Social Networks as an Alternative Environment for the Implementation of Scientific Communication

Alina Petrushka[1][0000-0002-8769-4599], Maria Komova[2][0000-0002-4115-3690], Ivan Demydov[3][0000-0002-1221-3885]

Lviv Polytechnic National University, S. Bandera str. 12, 79013 Lviv, Ukraine
alina.stashko@gmail.com[1], maria.komova@gmail.com[2], ivan.demydov@gmail.com[3]

Abstract. The article realizes the goal of identifying the potential of social networks to ensure the completeness of the implementation of scientific communication. For this purpose, identification of information resources for scientific communication has been conducted. Grouping and classification of social scientific networks, analysis of the functional assignment of resources and their ranking for the coverage of services were carried out. Social scientific networks were analyzed on the subject of completeness of providing various aspects of scientific activity: satisfaction of information needs of a scientist, establishment of scientific communication, promotion of scientific results, library and bibliographic support of the scientific activity and evaluation of scientific results. Comparison of the social networks' status on various indicators allows identifying the following patterns: according to the coverage of services social networks reveal a small spread of indicators; gradation of similar resources by the frequency of mentions in the search results showed a significant spread of indicators; ResearchGate is the only social scientific network that retains the dominant position in both graduation rates.

Keywords: social network, scientific community, scientific communication, services, altmetrics.

1 Introduction

The application of social networks for scientific communication and use of traditional and alternative metrics evaluation of scientific importance publications widely discussed in special journals and electronic sources. Evolution of the development of social networks as an environment for scientific communication has been investigated by José Luis Ortega. The author considered that Nature Network and BiomedExperts are the first special social networks. These resources have been determined as different by structural construction and function-ing concepts, but identical by the common goal: to become a platform for social communication for researchers. Scholar qualifies CiteULike and BibSonomy as the most representative social book-marking services that illustrate the impact of folksonomy and social tagging on the development of the first social networks. The analysis of Mendeley and Zotero has been conducted

in terms of their potential for reference management as well as the implementation of additional functions for bibliographic search. ResearchGate and Academia.edu were identified as the most important examples of document sharing sites. According to the scientist, these platforms can be considered the last stage of the evolution of social networking sites, the resources of which involves the exchange of documents as the main interactive activity among researchers [18].

A new media system dependency theory as one of the prominent theories in terms of deepening making interdisciplinary links in scientific communication has been suggested by Jafar Mehrad and Zahra Yousefi. Researchers introduced its application in theoretical studies in computer science and knowledge. Especially in the studies of fields such as information seeking and searching, collection development, notices and service dissemination, information recovery, and also the field of promoting reading [16].

Numerous traditional and alternative metrics actualizes the issue of their effectiveness. A comprehensive model for the evaluation of the scientists' achievements, based on a systematic review of literature on metrics and models, is proposed. All Web of Science databases (including Core Collection, MEDLINE and BIOSIS Citation Index) have been analyzed. Established approaches (citations and outputs, h-index and journal impact factor) remained dominant in the literature and in practice. New bibliometric methods including: measures based on PageRank algorithms or 'altmetric' data, methods to apply peer judgement and techniques to assign values to publication quantity and quality. Each assessment method tended to prioritise certain aspects of achievement over others [3].

Haunschild, R. and Bornmann, L. continued to search for an optimal methodology for using Web indicators to evaluate scientific achievements. They proposed the normalization of sectoral and time indicators for measuring scattered data. The new indicators were suggested (Mantel–Haenszel quotient, MHq) to aggregate data from different groups of Twitter. The conducted research confirmed that the MHq index meets the requirements of convergent validity and is capable of reflecting the qualitative characteristics of scientific activity [8].

In order to determine the effectiveness of search engine the open access multidisciplinary citation database Google Scholar was investigated. As result of the representative thematic search, it was found that the system is able to provide a wide search result: more than 1000 records even for a very specific search query. Highly cited papers reflect only part of the results and do not allow you to set the exact number of documents from the selected topic. The question of the effectiveness of the search, the choice of the rational search strategy is considered. Search effectiveness is reduced by the presence of semantic and linguistic barriers: the incompatibility of queries and documents on the language, the precise wording of the search query [9].

