Web Indicators of ICT Use in the Work of Ukrainian Dissertation Committees and Graduate Schools as Element of Open Science

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Abstract. Today an enormous amount of problems in building a system of efficient education and science is on the discussion agenda in Ukraine. A decrease in the number of scientists in the country has been observed in the last 15 years. At the same time, the amount of postgraduate students and people aiming at obtaining their doctorate is increasing. Notably, similar indicators are also observed in the majority of post-soviet countries. One complicating factor is that the system of scientific personnel training in Ukraine is very restrictive and closed. The proportion of research results published using a free access scheme to the overall bulk of publications is still very small, in particular if compared to the level of ICT development. Therefore, a major part of the publications still remains inaccessible from the outside. In this study we investigate the openness and accessibility of the preparation of the academic staff in Ukraine. To partly overcome some of the problems, we propose an our vision on ICT development of DC & GS infrastructure. In this article we analyzed the performance of DC and GS through their web indicators.

Keywords: Web · Information and communication technology · Education and learning process · ICT infrastructure · Open science

> "If it's not on the Web, it doesn't exist at all"
> Sarah Stevens-Rayburn & Ellen N. Bouton, 1997.

1 Introduction

The main catalyst for socio-economic development of a state potential is the ability to create, collect, and effectively manage knowledge that is comes out from the best scholarly research practices. The countries which have made it to their development strategy and implemented the effective interaction with the business enjoy TOP ratings in the World rankings. In the age of information technologies, it takes one not years, but rather days to bear the bell of scientific research and excel the competitors. The companies which are the first in the market are more likely to benefit from a positive effect caused by the introduction of new knowledge. Globalization is adjusting the cooperation

V. Yakovyna et al. (Eds.): ICTERI 2015, CCIS 594, pp. 3–19, 2016.
DOI: 10.1007/978-3-319-30246-1_1

between science and industry. More and more funds are invested in scientific research and development to capture the leadership in the market. A modern country's development is stimulated by the transition from aresource-based economy to hi-tech. There is an opportunity to create "intellectual dollars" without any resource, but people. The results of intellectual work become a hard currency. For example, Japan, though it had no natural resources, managed to become the leader in world's economy. The monetary value of the biggest hi-tech (IT) companies is at a scale of the budgets of some developed countries (Apple– $ 711 billion, Microsoft – $ 349 billion, Google – $ 365 billion).

The Open Science (OS) movement gains popularity in the world of clerisy, aiming to make research results and source data accessible to public at all levels. However, there is a conflict between the desire of scientists to have access to shared resources and make profit by using these resources [1]. In recent years, many governments try to impose the policy of openness regarding scientific knowledge, especially, if it is funded with public money. One way is the enforcement of providing open access to the results of all research projects performed at public expense. An indicative example is the US, which grant annually about $ 60 billion for research. In 2008, the US Congress imposed the obligation to grant free access in a year after the first publication to all the research papers based on the studies conducted by the National Institute for Health (which receives circa the half of the total public funding for science). Similar measures are now considered by many other countries.

Today, a lot of research in Ukraine is devoted to the problems of higher education and, in particular, the use of ICT for training students, creating information and communication environments in the universities, etc. However, in the scholarly literature insufficient attention is paid to the development of information and communication models of interaction with ICT in academic staff training. Moreover, today we are talking about the need for openness and accessibility of scientific activity, whereas a substantial part of the scholarly output never reaches its reader within and even more outside the professional academic community. This problem is particularly acute in the post-soviet countries. Regionalism of entire areas in science, convention, low connection with contemporary scientific trends, low level of foreign language knowledge by scientists, lack of self-developing scientific community, low competition with other countries, lack of motivation, poor funding, brain drain, and a number of other factors result in the continuing archaism of scientific brainpower training in Ukraine.

