Development of Scientific Content Management, Evaluation and Publication Software

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Abstract: With the development of information and communication technologies, the workflow of many processes has also changed. A scientific publication processes are also facing these changes. Publishing scientific articles is an expensive and time-consuming process that requires significant prior investment and technical expertise. On the other hand, the information systems are subject to updates, and without changes, they can become incompatible with new technologies after some period. In this study, the update of online publication and scientific content management system was analyzed. The system was tested for the quality in use and performance, as well as to accordance with WCAG 2.0 accessibility checkpoints and user perception. The same tests were conducted after an update. Results of the tests showed that mostly the feature updates affected users' perception, while improvements of performance higher compliance with accessibility standards had less effect. The further effect of a feature system update, such as menu position and type of implementation, were observed. The design allows to manage several journals. Moreover, the design allows adding new journals to the system as well. The publishing process in a system is article based. Unlike the previous version, the system stores an article metadata and can work with .pdf format. In addition, in this study we consider the requirements that need to be met by a publishing software.

Keywords: Scientific Content Management System; electronic document; Web application; Database creation

Илимий Контент Башкаруу, Балоо, Оңдоо жана Публикациялоо Системасын Өнүктүрүү

Аннотация: Маалымат жана коммуникация технологияларынын өнүгүшү, көптөгөн иштердин жүргүзүү жолдорун өзгөртүүдө. Күнүбүздө академиялык публикация (жарыялоо) процесстери дагы бул өзгөрүүлөргө кабылууда. Буга байланыштуу белгилүү бир багытта жасалган маалымат системаларынын кызмат аспаптарын публикацияда колдонуу күндөн күнгө артууда жана жаңылануда. Тандалган дизайн азыркы колдонулганан системанын берилиштер базасы жана URL түзүлүшүн сактап калуу максаты менен кайрадан курулуп чыккан. Бул кадамда MANAS журналдарынын макала архиви өзүнүн уникалдуу адреси боюнча сакталышы зарыл. Жаңы система бир гана эмес, бир канча журналды башкарууга мүмкүнчүлүк түзө алууда. Ошол эле учурда, жаңы журналдарды кошуп, аларды дагы башкаруу мүмкүнчүлүгү түзүлгөн. Системада процесс макала жүктөө менен башталып, макала негизинде жүргүзүлөт. Иштелип чыккан система, программдык жабдыктарга коюлуучу талаптарга жооп бере тургандыгы тууралу тесттер каралып чыккан.

Ачкыч сөздөр: *Илимий контент башкаруу системасы, электрондук документ айлантуу, веб тиркеме, берилиштер базасын түзүү*

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1. INTRODUCTION

Publishing scientific articles is an expensive and time-consuming process that requires significant prior investment and technical expertise. With the development of information and communication technologies, academic publishing changes its traditional forms. Internet-based communication provides the authors with faster and easier service. Thus, the number of systems for managing the editorial process is increasing day by day. At present, there are a large number of electronic publication and online workflow management systems. The development of such systems provides quick access to the contents of the journals, allowing a large indexing opportunity with various indexes and databases, and increasing the visibility of scientific articles published in a system. In addition, online processing of the editorial workflow ensures the quick and accurate peer-review and editorial processes of scientific articles. In addition, it ensures visibility of journal's content.

For the efficient interaction with users of the journal management systems, at each phase of the workflow, these systems should be easy in use and operational, since the editorial process requires the exchange of information between many members of the workflow process. In addition, the roles should be distributed carefully, since the peer-review process in scientific articles must be blinded; thus, the access right to the information among participants are different.

Generally, the users of the scientific publishing system are not technicians. For this reason, the scientific publishing software is also a web content management system, which allows users with less technical training to work with the web application (upload articles, fill forms, do proof-editing, etc.). Journals management systems are tools designed for users who have little knowledge in programming or markup languages; thus, to easily create and manage website content, and communicate with an editorial office, the interface of journal's website should be user-friendly [16].