The field of studying the effectiveness of the search engine of a particular database can be defined by the topics with different levels of relevance. With the growth of rivalry in the education sphere there are an urgent set of issues related with protecting system of University information image from deliberate hostile actions, defining scenarios of development of educational web forum, formatting of information image of

the University as a result of Web communities activity, defining institution with low informational activity. [11-13; 24].

A common problem is the comparative analysis of the potential of various databases, traditional and alternative metrics. The actual study of the connection between traditional citation indicators and alternative metrics is presented by Nosrat Riahinia. Comparing the results of the search for relevant articles in Essential Science Indicators (ESI) and Web of Science (WoS) databases and then in Mendeley, author has defined the number of article readers and their academic status. An actual study of the connection between traditional citation indicators and alternate metrics for Mendeley. The results of the study confirm two hypotheses: 1. readers' indexes and citations in Mendeley have a significant positive correlation with the indicators in ESI and WoS; 2. The most frequently cited articles in ESI and WoS have attracted more readers in Mendeley than low-cited publications. The research confirms the considerable potential of Mendeley in tagging articles, creation of searchable folksonomy of information and bibliography management as a source of data in information retrieval studies [22].

The conceptual model of citation research with the help of altmetrics in a social network for scientists is offered Mendeley, CiteULike and Figshare web services and common social media: Twitter, Facebook and Wikipedia. The representative sample of articles, implemented with the help of altmetrics PLOS, has shown that Mendeley has the highest rates of influence on the state of scientific works' citation. Mendeley plays a significant role in citing through the mediator factor. Twitter also has some positive value for citing through the mediator factor. At the same time, CiteULike and Figshare, Facebook and Wikipedia do not open a productive way to cite [5].

The introduction of informational journals on Facebook and the analysis of altmetric data abuot interaction between scientists and published articles was investigated. The collection of altmetric data for assessing the importance of the articles' content and comments was carried out through the interface of Facebook applications [2].

The connection between the citing counting indicator and altmetricts or new metrics in medical journals that have the highest indexes in the Scopus databases and have been selected as a research group from the Scimago Journal (SJR) is studied. Significant correlation between the altmetrics of the scientific journals through F1000, Mention, Facebook, and News and their citations was discovered. There was no significant correlation between altmetrics of Reddit, Blog posts, Google+, Tweets and citations [23]. The question of the scientific significance of the text, the intellectual aspects of academic integrity, is the subject of a few publications.

The question of the scientific significance of the text from the point of view of semantic similarity was explored with the help of a collection of open access articles from PubMed. Calculations of text similarity reveal up to 77% of the semantic similarity of scientific content. The following patterns have been found: in homogeneous branch environments, the effective discovery of the semantic similarity of the text is provided by abstracts, whereas in heterogeneous environments a complete elaboration of texts or databases is required [25]. The questions of the quality of the theses' abstracts on the basis of ANSI / NISO Z39.14 (R2015) have been studied. Abstracts are considered as a valuable tool for assessing the conformity of documents while seeking information. The study shows that a model for writing abstracts should be developed on

the basis of international standards [10]. Differences in the methodology of data collection in social media, which may have an influence on the analytical use of altmetric data, are investigated. The results of the research show that different forms of accessing data from various social media platforms, with different approaches to collect, at operating a generalization and update social media metrics leads to significant differences in data and indicators [26]. The demographic characteristics of Mendeley and Zotero users, their relation to the key issues of scientific communication (open access, expert evaluation, the confidentiality of the information) were analyzed. . Results show strong differences between platforms: Mendeley users are younger and more gender-balanced; Zotero users are more engaged in social media and more likely to come from the social sciences and humanities. Zotero users are more likely to use the platform's search functions and to organize their libraries, while Mendeley users are more likely to take advantage of some of the discovery and networking features such as browsing papers and groups and connecting with other users [4]. The connection between altmetrics and traditional forms of scientific communication, such as journal articles and references to cited sources, is investigated [15]. The current issue of the prospect of the altmetric version of the bibliometry regarding the evaluation of the influence and importance of the publication. Altmetric and bibliometric analysis apply to the most significant articles in each branch. The hypothesis is substantiated: the high citability of the articles can positively correlate with the levels of the article importance, which is confirmed by the altmetric estimation (AS) and ranking. To verify the hypothesis, authot analyzed 100 most cited articles by subject, journal, author, year, institution and AS. The conducted research made it possible to assert that the bibliometric and altmetric analyzes reveal important, but different perspectives for determining the importance of the article [19].