Scientometrics is rapidly developing nowadays. Using information technology allows creating new services for the development of scientific and research activity. Many global companies invest billions of dollars in services to support research activity, thereby creating a serious market not for the research results but for the research process support. Herewith the trend shifts toward commercial projects. The examples of such companies are Apple, Microsoft, Google, Elsevier, Thomson Reuters, not to mention many others. The most outstanding services with rapidly growing impact are Google Scholar, Scopus, Orcid, Academia.edu, Research Gate, Mendeley, arXiv.org, cs2n, Epernicus, Myexperiment, Network.nature, Science-community. These services contribute to satisfying the needs of the scientific community. In fact, these positively influence scientific and technical progress and create a new paradigm of scientific research. A big number of the recently created scientometric services allow assessing

the relevance of the research results by a scientist, the number of his publications, citations, storage, etc. Having these measurements at hand opens up new opportunities and prospects. Our time ischaracterized by the high rates of the accumulation of new knowledge, in particular in the form of research results. Provided that the integration of research activities is currently (and naturally) low, a huge amount of scientific and research information falls out of search visibility and accessibility. Information technology is the only way to arrange and create effective search tools for acquiring the necessary knowledge. The objective of our research is to investigate the transparency of specialized scientific bodies and offer the vision of their supporting ICT infrastructure. Accordingly, the rest of the paper is structured as follows.

Present article includes such sections, as description of the methodological and experimental parts (2–4), discussion of basic components of Dissertation Committees (DC) and Graduate Schools (GS) ICT infrastructure and main ways and methods of their realization (5).

2 Related Work

David [2] mentions that the goal of Open Science is to do scientific research in a way that facts and their distribution is made available at all the levels of the concerned public. The same article states that the movement arose in the XVII century. Due to the fact that the public demand for access to scientific knowledge has become so large that there was a need for a group of scientists to share their resources with each other, so that they could conduct research collectively [2].

The term E-Science (or eScience) was proposed by John Taylor, the Director-General of the United Kingdom Office of Science and Technology in 1999 and was used to describe a large funding initiative, starting from November 2000. E-Science has been interpreted more broadly since as “the application of computer technology to the implementation of modern scientific research, including training, experimentation, accumulation, dissemination of results and long-term storage and access to all materials obtained through the scientific process. These may include modeling and analysis of facts, electronic/digitized laboratory notebooks, raw materials and built-in data sets, handwritten production and design options, preprints and print and/or electronic publications” [3].

Koichiro Matsuura, the President of UNESCO, wrote in his preface to [4]: “Societies that are based on the knowledge will need to share them to keep their human nature”.

In 2014, the IEEE eScience community proposed a condensed definition [5]: “eScience encourages innovation in collaborative, computationally or facts intensive research in all the disciplines throughout the research life cycle”.

Michael Nielsen, a physicist and propagandist of Open Science, colorfully describes in [6] the way the new instruments need to look like to facilitate the dissemination of the culture of cooperation and openness among scientists. One of such tools exists now. This is arXiv – a site that allows physicists to publish preprints of their works before the official publication of the article. This promotes to get in faster feedback and to disseminate the new discoveries. Nielsen also acts for publishing not only conclusions, but all the original data – this is the thing physicistshave been dreaming of for a long time. Journals could help them do that if they wanted to [6].

The most basic obligation of a scientific journal is to perform peer review, arXiv founder Ginsparg says. He laments that a large proportion of open-access scientific publishers "clearly are not doing that." Ensuring that journals honor their obligation is a challenge that the scientific community must rise to. "Journals without quality control are destructive, especially for developing world countries where governments and universities are filling up with people with bogus scientific credentials," Ginsparg says [7].

The peer review system for scientific papers on one hand offers an opportunity to obtain a (preliminary) critical assessment of a manuscript, but on the other hand it slows down the publication of research results. In this system, a review process is rarely accomplished in less than a month. The reviewers often request authors to revise some parts of the material or conduct additional studies. As a result, the time before the publication stretches for about six months or more. However, Michael Eisen, the co-founder of the Public Library of Science (PLoS), mentioned that according to his experience the "most serious incompletes are detected only after the article is published." The same applies to other scientific works, including dissertations for a degree [8].

It is a big problem in modern conditions of development of information technology is a plagiarism. Although information technology can be used in recognition of plagiarism, it is one of the major problems of scientific research. So, the American researcher Bela Gripp in her dissertation says that "… even today's best performing systems cannot reliably identify more heavily disguised forms of plagiarism, including paraphrases, translated plagiarism, or idea plagiarism. This weakness of current systems results in a large percentage of disguised scientific plagiarism going undetected. While the easily recognizable copy & paste-type plagiarism typically occurs among students and has no serious consequences for society, disguised plagiarism in the sciences, such as plagiarized medical studies in which results are copied without the corresponding experiments having been performed, can jeopardize patient safety" [9].

The cases are known in history when after many years after the defense a person was divested a degree and even was fired after the examination of his work regarding qualitative or even plagiarism.

