development of the World Wide Web. It is divided into three phases, each of them has its own characteristics. The first phase is known as Web 1.0. This phase of the Internet had only one-way communication between the user and the website. Since 2003, a new phase has appeared - Web 2.0; the user was able to leave feedback online and received at least some communication. Now humans exist in the third phase of the Internet - Web 3.0 that is called the semantic network or intelligent network. Users are able to communicate and receive feedback; they completely changed the interface of web resources, which became integrated. The machine is able to understand and catalog data in a human way. The emergence of the third phase contributed to the creation of a global data warehouse, which uses different formats of information (The Ivy Group, 2020).

Despite the seemingly logical and understandable components, there are no standardized characteristics of all existing web and library standards that would be used as basic worldwide. All available parameters and characteristics are usually freely interpreted by those who represent them, but of course, they all in one way or another reproduce the general meaning.

2. Material and methods

On library resources, which was developed by using semantic web technologies or factor analysis, it is easier for users to find, access and receive educational and scientific materials. Scientific organizations' web applications should provide access to catalogs, repositories of materials and data that are available in various formats.

Adoption and implementation of technologies allowed to share and reuse resources with the help of ontologies, which provide better library services.

Referring to the usual records of the bibliographic catalog, we can outline how important the transition from the volume of available documents to the amount of related data that characterizes the semantic. Unfortunately, now the library does not use all the power of the Internet, hiding the contents of their databases in the internal LANs.

Through semantic schema, libraries can bind bibliographic data publications provided their publishers, with other data. Thus, data published by other people or libraries about a particular publication can be reused. The library can provide selected information to its readers on the website, adapted to their needs.

Libraries should participate in the semantic schemes to remain visible in the future knowledge society. In addition, libraries can develop resources and innovative services for their users, such as improved search functions, based on semantic network technologies, (Borst et all, 2013), (Ydagiri & Ramesh, 2013).

Since the 1990s, web technologies have been widely used and have a huge impact on the services of academic libraries. Academic libraries are deploying platforms for integrated library services and web technologies to provide an interactive, semantic, and responsive interface through search technologies, electronic resources, audiovisual tools, blogs, and social networking sites.

In 1993, made public the WWW technology. In 1994, Tim Berners-Lee (Berners-Lee, 2017) founded the World Wide Web Consortium (W3C), an organization that develops technical standards for the Internet. The era of Web 1.0 has begun. With the advent of websites, content that was previously scheduled on radio and TV has become available at any time from any computer connected to the Internet. Berners-Lee described Web 1.0 as a read-only web. This characteristic

reflects the fact that the information was presented on static pages. Most users consumed content posted online by a minority. The network was filled with simple resources: sites with ads, online store catalogs, thematic forums and personal pages. The ability to comment on the content was limited to a separate guest page on the site, and comments had to be sent using an email client.

The early World Wide Web was a chaotic decentralized system of many independent computers that communicated directly with each other through modems and telephone networks. Later, Internet connection became more accessible thanks to centralized ISPs and dedicated lines. Powerful personal computers have become more accessible to users. DHTML and AJAX technologies have emerged, on which modern web applications are based.

Table 1. Comparative analysis of Web standards

	Web 1.0	**Web 2.0**	**Web 3.0**
Year	1996	2006	2016
Title	The Web	The Social Web	The Semantic Web
Type	Read-only	Read-write	Read-write-execute
Content type	Text, graphic information	2D portals, personal blogs, videos	3D, user avatar, profit, multiplayer virtual environment, integrated games, education and business
Aim	Companies publish content that people consume	People publish content that other people can consume, companies create platforms that allow people to pub-lish content to other people (e.g. Flickr, YouTube, Adsense, Wikipedia, Blogger, MySpace, RSS, Digg)	People create applica-tions that other people can interact with, com-panies create platforms that allow people to publish services using links between people or special content (e.g. Facebook,Google Maps)
Communication type	Message boards	Portals	Semantic forums and portals: SIOC, OpenLink DataSpaces
Communication network	Friends lists, address book	Social networks	Semantic social networks: FOAF, People Aggregator
Share content between websites type	HTML / Portals	XML / RSS	RDF / RDFS / OWL
Use of Artificial Inteligence (AI)	Lack of AI	Lack of AI	Presence of AI
Messaging notification	Web servers	Instant messaging	Personal intelligent digital assistants
Framework type	Enterprise portals	JavaScript frameworks	Semantic Digital Libraries
Type of connection	Dial-up, Cable	Dial-up, Wi-Fi Hotspot	Wi-Fi Hotspot, Mobile