In this regard, the workflow of scientific journals of a university and the current situation was evaluated in terms of usability and security issues. These events were intended to discuss the situation, deficiencies, and limitations of the current system with the participation of our Editorial Board and editors. In the second phase of the study, the Scientific Content Management, Editing and Publishing System was designed and software implementation was carried out based on the knowledge and experiences obtained within the scope of the initial studies. According to Fleischmann at al. (2016), the system update has a positive effect on the users' continuance intentions [13]. Thus, at the third phase of the study, it was aimed to carry out the usability, accessibility and security tests of the developed system in the third phase of the study.

2. LITERATURE REVIEW

There are three types of Web Content Management Systems that can be implemented as models for the Scientific Publishing System: offline processing, online processing, and hybrid systems [17]. One of the main problems of the scientific content management process is that this process is time-consuming since it included several procedures such as review itself and writing review reports, final decision making and article publication. For this purpose, there was a need for a system that could speed up the evaluation and publication process [10].

In 2003, the electronic journal management system presented by [4] was established using a three-tiered information system architecture. In 2005, the study by Willinsky provided an inside view of the Open Journal System (OPJ), a journal preparation and publishing software developed under the Public Knowledge Project at British Columbia University [29]. In this article, it is said that the OJP system is designed to reduce the time and energy devoted to communication and administrative tasks related to organizing a scientific journal workflow process. At the same time, the accountability and productivity of the editorial processes are improved due to record keeping. This project lasted 3 years and totaled in $155,000. The open journal system can support the workflow of many journals at the same time. But there are systems that are developed for a single journal. The BIMF [5] system was presented as a journal evaluation and publishing system developed to support the BMIF Journal editorial work. This system enables authors and reviewers to upload articles or peer-review results; additionally, it supports document flow tracking and semi-automatic correspondence. Also, within the context of TUBITAK ULAKBIM Dergipark Project, the journal management system for national academic journals was established in Turkey. In this system, by 2013 there were 942 scientific journals registered [28].

As the overview suggests, there are many systems dedicated to the automatization of the editorial process; they are different by size, coverage and built platforms. There are many studies on comparing these systems as well. For example, Sitko et al. [26], compared 4 systems, namely, Serials Solutions, JournalWebCite, TDNet, and Serials Cybrarian in terms of common serials control problems. [6] have conducted a very comprehensive study of open source electronic publishing systems in November 2006 and July 2007. There were 7 platforms compared in this study, which are:

- DPubS (Digital Publication System), developed by Ehling in 2005 [9];
- GNU Eprints system by the University of Southampton [14];
- Net7 and HyperJournal system by Pisa University [3];
- British Columbia University's Open Journal System [29];
- Rice University's Connexions / Rhaptos project,
- Uppsala University's DiVA Digital Vetenskapliga Arkivet) [1]
- Topaz project (2005) by TUBITAK ULAKBIM in Turkey [27].

Although these systems are built using different platforms, each system has unique and useful options.

3. MATERIALS AND METHOD

For this study, we have carried out several tests. Since at the university, there are four functioning journals, which are indexed by several abstracting and indexing services, at the first stage, the overall schema of the Scientific Content Management Evaluation, Editing and Publishing System was drawn during the design and development phase to preserve the links of the archives. In addition, we have conducted interviews with the editors and publication office staff to analyze the drawbacks of the previous system being used by these journals.

The next stage was an implementation stage. During the development of the system, a novel and commonly used technologies were used to meet the requirements for publishing applications. The system works through a web browser client-server application. Between a client and server,

an HTTP (Hypertext Transfer Protocol) protocol is used. For the development of server (back-end) part, PHP 5.6 programming language and object-oriented framework Symfony 2.8 were utilized. The choice was due to reliability and efficiency in the use of MVC architecture. Symfony framework uses the Doctrine to ease the content management, and Twig template to facilitate the design implementation. In addition, security system in the Symfony framework is very reliable and very comfortable to use. In the client (front-end) part, HTML5, CSS3, JavaScript, and FontAwesome, Twitter Bootstrap, jQuery libraries were used. As a database management systems, MySQL 5.5 database management system is used since the MySQL web application systems are among the most frequently used system which best suits with PHP programming language [7].