2 Research Results

2.1 Algorithm for Searching and Selecting Social Scientific Networks

Proposed algorithm for searching and selection of social scientific networks involves the use of Internet resources without exploitation of special software and hardware. Following steps are allocated:

- formation of information queries
- information retrieval according to the search queries
- content analysis of search results
- identification and accounting of the nominations of social scientific networks.

Formation of search query and information retrieval conduction. Search queries were formulated based on the general principles of search engines. Namely, search queries are phrases – the keywords that most closely correspond to the need identification and selection of social networks for scientific communication:

- social scientific network
- scientific communication

– scientific networking
– scientific sharing.

Content analysis of search results. Investigation of four search queries whose semantics are practically synonymous indicates a different level of relevancy between the search query and the search result in each case. It turns out to be a large discrepancy of obtained results, depending on selected keywords to form the search image of the document. By means of content analysis of the first 50 search result engine pages for each of the search queries, in general, 41 social networks were identified. These social networks have been grouped and ranked by frequency of mentions in the search results. The greatest completeness of the results was obtained by query "social scientific network" (see Table 1).

Table 1. Identified social networks on information query «social scientific network».

Rank	Social networks	Frequency of mentions in the search results
1	ResearchGate	20
2	Mendeley, Twitter, Academia.edu	13
3	Linkedin	12
4	Facebook	9
5	BiomedExpert	7
6	CiteUlike, GoogleScholar, Google+	4
7	Frontiers (Loop), ResearcherID,	3
8	Zotero, Figshare, PubMed, Connotea	2
9	Scilinks LabsExplorer, Selectmindes.com, neeetz, DoctorsHangout.com, Ozmosis, Sermo, NatureNetwork, BibSonomy, DockChek, Docteo, Agrivivo, Scienceblogs, Laboratree, myExperiment, Epernicus, Scitable, ScienceSocialCommunity, GitHub, ResearchBlogging, SlideShare, Kudos, MyscienceWork, UnitedAcademics, LabRoots	1

Significantly less complete results were provided by query "scientific communication". No social network nomination has been identified by searching for "scientific networking" and "scientific sharing" (see Table 2).

Table 2. Identified social networks on information query «Scientific communication».

Rank	Social networks	Frequency of mentions in the search results
1	Facebook	3
2	Twitter	2
3	Linkedin, Google+	1

2.2 Selection criteria of social networks for scientific communication

To determine the object of research, we draw up a classification scheme for social networks that researcher can use for open scientific communication:

– by the frequency of mentions in the search results (see Table 1, Table 2)
– by the classification features (see Table 3).

Table 3. Classification features of social networks.

Feature	Species	Subspecies	Social network
Possibility of joining	Public (allowing anyone to join)		ResearchGate, Mendeley, Twitter, Academia.edu, Linkedin, Facebook, BiomedExperts, CiteUlike, GoogleScholar, Google+, Frontiers (Loop), ResearcherID, Zotero, Figshare, PubMed, Connotea
	Non-public (not allowing anyone to join)		–
Breadth of content coverage	Specialized	Professional	ResearchGate, Mendeley, Academia.edu, BiomedExperts, CiteUlike, GoogleScholar, Frontiers (Loop), ResearcherID, Zotero, Figshare, PubMed, Connotea
		Corporate	–
	Non-specialized		Twitter, Linkedin, Facebook, Google+
Disciplines	Universal		ResearchGate, Mendeley, Academia.edu, CiteUlike, GoogleScholar, Frontiers (Loop), ResearcherID, Zotero, Figshare, Connotea
	Sectoral		BiomedExperts.com, PubMed

By the frequency of references in the search results, we select the social networks that were mentioned more than once. These resources are ResearchGate, Mendeley, Twitter, Academia.edu, LinkedIn, Facebook, BiomedExperts, CiteUlike, GoogleScholar, Google+, Frontiers (Loop), ResearcherID, Zotero, Figshare, PubMed, Connotea.
On the basis of classification features we select public specialized information resources of a universal direction. Such selection criteria are the ResearchGate [20], Mendeley [17], Academia.edu [1], CiteUlike, GoogleScholar [6], Frontiers (Loop) [14], ResearcherID [21], Zotero [27], Figshare [7], and Connotea social science networks. Given that CiteUlike and Connotea have officially ceased to exist, we consider that their analysis is not feasible.