The main innovations of the next era were not in technology, but in ways to use technology. Darcy DiNucci first used the term Web 2.0 in 1999 (DiNucci, 1999). By Web 2.0, DiNucci meant the future of the network, in which HTML and hyperlinks are used by many different devices. Today, these ideas rather describe the technology of the Internet of Things, and the term Web 2.0

has taken on a new meaning. The next development round of the concept began after the first Web 2.0 Conference in 2004. Then in their reports Dale Dougherty (Thomas, 2009) and Tim O'Reilly (O'Reilly, 2005) known publishers described the new website as a platform for applications and that the value of content is generated by users. Web 2.0 is now a network of interactive websites and platforms where content is produced by users, by the owner of the resource. Facebook, YouTube and Twitter are platforms of the Web 2.0 era focused on user-friendly content and social interactions.

The mobile revolution of the early 2000s gave us handheld computers able to record and publish content. Websites created for viewing content on mobile devices have appeared. The lack of binding to the desktop with a home PC along with location sensors in smartphones has opened a niche for geolocation services. Mobile applications and platforms for their distribution have appeared. Crowdfunding projects like Kickstarter and IndieGoGo have become popular on the new web. With publicly available content distribution tools, it has become easier to convey messages to others around the world. As a result, the concepts for describing new social phenomena in the network have become entrenched in everyday use: "trolling", "flood" and "spam". The era of Web 2.0 has been going on since the mid-2000s, but ideas about the next stage of network development - Web 3.0 - were formed in the first ten years of the World Wide Web (Aslam & Sonkar, 2019).

The first central idea of Web 3.0 is the semantic web. Tim Berners-Lee, first described the semantic web in 1994 (Berners-Lee, 2017). Later, his paper (Berners-Lee et al., 2001) in Scientific American brought the idea popularity in the Internet community, and the concepts of "Web 3.0" and "semantic web" became almost interchangeable. Nowadays semantic web is one of the core technologies. In 2007, the author of the modern term Web 2.0, Tim O'Reilly, distinguished between the concepts of Web 3.0 and the semantic web (O'Reilly, 2005). O'Reilly described Web 3.0 as the interaction between the Internet and the offline world. This interaction is realized through sensors and smart devices - that is called "the Internet of Things." In addition to the progress of technology, a new era of network means social and economic change (Ahmed & Zia, 2019).

Web 3.0 is a web infrastructure with several basic technologies: blockchain, machine learning and AI, the semantic web and the Internet of Things. Each of these technologies is an integral part of the future network with its role in the ecosystem.

The essence of this concept is to make all the information on the network readable and "understandable" for machines. To implement the semantic web of all information in the network you need to assign metadata - information about information. Thanks to metadata, the algorithm can "understand" the context, build logical relationships between blocks of information and form associations, almost like humans. A key element in the implementation of semantic web from the W3C is a set of specifications of Resource Description Framework - a model for describing information through special understandable approval machines. The triplet consists of three parts: "subject", "predicate" and "object". These statements can describe anything: a person, a web application or a piece of music. One of the RDF implementations is the Dublin Core. This is a database of English language concepts to describe any digital or physical resource such as a YouTube video or printed book. Popular e-book format *.epub* uses Dublin Core metadata for presentation files OPF.

Table 2. Comparative analysis of libraries standards

Library 1.0	**Library 2.0**	**Library 3.0**	**Library 4.0**
Based on Web.1.0	Based on Web.2.0	Based on Web.3.0	Intellectual library
Closed storage	Open access to books	Virtual help service	Massive data library. Cloud computing, such as integrated library resource management, remote access to resources and services

Services available only within the library	Services are available everywhere. Electronic subscrip-tion management systems, simultaneous search of all electronic resources	Librarian 3.0 (serves the user via the Internet)	Context-dependent library. Wayfinder, book status infor-mation, MyLibrary features
Traditional electronic catalog	Catalog with the ability to add com-ments, a selection of books, rss	Mobile library	Augmented reality.
Newsletter	RSS-stream	Mobile OPAC (online public access catalog)	Advanced recognition capabilities.
Helpline by phone	Virtual help service	QR codes	Creative space (Makerspace)
Individual library activities	Participation in corporate projects	Cloud computing	
	Bar code	RFID	Geotagging
	Library website	The library has a «space» in social net-works, virtual worlds, creates and maintains its blogs and wikis.	Personalized library ("My library")

Machine learning is a system of methods and algorithms used by the computer to solve problems without explicit solving instructions. The algorithm learns to perform a specific task. It analyzes the data set, independently detects patterns in them, that are then used in the respective task.