Finally, user experience tests were conducted. This stage consisted of several phrases, namely, technical usability tests of the system and quality in use tests. The technical usability test of website or web software is one of the key features to be a useful and quality product [18; 19]. According to ISO 9241-11, usability means that a product is to be effective, efficient and satisfied by the user within a defined set of contexts and objectives by a particular group of users. It is crucial in determining how easily a website can be used and meet the needs of users [8] and affects the effectiveness and efficiency of the site and increases the satisfaction of its users [2]. Next tests were on the accessibility of a system. According to the W3C, "Web Content Accessibility is the standard that will enable more accessible Web content for disabled people" [31]. It is an effective factor for web applications to be easily found by search engines because search engines pay more attention to Web Standards Websites. The Web Content Accessibility Guide developed by the W3C is the accessibility criteria [15] used to categorize websites as AA or AAA in order for web pages to comply with these guidelines. We have prepared the Scientific Content Management Assessment, Editing and Publishing Systemizations to be developed in such a way, taking into account the accessibility features that provide ease of use for our disabled visibility.

Security is a very important point in websites [32]. For example, in [4], Apache web server SSL encryption mechanism was used to ensure the security of the system. In addition, there are problems with the use of network applications. Bad coding problems are caused by SQL injection and cross-site scripting can lead to an attack and cause data loss or bring it to the full stopping point of the web application [23], so it is necessary to perform certain attack resistance tests on the host system.

During the web usability testing, the design of the system was examined for usability problems. Tests were made on loading speed and size of main page and number of broken links. In addition, tests were conducted on the compliance of the system with WCAG 2.0 accessibility guidelines. Finally, security test of a system was conducted.

4. SYSTEM ARCHITECTURE

4.1. Roles

In our system, 4 main roles are presented, namely, an editor-in-chief, a field editor, a reviewer and an author mode. In addition, the web application administrator role is available.

ROLE_AUTHOR - after the successful registration in the system, a user is added to the author group, and an author role is assigned. Users in this group can configure personal information, create a new submission and send manuscripts to editors and are able to see the status of their

manuscripts. However, users in this group cannot change the submitted manuscripts; they have read-only access to articles after submission. Options in an author's dashboard are:

- Start New Submission – launches a new manuscript submission process.
- Unsubmitted Articles – lists manuscripts for which the submission process have started but not finished.
- Submitted Articles – lists manuscripts under a review process.
- Articles with the decision – lists manuscripts for which the review process has ended and the decision was made.
- Profile – the option for profile settings.

ROLE_REVIEWER – authors that are available as reviewers can apply to the editor-in-chief to become a reviewer. By the decision of the editor-in-chief, an author can be added to the list of reviewers, thus, a reviewer role is assigned. In this role, the basic information about the articles sent for peer-review to the reviewer, such as title, abstract, keywords, references, files, is available. After the peer-review is complete, the article is sent back to the editor. Options in a reviewer's dashboard are:

- New Articles –new peer-review requests are listed. A reviewer can reject a request, in this case, the request is moved to the work history as rejected. If a reviewer accepts the request, then access to the manuscript details (except author(s) name) and the full text is provided.
- Work history – presents the history of all peer-review requests, status, and decisions on that submissions.

ROLE_EDITOR – only a system administrator can assign this role by request of an editor-in-chief. Editors have a read type of access to the articles in some research area, as well as to the status of these articles. An editor has an access right to forward articles to reviewers and evaluate them based on the peer-review results. In addition, the users of this group can contact authors if minor changes are needed in a manuscript. However, they cannot make a final decision about manuscripts. In a field-editor dashboard, there are options are listed in the left menu, which are:

- New Articles – under this option, new articles that have been forwarded by an editor-in-chief are listed. In this list, a title of manuscripts and name of corresponding authors are given. Since our journals are multidisciplinary, the area of study is also present in the list, together with a link to a manuscript file and a date of submission.
- Forwarded Articles– under this option, articles that have been assigned to reviewers are listed, together with a name of a field-editor and a forwarded date.
- Articles with decision option list all the manuscripts with peer-review decisions. These articles are forwarded to an editor-in-chief with field-editor comments and suggested action toward the manuscript.
- Work history – presents the history of all submissions in this research area and decisions on that submissions.

