Scientific Social Networks in the System of Presentation of Scientific Content

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Abstract. The article defines the positions of scientific social networks in the system of presentation and dissemination of scientific content. The research is conducted in the aspect of conformity of technical characteristics of electronic scientific sources with the requirements of the convenience of meeting information needs. To this purpose, two groups of formalized technical characteristics of scientific content, which form the basis for determining indicators such as cross-platforming, accessibility and visibility, have been proposed. Through the offered basic indicators the complex indicator of usability of scientific content is determined. These are important indicators for decision-making in assessing the quality of scientific sources to meet the information needs of consumers of scientific content. In accordance with the proposed formalized technical characteristics, an analysis of scientific publications of periodicals indexed in the Scopus database by quartiles in the subject area "Library and Information Science". The coverage of the study is 200 scientific publications of 1-4 quartiles. The leader in the placement of full-text versions of the analyzed publications in all quartiles is the specialized social network for scientists Research Gate. Across the sample, Research Gate offers access to 88 publications as opposed to Academia.edu, which offers access to 11 publications. In general, social networks provide access to full-text versions of 49% of the analyzed publications, which improves their visibility and ccessibility, and contributes to meeting the information needs of consumers of scientific content.

Keywords: scientific social networks, scientific content, electronic scientific document, information needs, evaluation of scientific content.

1 Introduction

Advances in IT have become a powerful impetus for the transformation of scientific communication. The journal model, as the main mechanism for disseminating new scientific knowledge, has undergone significant changes and has received many alternatives. A new level of scientific communication system's development was marked by the emergence of specialized resources in the information industry market: social networks for scientists, repositories, electronic archives, bibliometric systems covering databases of peer-reviewed scientific literature, as well as bibliographic managers. Recently, there has been a growing interest in exploring various aspects of scientific communication in the context of the presentation and dissemination of scientific content. In this context, the topical issues for lively discussions are the expediency of providing open access to scientific knowledge and the specificity of assessing its quality. The scientific community has not yet reached unity in providing open access because of significant ethical and technical risks [19]. The use of open science practices contributes to the openness, integrity and reproducibility of scientific research [3]. In terms of quantitative evaluation of the results of scientific activities, open access provides "visibility" of scientific content and therefore promotes its citation [7; 8]. An important area of research of the system of presentation of scientific content based on the journal model is to assess the importance of social networks in terms of dissemination of electronic scientific documents and meeting information needs of scientists.

The purpose of the study is to determine the position of scientific social networks in the system of presentation of scientific content. To achieve this goal, it is necessary to complete the following tasks:

- to define formalized technical characteristics of electronic scientific documents;
- to correlate the technical characteristics of scientific content with the convenience of meeting information needs;
- to analyze the positioning of social networks in the system of certain technical characteristics of electronic scientific documents.

2 Methodology

The research is based on the use of such methods as analysis, synthesis, mathematical formalization, grouping, stratification, statistical method. Analysis and synthesis are the basis for identifying the technical characteristics of electronic scientific documents. The method of mathematical formalization was used to analytically represent the identified technical characteristics of the scientific content and the following indicators of its quality: usability, cross-platforming, accessibility and visibility of scientific content. By the proposed formalized technical characteristics, an analysis of scientific publications of periodicals was carried out. It provided the following:

1. forming a sample of 10 Open Access scientific journals indexed in the Scopus abstract database in the Library and Information Science subject area in each quartile of Q1, Q2, Q3 and Q4 (40 journals in total);
2. analysis of the websites of the selected journals to identify the technical characteristics of the 5 recent scientific publications: file format, file size, type of file access rights, availability of abstracts, full-text availability (200 publications in total);
3. analysis of publications using Google Scholar search engine to identify characteristics: number of available versions, accessibility through social networks, accessibility through e-archives / repositories; if the journal is polylingual, several language versions of the same document can be submitted on the journal's website, in which case we search for the full texts in all the languages presented for completeness of the search result.

Statistical analysis of the collected analytical data was carried out, the structure of the system of presentation of scientific content and the position of scientific social networks within the system were determined.

3 Related Works

The issue of the scientific content's presentation in the system of scientific social networks is studied in various aspects.