Tugo Pagano and Maria Alessandra Rossi suggest [10] that politics aimed at overcoming the disadvantages of excessive privatization of knowledge can play an important role in stimulating the economy. Efforts should be focused to maintain and enhance the role of open science. The institutions of open science have allowed the flourishing of industrial development from the beginning, and should have a much more important role in the architecture of the future post-crisis global economy. This can be achieved through the institute of World Research Organization (WRO) which can master some of the benefits of open science to overcome the well-known free rider problem associated with contributions to the last.

In 2004, the research group Laboratorio de Internet from Spain, which studies educational and scientific activities on the Internet, started the Webometrics (www.webometrics.info) project with the aim to rate University web sites. The subject of their analysis is the university domain. Webometrics researchers emphasizethat the presence of a university website allows to simplify the publication of scientific works by faculty and research staff, compared to the publication in print, and also provides the information the fields of their professional activities. Online publications are much

cheaper than paper publications and have broader potential audience. Publishing online facilitates to broadening the access to academic resources for scientific, commercial, political, and cultural organizations both from within a country and abroad. The rating scale is based on the four criteria that take into account the entire Web data within the university domain: Visibility, Presence, Openness, and Excellence. Each criterion has a weight corresponding to its importance [11].

The report by UNESCO on information technology in education [4] shows that in Ukraine there is a "rapid advancement of ICT into the sphere of education, which needs continuous improvement in the efficiency of use of the new ICT in the educational process, timely updates of educational content, and an increase in the quality of ICT training". However, there are some problems which are primarily associated with the low psychological, methodological, and pedagogical readiness of teachers to the rapid changes in information technology.

The issue of the openness of an education system and science often comes up in relation to international research funding instruments, such as Tempus, Erasmus, and others, and related projects. Every year, they attract the attention of many Ukrainian and foreign universities, research organizations and structures.

In 2006–2008 our Kherson State University (KSU) participated in the following European projects: Tempus TACIS CP No 20069-1998 "Information Infrastructure of Higher Education Institutions"; Tempus TACIS MP JEP 23010-2002 "UniT-Net: Information Technologies in the University Management Network"; US Department of State Freedom Grant S-ECAAS-03-GR-214(DD) "Nothern New York and Southern Ukraine: New Partnership of University for Business and Economics Development", which resulted in the development and implementation of scientific and management processes of analytical information systems and services. More detailed information can be found in the articles by G. Gardner [12], V. Ermolayev [13], A. Spivakovsky [14].

The results on the interrelation of ICT and educational process and the influence of ICT on professional and information competencies of the future university graduates have been presented in our previous publications [15, 16]. The authors have also conducted the investigation of the technical component of the feedback services implementation in KSU [17] and their impact on the preparedness of the students to use ICT for educational and non-educational purposes, and forming the ICT infrastructure in a higher educational institution [18, 19].

3 Experimental Settings

Today, Ukraine possesses a historically established system of scientific training. The foundations of this system were laid in the Soviet Union. This system is very similar to the system of post-soviet countries.

According to the State Statistics Service, 2011 [19], Ukraine had 14 895 "doctors of science" and 84 979 "candidates of science" (the analog of a PhD) covering arts, legal studies, and sciences. Among them 4 417 doctors and 16 176 candidates of science work in sciences. In addition, as reported by the "Voice of Ukraine" newspaper, the National Academy of Sciences of Ukraine employs today 2 564 doctors and 7 956 candidates of science [20].

In the last 19 years the number of researchers in Ukraine, decreased by more than 100 thousand people, while the number of graduate students increased by almost 2 times. The trend similar to the decrease in the research staff members can be observed in the numbers of domestic research and development organizations.

In Ukraine there are 988 Dissertation Committees [21]. DC are the expert councils in different scientific domains which form the National organizational infrastructure, accepting candidate and doctoral dissertations for examination, doing the expertise, hosting the defenses of dissertations, and further awarding advanced academic degrees. The aim of this infrastructure is to foster the development of the innovative elite of Ukraine which is considered as a driving force for scientific and technological progress. Preparatory work before the work of Dissertation Committee is carried out in the Graduate Schools. In Ukraine, there are about 300 universities, in which Graduate Schools operate, where about 34 thousand graduate students conduct the researches.

Given the importance of the DC infrastructure, the foci of this study are to:

- Assess the openness and accessibility of the preparation of academic staff in Ukraine within the system using the DC.
- Specify the requirements for the construction of the ICT infrastructure in this area.