2.3 Analysis of the functionality of social scientific networks

Selected social scientific networks are analyzed on the subject of completeness of providing various aspects of scientific activity. Main aspects of scientific activity include:

- satisfaction of information needs of a scientist
- establishment of scientific communication
- promotion of scientific results
- library and bibliographic support of the scientific activity
- evaluation of scientific results.

Each of the identified aspects reflects the specific needs of the scientific community. The list of services offering social networks is a measure of satisfaction of these needs. After analyzing the resources of each of the selected social networks, the list of services that they provide was identified. Identified services were grouped according to certain aspects of scientific activity. This approach allowed to establish not only the functional capabilities of social scientific networks but also to compare tools to satisfy the specific needs of the scientific community. Thus, the analysis will establish:

- ranking of social scientific networks by the breadth of the offered services
- ranking of services according to their representation in social networks.

Satisfaction of information needs of a scientist. The information needs of the researcher are primarily related to the need searching interesting scientific content, scientific and popular science events, monitoring grants and projects, as well as the opportunity to take part in live scientific discussion through scientific blogs, forums.
The most comprehensive coverage of the information needs of researchers is offered by ResearchGate, which has the maximum amount of services for this purpose. The Mendeley, Academia.edu, ResearcherID (Publons) and Figshare networks cover 67% of the offered services. The level of information needs satisfaction of scientists by other networks puts Frontiers (Loop) – 50%, Zotero vbn – 33%, GoogleScholar – 17% (see Table 4).

Table 4. Satisfaction of information needs of a scientist.

Services of social network	ResearchGate	Mendeley	Academia.edu	GoogleScholar	Frontiers (Loop)	ResearcherID (Publons)	Zotero	Figshare
Search for scientific conferences and popular science	+				+	+		+

Services of social network	ResearchGate	Mendeley	Academia.edu	GoogleScholar	Frontiers (Loop)	ResearcherID (Publons)	Zotero	Figshare
events								
Search for researchers and publications	+	+	+	+	+	+	+	+
Monitoring grants, scientific projects	+	+	+		+			+
Scientific jobs offer	+	+	+			+		
Thematic blogs, forums, public groups	+	+	+			+	+	+
"Ask question - get answers"	+							

According to its representation in social scientific networks, the service Search for researchers and publications, which provide all the analyzed resources, became the most widely used. Selectively offered services: Thematic blogs, forums, public groups – in 75% of networks; Search for scientific conferences and popular science events – 62%, Scientific jobs offer – 50%. The exclusive service, which is the ability to receive from scientific community answers to the researcher's question, is offered only by the ResearchGate.

Establishment of scientific communication. The scientific activity involves establishing communication links in order to implement scientific collaboration and information exchange. This contributes to the increase of the efficiency and effectiveness of new scientific content formation.

In the field of scientific communication, the leader also is ResearchGate, which covers 100% of the offered services. Enough covering the similar services have networks: Mendeley, Academia.edu, Frontiers (Loop), Zotero, Figshare – 80%. GoogleScholar and ResearcherID (Publons) offer respectively 60% and 40% of the identified services.

Search partners for scientific cooperation is the base for all social networks. Variable are services: Add a list of co-authors and Follow other researchers, offered at 87% of resources; Monitor followers – at 62%; Groups by interests – at 37% (see Table 5).

Table 5. Establishment of scientific communication.