3.1 Legislative and normative regulation of information retrieval

The functioning of scientific information in the conditions of informatization of all spheres of public life causes actualization of the question of legislative and normative regulation of information search for conducting scientific research. The information society raises the necessity of legislative regulation of the features of copyright to meet the information needs of users. The Copyright Directive in the Digital Single Market is considered. It substantiates the concept of sui generis database right. The research covers the issues of the functioning of libraries and repositories in the context of the new legislation [11].

3.2 Scientometric research

Scientometric review of the evolution of digital forensics research covers the sources from 1990 to 2019. Common keyword cloud, surging keywords and co-citation networks were visualized using CiteSpace V technologies (Visualizing Patterns and Trends in Scientific Literature). Based on the analysis, it was established the following: the research contents of digital forensics cover a wide range of traditional and innovative issues (basic theory and methods, physical equipment and forensic methods, image forgery identification, file recovery and data extraction, smartphones and social network forensics, case-based forensics and crime forensics,

automatic identification technology and tools, cloud computing and cloud forensics); the research evolutional paths were followed by storage media, image forensics technologies, data recovery technologies, encryption and decryption technologies, human and social characteristics; The breakthrough of image forgery identification technology accelerated the development of digital forensics; smartphone and social network forensics and automated forensics technologies bring important paradigm changes; in the future, automatic forensics and cloud forensics will be hot research directions [9].

3.3 Conceptual modelling of information needs

The conceptual framework of information needs that are developed on the interconnection of information needs and work tasks. It shows that task-based information needs depend on both individual characteristics of users and work task context. The conceptual framework of information needs is considered as a symbiosis of horizontal and vertical relationships to meet information needs. Horizontal relationships imply the direct and consistent search for information in various, heterogeneous sources, in particular in social networks. In modern conditions, it has acquired the status of a significant source of information. Vertical relationships determine the context of the job: communication of general and specific tasks, interaction with the source of information, communication with parallel information needs. Thus, the framework is formed by the sequential, vertical and horizontal relationships, which form the analytical network of information search according to the work task [4]. Algorithms of search behaviour of users in the context of interactive social book search technology (SBS) using socially constructed metadata on the basic and multi-stage user interfaces are presented. It proves that the search engine, the user interface (UI), and the nature of the tasks influence the behaviour of users during book searching. This research is relevant and important for experts in the field of interface design, web search engine development, book search, digital libraries, social networks, web site cataloguing and e-commerce applications [18].

An information model of a community for online marketing, which is the basis for the accounting of information flows in online communities, is developed. Virtual communities in marketing activities are considered as participants in the communication process to make strategic and immediate decisions regarding specific actions and marketing events. For solving community selection tasks for the participation of representatives of the enterprise, the indicators of relevance and importance of online communities for marketing have been proposed [17].

Results of development of a formal approach for modelling the characteristics of users of social networks are given. Formalization and identification of characteristics of users of social networks are considered in the context of the problem of providing national security. Special attention is given to issues of exploring characteristics that describe the level of user interaction with other users and with communities [12].

3.4 Use of social networks in information search technologies

Social networks are an environment that contains a variety of different-branches information. They are the subject of various researches to determine the specific information needs of users. Social recommender systems (SRS) have got high popularity because they provide the user with the most relevant and attractive data using personalization techniques. Traditional recommender systems focused on information or document retrieval and then were extended with methods for music or movie recommendations. SRS are useful especially in the context of online stores: the user can quickly find relevant products, and the company can improve their revenue by recommending additional products. SRS are also used in the search for scientific information. Usually, researchers are looking for relevant papers using some search engines. A method that combines content-based, collaborative and social approaches was proposed. This method has been successfully used to find a journal or a conference for publication [10].The use of social networks in libraries of the Nordic countries has been analyzed. Communication technologies applied on 579 library websites and documentation centres in Denmark, Finland, Sweden and Iceland were studied. A topical issue is the distribution of posts from major social networks (Facebook, Twitter, Instagram, YouTube) on websites. Representation of scientific works in social networks of libraries is investigated. Mostly, social networks are used as a means of communication, distribution of content, facilitating online viewing of documents for news distribution, online courses provision and library events announcement. The libraries of the Nordic countries have relied on Web 2.0 technologies to meet the needs of their users [1]. The processes of information search optimization in search engines are explained, based on R. Taylor's theory on levels of users' of "visceral" information needs. A model of a modern organic and human-centric search engine information system for meeting the real information needs of users is described [6].