We will analyze web indicators the performance of DC and GS based on the following principles:

1. The availability of information;
2. Openness;
3. Weight;
4. Scientific;
5. Social significance.

The research into the current state of the system of interaction with ICT of the DC, the Higher Attestation Commission of Ukraine, and graduate students is impossible without the analysis, comparison and synthesis, abstract approach to the definition of the basic patterns of the use of information technologies, and logical approach to the description of possible implementations of innovative teaching methods. Hence, the study of this issue requires the use a carefully designed combination of exploratory, empirical, and statistical methods. Therefore, several methods are used:

- Exploratory – the analysis, synthesis, comparison, generalization and systematization of relevant information acquired from psychological and educational literature legal documents, standards and information resources. These sources are consulted and further generalized to define the essence of the information competency of university students and assess the theoretical and methodological bases of information competency formation. Pedagogical modeling is employed to build the model of informatics competency;
- Empirical – questionnaires, surveys, testing, and self-esteem; pedagogical experiments are used to test the hypotheses of the study;
- Statistical – the methods of mathematical statistics are employed to determine the reliability of the results on the basis of quantitative and qualitative analysis of the empirical data.

The analysis of the public (available on the Internet) information on the availability of data on DC and GS, and collecting the opinions of graduate students using a questionnaire on the use of information technology in their dissertation projects are the main research methods.

Considering that the DCs function as university bodies, such sites as Top 100 universities in the World, Top 10 European universities, Top 50 universities in Russia, Top 25 universities in Poland, Top 10 universities in the USA, Top 15 universities in UK, Top 20 universities in Asia [22], DC of Ukraine were the object of information analysis. Overall, 300 university sites were analyzed in the reported research.

The study of the current status the use of ICT to support the activities of DC/GS the following assessment aspects:

1. The availability of a web site for a DC/GS and its analysis;
2. The degree of openness of the information provided for a DC/GS: information about the members, dissertation abstracts, theses, etc.;
3. Information security;
4. The existence of DC/GS pages in social networks;
5. The availability of a feedback service.

Let us consider in more detail each of the assessment aspects.

1. While exploring the web sites of universities regarding the availability of information about the activities of the respective DC and GS, we have selected to use the following four criteria:
   - A university web site provides the information on the DC and GS and a link to its own website;
   - A DC and GS does not have a separate web site, but it has a page on the university web site;
   - A University website provides a brief information about the DC and GS;
   - There is no information about the DC and GS neither on the university website nor in social networks.
2. The openness to the information about a DC and GS for public:
   - Any Internet user can see the information;
   - A user can view the data only after registration on the web site;
   - Only the staff and students of the university can see the information.
3. Feedback facilities:
   - Providing a contact phone number;
   - Providing a contact e-mail address(es);
   - Providing the list of contact persons;
   - Providing the Skype ID for contacts;
   - Providing the schedule of DC and GS works.
4. The availability of information (pages) in social networks:
   - Due to a substantial impact of social networks on the communication among people today, it has been decided to account for the relevant indicators in our study an analysis of the availability of information about DC and GS: the availability of accounts or groups in social networks such as Vkontakte, Facebook, Google +, Twitter;

- To analyze the availability of video records of defense meetings the analysis of the YouTube content relevant to a DC and GS has been also undertaken.

5. The technical characteristics of DC and GS web sites.

With this common name we have combined the following criteria of examination of the sites:

- Number of pages on the website - research on the number of pages of the DC and GS or part of the website of the University with information about DC and GS, as one of the indicators influencing the position of the site in the search results;
- Dynamic - in this case we are not talking about the dynamic of the site per se, but about the frequency of updating information on the activities of the DC and GS. Thus we examine the frequency of updating information in the categories - weekly, monthly and annually;
- Authentication System - a study of the main elements and authentication mechanism;
- Usability - the assessment of convenience of use and ease of operation of the system, namely how well, clearly and correctly interface and website structure are implemented. Whether the site user can quickly find the information he needs. In order to evaluate the site based on this criterion, we conducted a brief analysis of the layout of the site; availability is checked on the website of dynamic elements, the availability of search and so on;
- Platform - by means of specialized web services was implemented the management system review site. Thus we have divided the sites into two categories - implemented using CMS and handwritten;
- CEO - the study of site positions in the results of search engines for specific user requests;
- Validity - the number of errors found by the validator;
- Multimedia content - a study on the website of the libraries of audio and video recordings protections scientific papers, photographs, etc.