Services of social network	ResearchGate	Mendeley	Academia.edu	GoogleScholar	Frontiers (Loop)	ResearcherID (Publons)	Zotero	Figshare
Search partners for scientific collaboration	+	+	+	+	+	+	+	+
Add list of co-authors	+	+	+	+	+	+		+
Groups by interests	+	+					+	
Follow other researchers	+	+	+	+	+		+	+
Monitor followers	+		+		+		+	+

Promotion of scientific results. Effective management of research activities is considered as a factor in the implementation of a successful scientific project at all stages of its life cycle. The key stage of the life cycle is the promotion of the scientific results, which involves providing maximum visibility in the scientific information space. Social scientific networks have a significant potential for dissemination and exchange of scientific information.

As regards the promotion of scientific results, none of the analyzed social networks does fully cover all the services offered. The leader in this area is ResearcherID (Publons), which offers 89% of all services. Networking has somewhat less coverage: Frontiers (Loop) – 78%, Mendeley – 72%, ResearchGate, Figshare – 67%. Less than half of the offered services are provided by GoogleScholar – 50%, Zotero – 44% and Academia.edu – 39%.

The basic services for promoting scientific activity are Create a personal scientific profile, Upload full-text publications and Add information about skills, interests and achievements provided by all social science networks analyzed. Services are widely available from Add links to other profiles, Add a list of scientific publications – in 87% of networks. Services with Add alternate names and Add information about editorial and peer review activity cover respectively 75% and 62% of social networks. The services of Create projects, Add a list of reviews, Add a list of edited manuscripts, which offer only 25% of the resources, have become insignificant. Exclusive is the Generate personal researcher badge provided by ResearcherID (Publons) and the Create personal Website offered by Academia.edu (see Table 6).

Table 6. Promotion of scientific results.

Services of social network	ResearchGate	Mendeley	Academia.edu	GoogleScholar	Frontiers (Loop)	ResearcherID (Publons)	Zotero	Figshare
Create a personal scientific profile	+	+	+	+	+	+	+	+
Generate personal researcher badge						+		
Create personal Web-site			+					
Add alternate names	+	+	+	+		+		+
Add links to other profiles, IDs	+	+	+	+	+	+		+
Create projects	+							+
Add a list of scientific publications:	+	+		+	+	+	+	+
- manually	+	+		+	+	+	+	+
- automatically proposed;	+	+		+	+	+		
- import list from other Web-resourses		+			+	+	+	+
Upload full-text publications:	+	+	+	+	+	+	+	+
- manually	+	+	+		+	+	+	+
- automatically proposed;	+	+			+	+		
- import documents from other Web-resourses		+		+	+	+	+	+
Add information about editorial and peer review activity	+	+			+	+		+
Add a list of reviews					+	+		
Add a list of edited manuscripts					+	+		
Add information about skills, interests and achievements (CV)	+	+	+	+	+	+	+	+

Library and bibliographic support of the scientific activity. Social scientific networks actively offer services that facilitate and optimize scientific activity. They integrate a toolkit for the identification, collection, organization and exchange of scientific information, bibliographic management.

The most comprehensive library and bibliographic support of scientific activity is the social scientific network Figshare, which offers 80% of the services. Coverage of this area by other networks: ResearchGate, Mendeley, ResearcherID (Publons), Zotero – 60% of services; Academia.edu, GoogleScholar, Frontiers (Loop) – 40% of services.
All services of this direction are presented in social scientific networks selectively. Services have become the most widespread: Create own library of publication - in 87% of networks, Bibliographic management – in 75% of networks and Share publications with other researchers – in 62% of networks. The services provided by Get a DOI for own publication and Follow publications, which are offered at 25% of the resources, are insignificant (see Table 7).

Table 7. Library and bibliographic support of the scientific activity.

Services of social network	ResearchGate	Mendeley	Academia.edu	GoogleScholar	Frontiers (Loop)	ResearcherID (Publons)	Zotero	Figshare
Get a DOI for own publication	+							+
Bibliographic management		+		+	+	+	+	+
Create own library of publication	+	+	+	+		+	+	+
Follow publications					+	+		
Share publications with other researchers	+	+	+				+	+

Evaluation of scientific results. An important stage in the life cycle of scientific research is its evaluation. Today, social networks became the field of active introduction of alternative metrics for assessing the influence of a scientist and the quality of scientific content. Along with the based on citations counting traditional metrics the influence of a scientist is also determined by the number of views of his personal profile, views and downloads of his publications, as well as the achievements in other fields of scientific activity.
Services for evaluating scientific activities are also covered by social research networks selectively. Zotero does not offer tools for evaluating scientific results at all. ResearchGate and Frontiers (Loop) are active in this area, providing 72% of the services to promote scientific content. The coverage of this area with other resources is somewhat lower: Academia.edu – 54%; ResearcherID (Publons) and Figshare – by 45%; Mendeley and GoogleScholar – 36%.