ROLE_CHIEF_EDITOR - this role can be assigned to a user by system administrator only. Editor-in-chief has an access to information about authors and reviewers, as well as to the list of editors. Additionally, users with this role have a read access to all manuscripts submitted to the journal. The final decision on whether accept or reject an article is also granted to an editor-in-chief, however, if the majority of reviewers suggested rejecting an article, an editor-in-chief

cannot change the final decision. After the final decision, authors are informed by e-mail. In addition, in an editor-in-chief mode, the right to create new volumes and issues are available. The system is an article-based, thus, after an author uploads a manuscript, first it is forwarded to the editor-in-chief. In an editor-in-chief dashboard, there are options are listed in the left menu, which are:

- New Articles – under this option, new articles that have been submitted are listed. In this list, a title of manuscripts and name of corresponding authors are given. Since our journals are multidisciplinary, the area of study is also present in the list, together with a link to a manuscript file and a date of submission.
- Forwarded Articles– under this option, articles that have been forwarded to field-editors are listed, together with a name of a field-editor and a forwarded date.
- Articles with decision option list all the manuscripts with peer-review decisions and field-editor comments. By the decision of the editorial board, these articles can either be rejected or accepted. Accepted articles are listed under the following option:
- Articles ready for publication – the list of articles that passed the peer-review process and were accepted for publication.
- Create a new issue option allows creating a new issue of a journal and adding accepted manuscripts to this issue.
- Work history – presents the history of all submissions and decisions on that submissions.

ROLE_ADMIN - the administrator of the system. An administration can add new journals to a system, as well as configure a journal data; can assigns roles to users. The pattern follows the one defined in [24], [25] and [30]