The problem of specifying a keyword-based query to extract data from structured databases is an important area of research. They are based on finding a set of interrelated tuples containing query keywords. The study covers the following: the selection of databases on the Web; proximity between keywords; query segmentation; detection of aggregate functions; ranking of relevant results; conducting an empirical evaluation of results to confirm relevance and competitiveness of research [13].

The methods of automatic content analysis on health issues are represented. A differentiated approach to meeting information needs has been identified: there are different online platforms for different patients, including social networks. A hybrid method was used to identify the thematic spectrum of online resources, using qualitative and quantitative indicators, and simulated the information needs of patients using different online platforms. Peer-generated platforms cover advanced information on emotional support topics, expert-generated platforms covered informational topics. Thus, social networks provide valuable multidimensional health information [15].

3.5 The functioning of institutional repositories of scientific sources in scientific and traditional communication

Obstacles in scientific and traditional communication for free access to information in institutional repositories have been explored. The role of digital repositories of universities and research centres in improving the quality of scientific research is described. The main factors that enhance beneficiaries' access to intellectual products and contribute to the effectiveness of research include the following: improving the mechanisms, procedures and policies for providing digital repository services; publishing articles in arbitrated periodicals; self-archiving of electronic copies; preserving intellectual content and making it accessible to users; removing financial and legal barriers to access information. The role of the Web in creating forms of scientific communication, providing open access for the implementation of scientific research, is particularly emphasized. at the same time, lack of openness for non-associated users declines access to the digital repository, scientific communication and complicates the management of intellectual property rights for beneficiaries [2].

The experience of forming the Dyuthi university repository of Cochin University of Science and Technology in Kerala, India, is generalized. Through a voluntary survey conducted by faculty members, it was found that a high level of awareness of the repository's resources was combined with the ability to satisfy their information needs. However, teachers exhibit a low level of mastery of self-archiving technologies in Dyuthi and other information resources, preferring traditional preservation strategies to store their works. It is suggested to increase Dyuthi's potential by enhancing repository features by implementing social communication technologies: commenting add-ons, request full-text copy add-ons, controlled vocabulary add-ons, the web of communication add-ons, restricted access, and storage facility similar to Google Drive [16].

The technology of open access and archiving of scientific publications used by the French National Centre for Scientific Research is presented. The Center performs the following functions: creation of full-text international databases, self-archiving by scientists, long-term preservation. The Centre has strong technical and information support, uses Eprint technology adapted to the French language, actively cooperates with national and international information centres [5].

The concept of Open Access to scientific publications gives the theoretical basis of a model of access to scientific knowledge, free from the limitations of traditional publishing and technologically supported by the Internet. The Scientific Repository of the Castello Branco Polytechnic Institute functions as an information system that allows preservation, storage and dissemination of scientific knowledge produced at the university. The repository promotes open access, increases the visibility and citation level of the scientific works, promotes minimizing plagiarism of content. The study was conducted to analyze the efficiency of the repository by considering the evolution and growth of the number of users, archiving and self-archiving, the number of published scientific documents. A survey distributed among members of the community was also conducted. The research shows that the strategy of repository

functioning is correct, but needs improvement to increase the access of users to the information resources [14].

Thus, the functional and content potential of scientific social networks is an organic component of scientific research in following aspects: legislative and normative regulation of information retrieval, scientometric research, conceptual modelling of information needs, use of social networks in information search technologies, the functioning of institutional repositories of scientific documents in the system of scientific and traditional communication.

4 Formalization of technical characteristics of scientific content

The technical characteristics of the scientific content determine the type of information recorded in the electronic document and the options for accessing it. Analysis of the system of presentation and dissemination of scientific content based on the journal model has allowed distinguishing two groups of indicators:

- features of types of information recording;
- information availability features (see Table 1).