The most common services for evaluating scientific activity are the Number of uploaded publications and Citations statistics, proposed by 87% of the networks. Reads statistics and Downloads statistics cover 62% and 50% of resources respectively. Less frequent services: Profile view statistics – in 37% of networks; Full-text reads statistics and Recommendations statistics – in 12% of networks. Separately, the applicable metrics should be considered. Traditional metrics (number of citations, h-index) are used by 37% of social science networks. The original alternative metrics use 62% of the resources (see Table 8).

Table 8. Evaluation of scientific results.

Services of social network	ResearchGate	Mendeley	Academia.edu	GoogleScholar	Frontiers (Loop)	ResearcherID (Publons)	Zotero	Figshare
Profile view statistics	+		+		+			
Number of uploaded publications	+	+	+	+	+	+		+
Reads statistics	+	+	+		+			+
Full-text reads statistics	+							
Downloads statistics	+		+		+			+
Citations statistics	+	+	+	+	+	+		+
Reviews statistics					+	+		
Editorial statistics					+	+		
Recommendations statistics	+							
Traditional metrics		+		+		+		
Original altmetrics	+		+	+	+			+

The research has shown that in the social scientific networks in the context of certain aspects of scientific activity inherent heterogeneity of ranking according to the coverage of the proposed services. Only in two of the six service groups (Satisfaction of information needs of a scientist and Establishment of scientific communication) ResearchGate is the explicit leader in providing services. In other groups, leadership has been distributed among other resources: the promotion of scientific results – ResearcherID (Publons); Bibliography and Bibliographic Support of the Scientific Activity – Figshare; Evaluation of Scientific Results – ResearchGate and Frontiers (Loop).

The continuous ranking of social scientific networks by covering the entire spectrum of services revealed the resources that most fully satisfy the needs of a scientist in the

conduct of the scientific activity. In this aspect, ResearchGate is the undisputed leader. However, Frontiers (Loop) and ResearcherID also show a fairly wide coverage of services. The second group of social science networks consist of resources Figshare, Mendeley and Academia.edu. GoogleScholar and Zotero have the lowest level of service offering (see Figure 1).

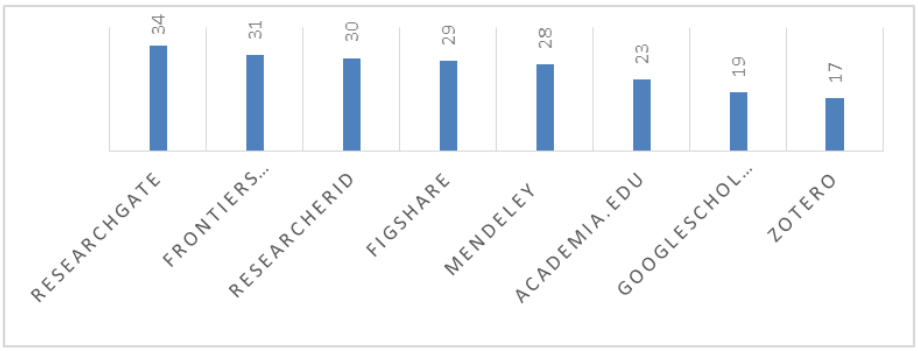

Fig. 1. Social scientific networks ranking by the frequency of mentions in search results.

The ranking of social scientific networks by the frequency of mentions in the search results revealed a significant difference in the status of the analyzed social networks (see Fig. 2).