Blockchain is a distributed database technology. The information in the blockchain is written in a chain of blocks connected in a strictly defined sequence. The blockchain-based system is able to operate without central administration and trust between participants. Instead of the director, decisions in such a system are made by voting. And the actions of the participants are subject to the protocol of consensus - a set of rules for creating and writing blocks to the register. Blockchain technologies play the role of a connecting element of the Web 3.0 ecosystem. Distributed registry is the basis of a decentralized network infrastructure in which web applications can share information. Due to decentralization, the transition to Web 3.0 can solve the problems of non-transparency of web services, network censorship and privacy of personal data. An open public register provides transparent reporting. Without central authority, one participant cannot impose a decision on others or gain access to someone else's encrypted data.

The number of components is based on the principles of factor analysis, which uses the orthogonal transformation of a set of observations with possibly related variables.

Thus, the standards that are implemented in the activities of the library directly depend on the development of web technologies.

Web applications and social networks are widely used to empower users, and for online information that leads service delivery to the next level. Information marketing, user engagement and outreach strategies became indispensable, respectively web content libraries and social networking tools have been organized into a single workflow process for managing library websites as information hubs.

Linking information Web 1.0, Web 2.0 user experience and Web 3.0 is the process of combining knowledge and their impact on the academic libraries, which allow to use of intelligent agents and interactive multi-application system for productive and intuitive user experience. Web 3.0 is conceptualized as a modernization of third-generation technology for the period 2010-

2020, and is mainly characterized by semantics - common sense and intelligence.

As a collaborative interactive platform, Web 3.0 includes a set of tools that contains markup data, crowdsourcing content, data mining and machine learning, the basic structures and architecture of the Internet to establish semantic connections so, that machines understand and interpret what people want - contextual, relevant results.

3. Experiment and results

It is logical that, on implementing any concept, it is necessary to perform testing not only on theoretical data, but also on real ones. As test data was selected information (reports received from 2017 to 2020) on the activities of the Scientific and Technical Library of Odessa National Academy of Food Technologies (Zinchenko, 2020); for example: funds, user capabilities, number of PCs, number of digitized copies, access to scientific databases, etc.

Currently, this library is in the phase of transition from the standard of Library 2.0 to the stage of Library 3.0, with the introduction of Web 3.0 technologies. The analysis was based on the comparison of these two standards and showed how much influence has implemented standards for work and libraries and their performance.

The Web 3.0 phase for academic libraries is based on the scientific, social, and semantic web architecture and data model (see Figure 1).

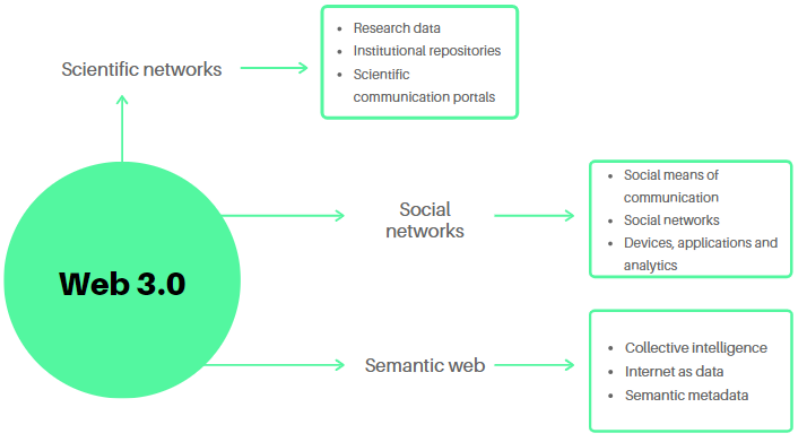

Figure 1. Web 3.0 phase components

Research on UX / YI library websites were based on web page structure, usability, navigation, user interface design, functionality, and decentralization of content development.