Table 1. Technical characteristics of scientific content

Characteristic	Symbol	Domain	Comment
Features of the type of information recording			
File format	CTFF	list of formats	DOC, PDF, HTML…
File size	CTFS	numeric	
File access type	CTFA	list of access rights	reading, downloading
Information accessibility features			
Availability of abstract materials	CTAM	{0,1}	Abstract, keywords, citation list
Full-text availability	CTFT	{0,1}	full text not available, full text available
Number of available versions	CTFV	natural number	
Accessibility via social networks	CTSN	{0,1}	not accessible via social networks, accessible via social networks
Accessibility via e-archives / repositories	CTFR	{0,1}	not accessible via e-archives, accessible via e-archives

Formalization and systematic elaboration of technical characteristics is an important element for the implementation of a software-algorithmic complex of

search and evaluation of the quality of scientific content. The mechanism for determining these characteristics is content analysis through specialized search engines. The main purpose of these characteristics is to determine indicators of such scientific content as cross-platforming, accessibility and visibility.

We consider the cross-platforming of scientific content as an opportunity to use it via various software and hardware platforms. This metric is determined by the features of the types of information recording, such as File format and File size:

$$ConCP(Con_i) = \frac{\mathrm{CTFS}(Con_i)CWF^{(\mathrm{CTFS})} + CFF(\mathrm{CTFF}(Con_i)CWF^{(\mathrm{CTFF})}}{CWF^{(\mathrm{CTFS})} + CWF^{(\mathrm{CTFF})}}, \quad (1)$$

where $CWF^{(\mathrm{CTFS})}, CWF^{(\mathrm{CTFF})}$ – weighting coefficients of the relevant characteristics; $0 < CFF(\mathrm{CTFF}(Con_i) < 1$ – the coefficient of the characteristic File format of scientific content.

We define the accessibility of the scientific content as a measure of the user's ability to process content. This metric is determined by information accessibility characteristics such as the Availability of abstracts, Full-text availability, and the feature of the type of information recording, such as File access rights:

$$ConAcc(Con_i) = \frac{\mathrm{CTFA}(Con_i)CWF^{(\mathrm{CTFA})} + \mathrm{CTAM}(Con_i)CWF^{(\mathrm{CTAM})} + \mathrm{CTFT}(Con_i)CWF^{(\mathrm{CTFT})}}{CWF^{(\mathrm{CTFA})} + CWF^{(\mathrm{CTAM})} + CWF^{(\mathrm{CTFT})}}, \quad (2)$$

where $CWF^{(\mathrm{CTFA})}, CWF^{(\mathrm{CTAM})}, CWF^{(\mathrm{CTFT})}$ – weighting coefficients of the relevant characteristics.

Visibility of scientific content is defined as an indicator of the availability of electronic document versions on other Internet resources. This metric is determined by information accessibility features, such as the Number of available versions, Accessibility via social networks, Accessibility via e-archives / repositories:

$$ConVis(Con_i) = \frac{CTFT(Con_i)CWF^{(CTFT)} + \mathrm{CTSN}(Con_i)CWF^{(\mathrm{CTSN})} + \mathrm{CTFR}(Con_i)CWF^{(\mathrm{CTFR})}}{CWF^{(CTFT)} + CWF^{(\mathrm{CTSN})} + CWF^{(\mathrm{CTFR})}}, \quad (3)$$

where $CWF^{(CTFT)}, CWF^{(\mathrm{CTSN})}, CWF^{(\mathrm{CTFR})}$ – weighting coefficients of the relevant characteristics.

Weighting coefficients can be set by the expert method. Their value varies depending on the particular information needs of different groups of consumers of scientific content.

By the proposed basic technical indicators, we define a comprehensive indicator of the usability of scientific content:

$$ConUs(Con_i) = ConCP(Con_i) + ConAcc(Con_i) + ConVis(Con_i) \quad (4)$$

These indicators are important for decision-making in evaluating the quality of scientific sources for the convenience and ease of meeting the information needs of consumers of scientific content.