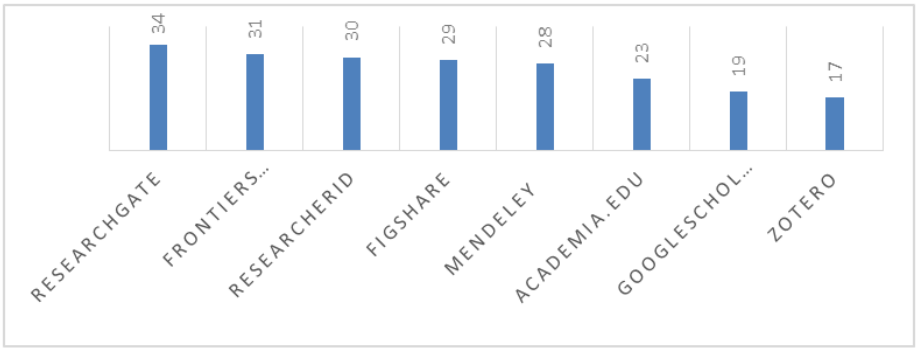

Fig. 2. Social scientific networks ranking by the breadth of the offered services.

Comparison of the social networks' status on various indicators allows identifying the following patterns:

- social networks according to the coverage of services reveal a small spread of indicators, the gradation of similar resources by the frequency of mentions in the search results showed a significant spread of indicators;
- ResearchGate is the only social scientific network that retains the dominant position in the gradation in both graduation rates.

3 Conclusion

The investigation of social scientific networks ResearchGate, Mendeley, Academia.edu, GoogleScholar, Frontiers (Loop), ResearcherID, Zotero and Figshare have been implemented in terms of service coverage to provide scientific activity. Selected social scientific networks were analyzed on the subject of completeness of providing various aspects of scientific activity: satisfaction of information needs of a scientist, establishment of scientific communication, promotion of scientific results, library and bibliographic support of the scientific activity and evaluation of scientific results. Identified services were grouped according to certain aspects of scientific activity. This approach allowed to establish functional capabilities of social scientific networks and tools to satisfy the specific needs of the scientific community. The analysis established ranking of social scientific networks by the breadth of the offered services and ranking of services according to their representation in social networks. Comparison of the social networks' status on various indicators allows identifying the following patterns: according to the coverage of services social networks reveal a small spread of indicators; gradation of similar resources by the frequency of mentions in the search results showed a significant spread of indicators; ResearchGate is the only social scientific network that retains the dominant position in both graduation rates.

References

1. Academia.edu Homepage, https://www.academia.edu/, last accessed 2019/01/23.
2. Araujo, R. F., Murakami, Tiago R. M., Kroll do Prado J. M.: The performance impact of the brazilian information science journals on Facebook: an altmetric study. Comunicação, 19.01, 365–379 (2018). DOI: 10.20396/rdbci.v16i2.8650461.
3. Braithwaite, J., Herkes J, Churruca K, et al: Comprehensive Researcher Achievement Model (CRAM): a framework for measuring researcher achievement, impact and influence derived from a systematic literature review of metrics and models. BMJ Open 9, e025320 (2019). DOI: 10.1136/bmjopen-2018-025320.
4. Chen, P.-Y., Hayes, E., Lariviere, V., Sugimoto, C. R.: Social reference managers and their users: A survey of demographics and ideologies. PLoS ONE 13(7), e0198033, (2018). DOI: 10.1371/journal.pone.0198033.
5. Ebrahimy, S., Setareh, F.: Direct and Indirect Influence of Altmetrics on Citation in Social Systems: Assessing a New Conceptual Model. International Journal of Information Science and Management 16 (2), 161–173 (2018).
6. GoogleScholar Homepage, https://scholar.google.com.ua/, last accessed 2019/01/23.
7. Figshare Homepage, https://figshare.com/, last accessed 2019/01/25.
8. Haunschild, R., Bornmann, L.: Field- and time-normalization of data with many zeros: an empirical analysis using citation and Twitter data. Scientometrics 116, 997–1012 (2018).
9. Houshyar, M., Sotudeh, H.: A Reflection on the Applicability of Google Scholar as a Tool for Comprehensive Retrieval in Bibliometric Research and Systematic Reviews. International Journal of Information Science and Management 16 (2), 1–17 (2018).
10. Karimi, M., Kazerani, M., Shekofteh, M., Jahanihashemi, H.: Quality Evaluation of Academic Thesis Abstracts Based on ANSI / NISO Z39.14 (R2015) Standard: A Case Study. International Journal of Information Science and Management 17 (1), 83–95 (2019).