The scenario of passing to the Web 3.0 phase for libraries that are in the transition phase of Library 2.0 reflects the transitions of academic librarianship in the following key elements (see Table 3) (Balaji et al., 2018).

Table 3. Transition from Web 2.0 to Web 3.0 standards

Web 2.0	**Web 3.0**	**Involvement**
Keepers of information	Information intermediaries	Librarians must help users to find information on the Internet and to process this information. The librarian is not a simple custodian.This is the process of converting from "where to find" to "how to use"
Social Web	Semantic/Mobile Web	Mobile devices, applications, open access channels / spaces of scientific communication, supplemented by semantic infrastructure

Information repositories	Comprehensive (integrated) search	One window to search for the entire amount of information, the presence of a meta-search
Subject librarianship	Functional support	Repositioning libraries with new functional roles is discussed. For example, research data management.
Web accessibility	Web adaptability	Web standards will evolve to be more inclusive, with a reliable web architecture for easy maintenance.

Based on the information presented above and with the involvement of the principal components method, component-parametric systems were built with the subsequent indication of transient data and characteristics.

The proposed characteristic of the standards and phases of the Web presented in Table 4, despite the standard, ~~it~~ can be scaled, in terms of both parameters and components that describe them. All parameters and components are marked by the prefix *sw*.

The numbers next to the standard is a parametric element which is a prefix and a suffix. The prefix is the number of the standard, and the suffix is the position of the element obtained as a result of the benchmarking characteristic. This encryption is used for web, science and library standards.

Table 4. Table of Web standards

Standard 1.0				**Standard 2.0**				**Standard n.0**			
Parameter: sw1.01				Parameter: sw2.01				Parameter: swn.01			
sw1.01	sw1.02	...	sw1.n	sw2.01	sw2.02	...	sw2.n	swn.01	swn.02	...	swn.n
Parameter: sw1.1.01				Parameter: sw2.2.01				Parameter: swn.n.01			
sw1.1.01	sw1.1.02	...	sw1.1.n	sw2.2.01	sw2.2.02	...	sw2.2.n	swn.n.01	swn.n.02	...	swn.n.n
Parameter: sw1.n.01				Parameter: sw2.n.01				Parameter: swN.N.01			
sw1.n.01	sw1.n.02	...	sw1.n.n	sw2.n.01	sw2.n.02	...	sw2.n.n	swN.N.01	swN.N.02	...	swN.N.N

The proposed characteristic of Library standards and phases presented in Table 5, despite the standard, can be scaled, in terms of both parameters and components that describe them. All parameters and components are marked by the prefix *sl*.

Table 5. Table of Library standards

Standard 1.0				**Standard 2.0**				**Standard n.0**			
Parameter: sl1.01				Parameter: sl2.01				Parameter: sln.01			
sl1.01	sl1.02	...	sl1.n	sl2.01	sl2.02	...	sl2.n	sln.01	sln.02	...	sln.n
Parameter: sl1.1.01				Parameter: sl2.2.01				Parameter: sln.n.01			
sl1.1.01	sl1.1.02	...	sl1.1.n	sl2.2.01	sl2.2.02	...	sl2.2.n	sln.n.01	sln.n.02	...	sln.n.n
Parameter: sl1.n.01				Parameter: sl2.n.01				Parameter: slN.N.01			
sl1.n.01	sl1.n.02	...	sl1.n.n	sl2.n.01	sl2.n.02	...	sl2.n.n	slN.N.01	slN.N.02	...	slN.N.N

Given the fact that the scientific component is an integral part of any process to the proposed methodology, it is proposed to introduce the parameters of the science standard for a generalized representation of the processes of the academic library.

The proposed characteristic of the standards and phases of Science presented in Table 6, despite the standard, ~~it~~ can be scaled, both in terms of parameters and components that describe them. All parameters and components are marked by the prefix *ssc*.