4.2. Database description

In the editorial process management system, a MySQL 5.5 database management system was utilized. The choice was due to automation that MySQL can provide to the most tasks such as retrieving an information based on specific queries [7]. The main attributes of the database, developed for our system is presented in Figure 1.
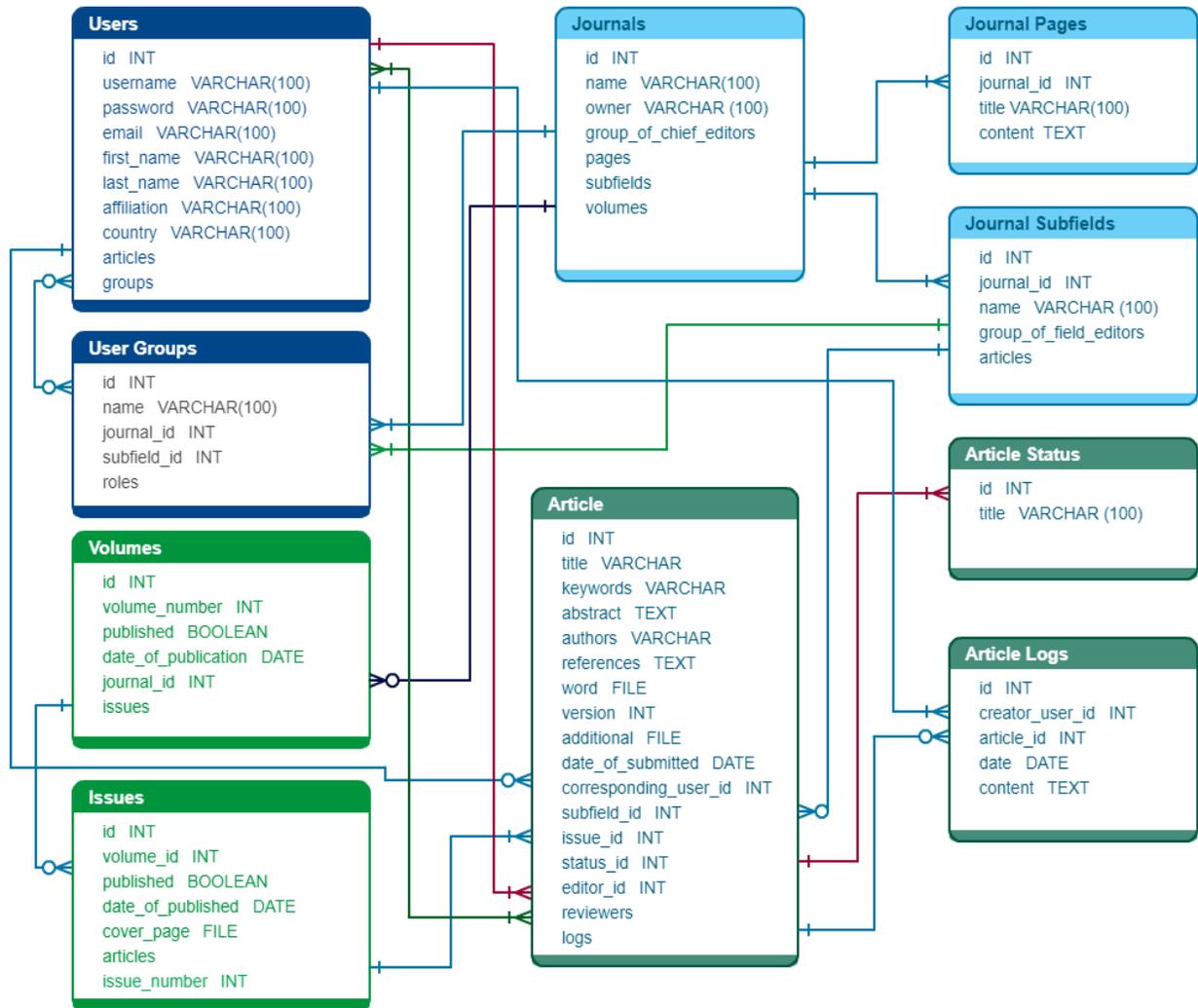
Figure 1. The simplified view of a system database

The database consists of three main parts, namely, users, journals and articles. At each of these parts, there are main tables, and the connections between these three tables define the author of a particular manuscript and to what journal the manuscript was submitted.

5. USER TEST RESULTS

5.1. Technical usability tests of the system

The severity of usability problems was determined, and the overall usability level of the design was defined [18]. During the web usability testing, the design of the system was examined for usability problems. The test was made on loading speed and size of the main page of a system [19], [21], and the main page of one a particular journal, as well as the number of broken links and response errors. The results of tests are presented in Table 1.

Table 1. Performance and number of errors in new and old systems.

	Main page		Journal page	
	New system	Old system	New system	Old system
Performance grade	88	89	88	77
Load time	4.57	2.28	3.92	3.44
Page size (kB)	937.1	821.7	660.9	508.3
Total number of requests	29	27	31	14
Response errors	0	4	0	0
Number of broken links	0	0	0	2

When comparing the performance grade of the main pages, the old application scored higher – 89 against 88 of a new application. However, grades of main pages of specific journals were higher in a new system. Also, the number of errors was decreased in a new application as well. Accessibility tests for compliance with WCAG 2.0 checkpoints were conducted using achecker.ca service. Results of the test are presented in Table 2.

Table 2. Accessibility checkpoints violated by websites.

Checkpoints		Main page		Journal page	
		New system	Old system	New system	Old system
Conformance level A	1.1.1		5		1
	1.3.1	2	2	3	4
	1.4.1		1		
	2.1.1	8	8		
	2.4.4			8	
	3.1.1		2		2
	3.3.2	2		4	2
	4.1.1		1	1	
Conformance level AA	1.4.4	13		41	
Conformance level AAA	1.4.6	12	1		

5.2. User perception tests

Since the Scientific Content Management Evaluation, Editing and Publishing System serves online, the end user evaluation system is one of the most important tests to be accepted by the user. According to Nielsen [20], the user testing is one of the most basic and useful methods. It includes 3 main steps. First, representative users should be chosen. Next, we ask them to perform representative tasks on a web application and, finally, define where users succeed, and tasks that were difficult to perform. In addition, Nielsen [22] observed that any system can be tested with 5 users. If a system has many disparate groups, then it was recommended to choose 3-4 users from

each group (Nielsen, 200). In this study, we have selected 4 users with the role "editor" and 5 users with the role "author" to test the usability of the publishing system.