The questionnaire which has been used to survey the use of ICT by graduate students in their preparation to defense consisted of 3 components:

- Quantitative indicators of the use of ICT by graduate students in the process of working with their DC;
- The availability of training courses for the use of ICT in the preparation to defense;
- The readiness of the subjects to authorize the open storage of their research results (articles, theses, dissertations) and review materials such as audio, video, etc.

4 Experimental Results

The result of the analysis of the websites of the universities of Ukraine regarding the information on DC and GS, personal web pages and sites of DC members is pictured in Table 1.

Table 1. The availability of information on the websites of the Universities on the DC and GS

	DC	GS
Have own web sites	9 %	2 %
Part of the University's website with detailed information DC and GS	47 %	3 %
Part of the University's website with short information DC and GS	37 %	84 %
No information about DC and GS	7 %	14 %
Information about the courses on IT in science		1 %
Information scientific leaders at the GS website		2 %

Only 9 % of the reviewed DC have their own web sites. 84 % of DC related information can be found on University web sites, taking into account that full information concerning the DC activities has been found only for 47 % of the reviewed DC. 7 % of the reviewed DC have no presence on the Internet. As for GS sites, we see, only 2 % of its have their own sites. Full information concerning the activities of the GS is placed only on the 3 % of the studied by GS, and 14 % of GSfrom the total number is not placed on the Internet for almost any information about themselves. These results pinpoint the major problems in the transformation of the contemporary Ukrainian scientific community into the Open Science community.

Only 4 DC web sites exploit a user authentication functionality distinguishing user roles. So, it can be stated that only 1 % of the reviewed DC have created some ICT based prototypes for the interaction between the applicants and the Ministry of Education.

About 30 % of the reviewed DC (and 2 % of GS) update the information on their web sites every week, whereas 51 % (94 %) of the information on these sites is updated several times per year (Fig. 1 shows an example). Consequently, the question arises on the reliability and relevance of this information.

As per the information on the reviewed web sites, the DC have no means to track scientometric indicators of the members of the DC, the candidates for a degree, and persons that had defended their theses in a particular DC, not to mention the presence of analysts defended dissertations and access to them, which makes the qualitative assessment of their activities impossible. 32 websites have usability problems in terms of the ease of use of their interfaces and poorly implemented site (keyword-based) search functionality. The latter is implemented on only 27 of the reviewed resources. Only 17 of the examined web sites provide the information on or references to resources like a "library".

Regarding the minimally present contact information of a DC (a phone number, address, contact person name, document templates), it is provided only on 4 of the reviewed web sites. Moreover, the contact phone number is mentioned only on 2 of them. Thus, in order to find the information a DC of relevance to a PhD project, one should get their list and addresses in the Ministry of Education and Science of Ukraine (where one also needs to go) and search for a relevant DC at the specified address.

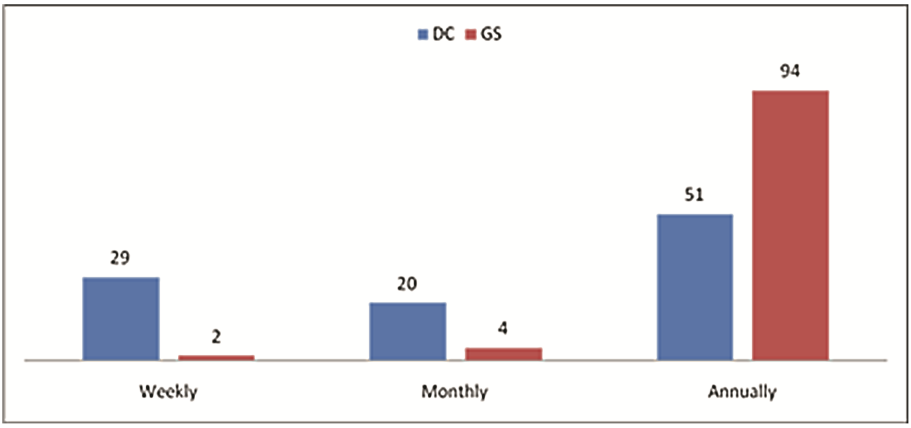

Fig. 1. Frequency of updates.

This is only the first problem in the application process. The required documents have also to be submitted to a DC by coming in person, since there is not a single web site that allows you to exchange the information and documents with a DC in the process of registration, filing and review of the thesis and so on.