5 Results

Following the chosen methodology, we analyze the positioning of social networks in the system of certain formalized technical characteristics of scientific content:

- Format: HTML - only if the full text of the article is presented on the journal site in HTML format;
- Permissions: reading and downloading the article is possible from the journal site without prior registration and payment;
- File size: downloadable PDF file size
- Preview accessibility:

– "full text" if there is a full text of the article directly on the journal's web site that does not need to be pre-load for familiarization (in HTML or PDF format);
– abstract, keywords, references are directly on the journal's web site that do not need to be preloaded for familiarization (in HTML format);

- Full text availability:

– journal site, if full text is available from the journal web site without prior registration;
– social networks, if the full text of the article can be viewed or downloaded from the author's profile on the social network;
– e-archives / repositories if the full text of the article can be viewed or downloaded from the e-archives / repositories;

- Number of versions available: the number of versions of the publication that were identified using the Google Scholar search engine.

A total of 200 recent scientific publications, presented on 40 Open Access periodicals (10 journals in each quartile Q1, Q2, Q3 and Q4) indexed in the Scopus abstract database in the Library and Information subject area, were analyzed. The results of the statistical analysis of the collected analytical data to establish the conformity of scientific content to certain technical characteristics and the positioning of scientific social networks in the system of presentation of scientific content are presented in table 2.

Table 2. Compliance of scientific content with technical characteristics

Characteristics	Comments	Q1	Q2	Q3	Q4	Total	Total, %
Format file (total number of publication in the quartile)	PDF searchable image exact	40	40	45	50	175	87
	PDF interactive	-	-	-	-	-	0
	PDF image only	10	-	5	-	15	7
Format file (total number of publication	HTML (if the full text at the	25	20	25	20	90	45

in the quartile)	web site)						
	XML	-	10	-	-	10	5
	ZIP (audio archives)	-	1	-	-	1	0,5
File size (average per quartile)	КБ	1564	1369	647	884	1116	
Access right (total number of publication in the quartile)	The need for registration	10	-	-	-	10	5
	Reading	50	50	50	50	200	100
	Download	50	40	50	50	190	95
Availability in mode «Preview» (total number of publication in the quartile)	Full text	30	30	40	35	135	67
	Abstract	40	44	50	40	174	87
	Keywords	35	25	25	40	125	62
	References	10	20	20	24	74	37
Accessibility of full text (total number of publication in the quartile)	Journal's web site	50	50	50	50	200	100
	Social networks	25	25	24	25	99	49
	E-archives, repositories	20	34	29	30	113	56
Available versions (average per quartile)	Numeric	2	4	3	4	3	

As the results of the study show, the most common format for presenting scientific content is PDF searchable image exact (87% of all analyzed publications), which allows to view, copy and search within a document. An interesting thing is when audio archives have been added to the publication. Although all the analyzed scientific journals are distributed according to the principle of open science, 5% of them require pre-registration to get acquainted with the archive of issues, which we consider as a barrier in meeting information needs.

The size of electronic documents within the analyzed sample of journals varies widely and is determined directly by the requirements of the editorial board for the volume and content of scientific publications. However, the analytical data revealed a certain pattern: the average size of publication files in 1st and 2nd quartiles' jornals is 1.5-2.5 times larger than in 3rd and 4th quartiles' jornals.

An analysis of the access rights to electronic scientific documents showed that 5% of scientific publications do not allow downloading, which complicates their processing by users. Accessibility in preview mode is determined by the ability to read the scientific content without having to download it. The analyzed publications are available in preview mode in different volumes: 82% - abstract; 67% - full text; 62% are keywords; 37% - citation list.

An important aspect of the convenience of meeting information needs is the dissemination of scientific content through alternative information resources:

specialized social networks for scholars (49% of publications) and repositories (56% of publications). Interestingly, the number of publications posted on the personal profiles of scientists on social networks is the same regardless of quartile. That is, social networks act as an active medium for promoting scientific content directly by its author. Concerning e-archives and repositories, the smallest number of publications placed in these resources belongs to 1 quartile. This can be explained by the fact that the first quartile editions are in the highest positions of the ratings and do not make additional promotion. In contrast, lower-ranked editions seek to improve their visibility.