Pre-testing questions and tasks were adopted to the publishing system from Fisher & Wright [12]. First, the general questions were asked on the computer experience and online article submission experience of users. Next, for each group of users 6 tasks were given. For each task, the 2-3 sub-tasks and evaluation of the page design were defined. Rating of sub-tasks was done by 5-point Likert type scaling, with 1 being "very difficult" and 5 being "very easy". The question on the design also rated by 5-point scale, with 5 being most attractive. First 2 tasks were similar for each group, that is, users were directed to register their accounts and activate it. Next 4 tasks were related to the roles. For the group of authors, tasks were mostly in the submission process, while users from the group of editors were asked to perform various tasks on the article processing. The pre-test survey showed that participants of the usability testing are users with an average level of proficiency with computers, who mostly work with word processing applications. Users with the role "editor" stated that they have an experience with online submission systems, while 2 users with an "author" role said that they had no experience. Usability tests were organized as two sessions with the delay in one day. The first day, the old system was tested, and the next day the same tasks were performed in the newly developed system.

The new system was rated higher than the old one and was equal to 4.39, while the cumulative ranking of the old system was 3.95. In addition, rates, given by users with an author role are higher than the rating of users with editor role, that is, 4.22 and 4.13, respectively. As users mentioned, one of the main usability problems of the old publishing system was in lack of clarity. The average rating of the systems' design indicated that the newly developed system showed ranked higher.

The analysis of comments, made during these tasks showed that a new system is perceived as more reliable and secure compared to the old one. Mostly, the reason for this perception was due to design, since users were non-technicians. As detailed questions showed, users perceive the position of the menu in a new system is more usable, and the fact that there were no drop-down options in these menu options give the sense of reliability.

6. DISCUSSIONS AND CONCLUSION

In this paper, a case study on the implementation of publication system for a university was conducted. The aim of the study was to show the implementation architecture and the difference in the user attitude when a software is updated. First, the existing journal management systems were reviewed and, based on the review results, a suitable design for the University's journals was selected. This design was reconfigured to store the database and URL addresses of the current system. Since for the indexing of a journal, the addresses play a vital role, at this stage, the preservation of the archive URL addresses of the existing journals and articles in the current system was taken into account. In the developed system, several journals can be managed. Furthermore, there is an option to add new journals as well. The workflow that begins with article uploading to the system is based on the article processing steps.

The system design ensures that all of the above procedures can be performed online and is recorded by the system in order to be able to control each log of the system. System design should be simple and easy to use, but workflow control should be tight to avoid repetition of

sending an article several times and sending it to several field editors. In addition, authors and reviewers have the access to track the article status and editors - to audit review processes for each article. The system will automatically generate reports at the same time.

After the article is accepted, the process passes to the publishing office side. The publication office should prepare the accepted article according to the journal's template. Once the article publication office has processed the article, it must be sent back to a corresponding author to approve or to make their own corrections on the final version of the article. This process is also intended to be done online in the system. In addition, the entire system will provide multilingual support in the future. Thus, our online platform can be used by other corporate publishing offices in the region.

In this study, tests on the quality of use, accessibility and user perception of two systems were conducted. Although the performance grade of the old system's main pages was higher, which can be explained by a simple design of an old system, the overall characteristics of a new system are higher.

The difference in user evaluation was mostly due to changes in the design of the system. As Fleischmann at al. (2016) states, the feature system update has a more positive effect on the users' continuance intentions compared to technical non-feature updates [13]; however, it can bring a hesitation and confusion [11]. In this study, the further effect of a feature system update, such as menu position and type of implementation, were observed.

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