The results of the review of the availability of information about Ukrainian DC and GS in social networks are shown in Fig. 2.

As can be seen in Fig. 2, 14 DC have a personal group or page in Vkontakte, 11 – in Facebook, 7 – in Twitter and 4 – in Google + . As for GS we see that only 5 of it have a personal group or page in Vkontakte, 3 in Facebook, 1 - in Twitter and 1 in Google +.

It is also important that YouTube is used, though to a small degree. So, a certain degree of openness of our science may be noted, in particular the openness of the preparation of the scientific staff.

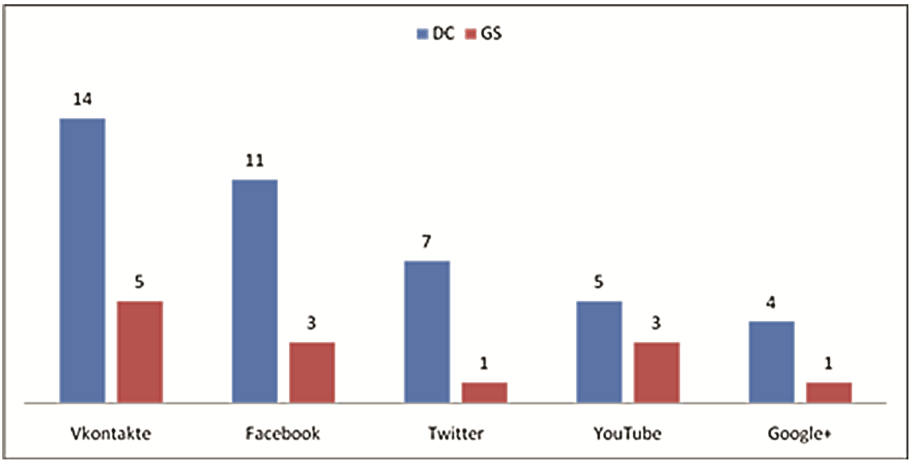

Fig. 2. The use of social networks in the work of DC and GS

The analysis of quantitative indicators of the use of ICT by graduate students for working with a DC is shown in Table 2.

Table 2. Quantitative indicators of the use of ICT by graduate students for working with a DC.

		Do not use	Rarely use	Always use
Usage of the Internet to search for information about DC	Working with DC website	80 %	15 %	5 %
	Search of information about the members of DC in SDB	93 %	5 %	2 %
	own profiles in SDB	95 %	4 %	1 %
	Work with El. repositories (dissertation and author's abstract)	40 %	50 %	10 %
Usage of El. Mail		30 %	40 %	30 %
Usage of Skype		84 %	10 %	6 %

The study reveals that only 2–3 % of the respondents know what is a scientific database (SDB) or a citation index, 7 % use these systems from time to time to find the necessary information, and only 4 % have their own profiles in such scientometric systems and databases like Scopus, Google Scholar, Mendeley, RSCI or others. It is important that the majority of the respondents are not interested in creating their own profiles in such scientometric systems. The main reason for that is the lack of recognition of their utility. Moreover, some of the profiles were created directly by the organizations where scientists work, or automatically by the systems that store their scientific articles. Thus the majority of respondents did not know whether they have a profile in any of the systems, whether these exist or not.

80 % of respondents do not think much about how their scientific publications are stored –in a paper or electronic form, and they believe that it is not of great importance. Thus, the majority of publications are going out of press in a paper form and are not further digitized – so remain unavailable to the scientific world.

93 % of respondents answered negatively about attending any course (or lectures) to get prepared for the use of ICT in their dissertation project (SDB, repositories, etc.).

Analyzing the readiness to the open storage of research results (articles, theses, dissertations) and materials of dissertation defense such as audio or video, we observes the following:

1. The majority of the respondents (80 %) support the publication of electronic copies of their scientific papers on the Internet, but at the same time consider it unnecessary and inconvenient. Further, all the respondents point out that the Ministry of Education and Science of Ukraine (MESU) has the publication requirements (regarding

the number of papers and form of publication, paper or electronic) to qualify for a degree which do not motivate providing open access. MESU requires that a qualified candidate has 5 publications at the MESU approved venues, one of which can only be published in an electronic edition and another one in an international or indexed international SDB. Thus, none of the applicants target to publish the electronic copies of their papers on the Internet. In some cases, this problem is solved by posting electronic copies on a digest web site or putting these into an electronic repository of a scientific institution of the applicant. Otherwise the articles remain inaccessible to the outside world;

2. The Problem with open access to the protected dissertations and abstracts is identical to the previous. In addition, the human factor needs to be taken in consideration. Providing free access to abstracts or theses means making these open for further examination after publication, hence the increase of the author's responsibility for its contents and quality. Therefore, open storage of scientific work of this type stimulates quality improvement. We see it in the results of the evaluation of the respondents ' answers to this question. Notably, 80 % of the respondents agree that the understanding that their work could be read by any other scientist clearly affects the quality of publications.