Google Scholar search has identified scientific social networks with available full-text versions of the analyzed publications: Research Gate and Academia.edu (see Figure 1).

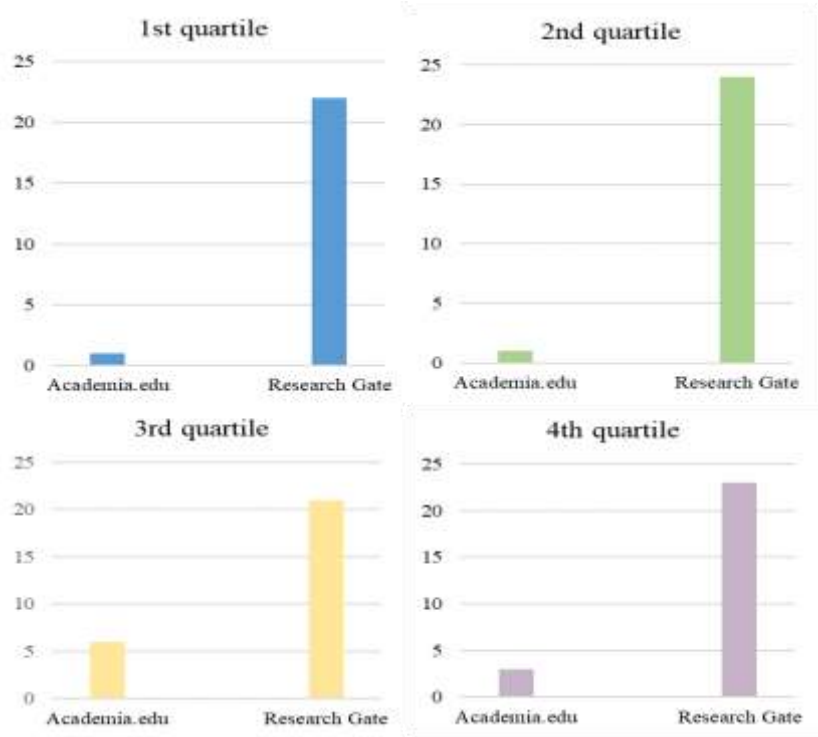

Fig. 1. Allocation of versions of scientific publications on social networks

The leader in the placement of full-text versions of the analyzed publications in all quartiles is the specialized social network for scientists Research Gate. Throughout the sample, Research Gate offers access to 88 publications as opposed to Academia.edu, which offers access only to 11 publications. In general, social networks provide access to full-text versions of 49% of the analyzed publications, which significantly improves their visibility and helps to improve the information needs of consumers of scientific content.

6 Conclusion

An important aspect of evaluating the quality of scientific content is determining the level of convenience of meeting information needs. In the context of the implementation of the journal model for the presentation and dissemination of scientific content through Internet resources, a major problem is to bring the technical characteristics of electronic scientific documents in line with the priorities of users. On this basis, two groups of formalized technical characteristics of scientific content were formed:

- features of the types of recording information that covers the File format, File size, File access type;
- accessibility features of the information that covers the Availability of abstract materials, Full-text availability, Number of available versions, Accessibility via social networks, Accessibility via e-archives / repositories.

Proposed characteristic are the basis for determining such indicators as cross-platforming, accessibility and visibility of the scientific content, as well as a comprehensive indicator of the usability of scientific content.

These indicators are important for decision-making in evaluating the quality of scientific sources to meet the information needs of consumers of scientific content. An essential element in determining the accessibility, visibility and overall usability of scientific content is its availability via social networks.

The analysis of scientific publications of periodicals indexed in the Scopus database regarding the correspondence of the formed groups of technical characteristics allowed positioning scientific social networks in the system of presentation and distribution of content. It is found that social networks provide access to full-text versions of 49% of the analyzed publications, which significantly improves their visibility and helps to increase the level of satisfaction of information needs of consumers of scientific content. In parallel with social networks, the practice of placing scientific documents in e-archives and university repositories, which contain full-text versions of 56% of all analyzed publications, is actively used. The leader in the placement of full-text versions of the analyzed publications in all quartiles is the specialized social network for scientists Research Gate.

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