Table 6. Table of Science Standards

Standard 1.0				**Standard 2.0**				**Standard n.0**			
Parameter: ssc.01				Parameter: ssc2.01				Parameter: sscn.01			
ssc1.01	ssc1.02	...	ssc1.n	ssc2.01	ssc2.02	...	ssc2.n	sscn.01	sscn.02	...	sscn.n
Parameter: ssc1.1.01				Parameter: ssc2.2.01				Parameter: sscn.n.01			
ssc1.1.01	ssc1.1.02	...	ssc1.1.n	ssc2.2.01	ssc2.2.02	...	ssc2.2.n	sscn.n.01	sscn.n.02	...	sscn.n.n
Parameter: ssc1.n.01				Parameter: ssc2.n.01				Parameter: sscN.N.01			
ssc1.n.01	ssc1.n.02	...	ssc1.n.n	ssc2.n.01	ssc2.n.02	...	ssc2.n.n	sscN.N.01	sscN.N.02	...	sscN.N.N

Of course, these tables have a generalized representation of all components of the selected parameters of the standards under consideration. It should be noted that the set variable component parameter can be represented as a phase. The phases *swN.N.N, slN.N.N, sscN.N.N* are a conditional characteristic that describes the state of the component of the specified parameter in the Tables 4-6. That is, comparing the same indicator in several organizations, it is entered into the corresponding field of the table, taking into account the standard of the parameter in question. As soon as the indicator reaches the maximum parameter of the standard, it can be argued that it has passed to the next one. To represent the methodology process, we take a conditional reference institution.

To visualize the proposed concept of benchmarking implementation of the standards of the reference institution, the following algorithm is used.

Suppose that there is a "*Standard institution*", the activities of which can be described by standards, parameters and components:

- Web: *W = {sw1.n.01 [sw1.n.01 … sw1.n.n], …, swn.01 [swn.n.01… swn.n.n]}*
- Library: *L={sl1.n.01 [sl1.n.01 … sl1.n.n], …, sln.n.01 [sln.n.01… sln.n.n]}*
- Science: *S={ssc1.n.01 [sc1.n.01 … ssc1.n.n]} , …, sscn.n.01 [scn.n.01 … sscn.n.n]}*

Thus the "*Standard institution*" can be represented by the system (1):

$$StInst = \begin{cases} W = \left\{ sw1.n.01\left[sw1.n.01...sw1.n.n \right], .., swn.01\left[swn.n.01...swn.n.n \right] \right\} \\ L = \left\{ sl1.n.01\left[sl1.n.01...sl1.n.n \right], .., sln.01\left[sln.n.01...sln.n.n \right] \right\} \\ S = \left\{ ss1.n.01\left[ss1.n.01...ss1.n.n \right], .., ssn.01\left[ssn.n.01...ssn.n.n \right] \right\} \end{cases}, \quad (1)$$

To perform benchmarking analysis, researchers use a sample of data from sources such as report results, introspection, rating systems, etc. To ensure the application of the characteristics for "*X institution*", a screening of its condition is performed, then the "*X institution*" will have the following features (2):

- Web: *WX = {Xsw1.01 [Xsw1.n.01…Xsw1.n.n], …, Xswn.01 [Xswn.n.01…Xswn.n.n]}*
- Library: *LX = {Xsl1.n.01 [Xsl1.n.01… Xsl1.n.n], …, Xsln.n.01 [Xsln.n.01… Xsln.n.n]}*
- Science: *SX = {Xssc1.n.01 [Xsc1.n.01 … Xssc1.n.n]} , …, Xsscn.n.01 [Xscn.n.01 … Xsscn.n.n]}*

Then, the system(2) can be built:

$$XInst = \begin{cases} WX = \left\{ Xsw1.n.01\left[Xsw1.n.01...Xsw1.n.n \right], .., Xswn.01\left[Xswn.n.01...Xswn.n.n \right] \right\} \\ LX = \left\{ Xsl1.n.01\left[Xsl1.n.01...Xsl1.n.n \right], .., Xsln.01\left[Xsln.n.01...Xsln.n.n \right] \right\} \\ SX = \left\{ Xss1.n.01\left[Xss1.n.01...Xss1.n.n \right], .., Xssn.01\left[Xssn.n.01...Xssn.n.n \right] \right\} \end{cases}, \quad (2)$$

After comparing the system "*Standard institution*" and "*X institution*", the parameters were determined, which must be paid attention to and perform all the necessary manipulations to ensure the implementation of all components of all parameters. The transition to the new phase parameter is impossible without the execution of all components of the parameter.

4. Conclusion

The research was conducted in the context of modern requirements for educational and research institutions, taking into account the global digitalization of resources and processes. Standard approaches are not effective, forcing the use of methodologies from other fields or even radically change everything. Approaches to the organization of information technology activities not only allow to choose the best practices on the example of key stakeholders in the industry, but also to implement them in their own activities.

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