11. Korzh, R., Fedushko, S., Trach, O., Shved, L., Bandrovskyi, H.: Detection of department with low information activity. In: Proceedings of the 12th International Scientific and Technical Conference on Computer Sciences and Information Technologies, CSIT 2017, pp. 224–227. Lviv (2017).
12. Korzh, R., Peleshchyshyn, A., Fedushko, S., Syerov, Y.: Protection of University Information Image from Focused Aggressive Actions. In: Szewczyk, R., Kaliczynsra, M. (eds.) Advances in Intelligent Systems and Computing: Recent Advances in Systems, Control and Information Technology, SCIT 2016, vol. 543, pp. 104–110. Springer, Poland (2017). DOI: 10.1007/978-3-319-48923-0_14.
13. Korzh, R., Peleshchyshyn, A., Syerov, Yu., Fedushko, S.: University's Information Image as a Result of University Web Communities' Activities. In: Shakhovska, N. (ed.) Advances in Intelligent Systems and Computing: Selected Papers from the International Conference on Computer Science and Information Technologies, CSIT 2016, vol. 512, pp. 115-127. Springer, Ukraine (2017). DOI: 10.1007/978-3-319-45991-2_8.
14. Loop Homepage, https://loop.frontiersin.org/, last accessed 2019/01/25.
15. Maggio, L. A., Leroux, T. C., Meyer H. S., Artino Jr., A. R.: MedEd: exploring the relationship between altmetrics and traditional measures of dissemination in health professions education. Perspect Med Educ 7, 239–247 (2018).
16. Mehrad, J., Yousefi, Z.: Introducing the Theory of "Media System Dependency" with Emphasis on its Potential Application in Theoretical Framework of Researches in the Field of Information Science and Knowledge. International Journal of Information Science and Management 16 (1), 1–14 (2018).
17. Mendeley Homepage, https://www.mendeley.com/, last accessed 2019/01/15.
18. Ortega, J. L.: Social Network Sites for Scientists. Elsevier Ltd, Cambridge, Kidlington (2016).
19. Powell, A. G. M. T., Bevan, V., Brown, Ch., Lewis W. G.: Altmetric Versus Bibliometric Perspective Regarding Publication Impact and Force. World Journal of Surgery 42 (9), 2745–2756 (2018). DOI: 10.1007/s00268-018-4579-9
20. ResearchGate Homepage, https://www.researchgate.net/, last accessed 2019/01/15.
21. ResearcherID Homepage, https://www.researcherid.com, last accessed 2019/01/25.
22. Riahinia, N., Rahimi, F., Rahimi, F., Mirhaghjoo, S., Alinezhad F.: Traditional Citation Indexes and Alternative Metrics of Readership. International Journal of Information Science and Management 16 (2), 61–278 (2018).
23. Salajegheh, M., Dayari, S.: Comparing the Citations Counts and Altmetrics of the Top Medical Science Journals in Scopus. International Journal of Information Science and Management 17 (1), 59–272 (2019).
24. Syerov, Yu., Fedushko, S., Loboda, Z.: Determination of Development Scenarios of the Educational Web Forum.In: Proceedings of the 11th International Scientific and Technical Conference on Computer Sciences and Information Technologies, CSIT 2016, pp. 73–76. Lviv (2016). DOI: 10.1109/STC-CSIT.2016.7589872.
25. Yousefi, Z., Sotudeh, H., Mirzabeigi, M., Fakhrahmad, S. M., Nikseresht, A., Mohammadi, M.: Investigating Text Power in Predicting Semantic Similarity. International Journal of Information Science and Management 17 (1), 17–231 (2019).
26. Zahedi, Z, Costas, R.: General discussion of data quality challenges in social media metrics: Extensive comparison of four major altmetric data aggregators. PLoS ONE. DOI: 10.1371/journal.pone.0197326 May 17, 2018 1 / 27.
27. Zotero Homepage, https://www.zotero.org/, last accessed 2019/01/15.