As an example, let us compare the quantities of the full versions of theses and abstracts stored in the repositories in Ukraine to numbers in the repositories in Germany, Great Britain, and Spain (top 30 repositories of each country rated by Webometrics, http://www.webometrics.info, were examined) – see Table 3. Ukraine has 46 repositories (Table 3) in total while having more than 300 universities.

Table 3. Numbers of dissertations and abstracts in open access repositories.

	Ukraine	Germany	UK	Spain
Numbers of repositories	46	117	146	64
Dissertation	1858	71656	16724	3586
Abstract	3532	22882	23617	18582

Only 15 % of the respondents agree that online video protection is useful, 30 % – to deposit their audio and video files providing open access, while the remaining 45 % believe that audio and video recording is unnecessary or even harmful as it bothers and disturbs focusing on the defense talk. To the question "if they would like and are ready to use specialized systems to work with a DC and MESU" 90 % of the respondents gave a positive answer. The most significant motive to this answer is potential reduction of time and financial expenses for data processing (sending and receiving documents, access to the proper information and so on).

5 Our Vision on ICT Development of DC & GS Infrastructure

As experimentally proven above, the effective implementation of the elements of OS must assume the existence of an appropriate ICT infrastructure as a scientific and educational system as a whole and its component parts (schools, universities, DC, and others) in particular.

The main elements of the ICT infrastructure of OS are researchers (academic staff), data and processes.

Speaking of ICT infrastructure DC we can determine its components as follows:

- Researcher – the applicants, the members of a DC/GS, the employees of MESU, and other users of the system have access to relevant information and participate in information processing, communication, and computing processes;
- Data – information about the work of DC, their employees, applicants, archives of theses, scientific publications, etc. as a tool to open exchange, recombination, and reuse are the important components of the infrastructure;
- Process – the procedures, services, tools, and methodologies that are used to collect, perform the transformation, analysis, visualization and storage of data, build models and simulations. The management of these processes is done both on the side of users (researchers) and of the specialized services and systems.

All the user roles have both generic and specific abilities in using the system. All roles can retrieve publicly available information while working with documentation is allowed only to certain roles.

One of element of the activity openness of DC and postgraduate study, we see in the creation of their accounts in scientometrics and bibliometrics systems, databases, scientific social networks. Today 345 scientific institutions of Ukraine have the profile in Googlescholar. We created the profile of DC K 67.051.02 and on the May 2015 it is the only one in Ukraine (data of the project “Ukrainian Bibliometrika Science”).

Using these resources, we can combine the results and indicators of scientific activities of applicants, post-doctoral students and members of the DC, and thus show their scientific orientation, number and topics of publications of DC members, their citation, the geography and dynamics. Thus, it will clear for each graduate student in what kind of field the GS/DC operates, and how valued the scientific activities of its members in the scientific world are, it will be the opportunity to compare and analyze GS and DC in real time.

The next important element is to develop a service that enables to conduct analytical processing of scientometric indicators and promote the adoption of administrative decisions in the scientific and educational activities by IT resources.

An example of such a resource is a service developed by us called Publication (http://publication.kspu.edu). Functional features of the service are:

- Collect information of scientometric indicators of scientists, organizations, research groups.
- Ordering and ranking the results. For example, the construction of ratings of departments, faculties, universities, research groups and scientists.

- Facilitation of user access to information about scientific publications.

The service creates the conditions for effective work of postgraduate students and collaboration of scientists. In addition, today, thanks to the work of the service, we will create some motivational environment conducive to increase quantitative and qualitative indicators of scientific activity.

As mentioned above, one of the major factors, influencing on scholar's rank, as well as its openness and visibility is posting the results of his scientific work in electronic repositories. Most often, there are books, some articles, theses. Much less often, there are dissertation and abstracts. And this is one of the main factors, which shows open, academically activity of DC and graduate schools. Currently, we have a working repository, which stores the results of the scientific work of the university and other research organizations operating on its base (http://ekhsuir.kspu.edu/).

The next element of the considered infrastructure should be the sites of a DC and postgraduate schools, as well as their pages on the sites of the university on the basis of which they operate.

Appropriate Web-resources we divide into 2 categories:

- Information site;
- Web-service.

Web-service we call the type of Web-resource, which supports not only the availability of information on the activities of DC/GS, and communications options for users to automate the "paper" processes of their work, namely:

- Possibility of supplying and receiving applications for entry into postgraduate school, registration in the special council;
- Ability to supply and reviewing of abstracts and dissertations (for DC);
- The ability to supply reports on the work of graduate students;
- Ability to create new accounts of all users of the service;
- Possibility of electronic document;
- Feedbacks.

Today there is a first version of the site DC K 67.051.02 (http://www.kspu.edu/About/ScientificCouncil/Specvchenarada.aspx) corresponding to most of the described requirements. Currently, we are working to transfer from "Information sites" to Web-Service corresponding to the fundamental principles of OS.

The site DC states:

- Basic information about the activities of a DC and its members (with links to their personal Web-page).
- information about past and future presentation;
- information about applicants and their scientific advisers;
- list of defended dissertations;
- links of DC profile in scientometric system GoogleScholar, and a page with the scientometric indices according to Scopus;
- created examples and documentation requirements which are necessary for filing and defence in DC;

- links of collection of scientific papers published by the University, and other "useful" links.

The feedback in this case is carried out by means of electronic mail. The new version of the site DC feedback will be implemented through the implementation of special modules and forms, such as Online-chat, presence of user's personal accounts with the ability to send and view messages, etc.

An important element of the OS, we see the use of video and audio services such as YouTube, Dailymotion.com, Yandex.Video, RuTube.ru and others. Their use provides the following features:

- Online broadcast the defense of theses;
- Storing audio and video dissertations defense;
- Storing video and audio lectures for teaching in postgraduate school, etc.

You should also pay attention to where and how the research results are published. From 1400 relevant scientific editions in Ukraine there is less than the third part has a website, while the main principle of the OS is the availability of research results to the outside world. Guided by these principles, we are working on the development and publication of a collection of scientific papers "Information Technologies in Education" (http://ite.kspu.edu/en), our scholars and scientists around the world are published. Today the collection has its own website there are the electronic versions of all the articles and the associated metadata, and pages with the ranking list of authors and publications.

Another element that we would like to note is the creation of online-resources for training postgraduate students. Studies show that in our country, very little attention is paid to this problem; there are no online-courses or disciplines in postgraduate school, which considered the potential of ICT as basic mean and the environment for scientific research.

Today, we are actively working on the creation of an open course on the use of ICT for undergraduates and postgraduate students.

6 Concluding Remarks and Future Work

Building a system of efficient education and science in Ukraine today is complicated by many serious problems. A system of training of scientific personnel in Ukraine is among the most restrictive and closed ones in the world. A similar trend is observed in the majority of post-soviet countries. The proportion of scientific research results published under a open access is still very small compared to the level of ICT development. The main part of research results still remains inaccessible for external users.

Today we are all talking about scientometrics, but at the same time have not the ability to track scientometric indicators DC, GS, candidates, not to mention the presence of analytics the defended dissertations and access for them, which makes it impossible for a qualitative assessment of their activities.

As the results of the research have shown, extremely weak is applying of ICT in training of scientific personnel. Processing of all documents required for graduate studies or for the protection of dissertations is going manually, requiring a lot of time and resources.

The creation as many services which allow an understanding of the existing sciencemetric systems and databases, presenting them their own researching results, as well as services that contribute to the analysis and ranking of the results that received, reflecting the work of a DC and graduate schools, will allow us to create an environment that will match the essential requirements of the OS.

Working in it, scientists can not only efficiently receive, but also to pass scientific knowledge to each other and the world community. Using of the electronic repositories, publication of research results in collections that have electronic copies and indexed by international databases will increase the coverage of scientific publications that will help to improve their visibility, citation, the development of interdisciplinary research.

As we see from Sect. 5, today we have not only offer to build a system of this level, but also some ready-made solutions to efficiently manage many operations of post-graduate and DC. The next step is the developing of the Web-services for the automation of a DC and GS, the establishment of guidelines and training courses for candidates to use ICT in science, in the course of post-graduate studies and dissertations defense.

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