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Quantitive Evalution of Involvement of Countries of the World in the International Open Access Movement

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Abstract

The article presents the developed method for the quantitative evaluation of involvement of countries of the world in the international open access movement. It consists in the identification of eight country open access indicators initially connected with the open access initiatives and instruments, their weighing, normalization and aggregation in the form of a weighted average value. In a second more strict approximation the number of indicators has been reduced up to six for the account of discarding the data duplicated in ROAR and Open DOAR. Budapest initiative and Berlin declaration were considered as the OA-initiatives, and data from the international registers DOAJ, SHERPA/RoMEO, ROAR MAP and the Webometrics OA-repositories ranking was considered as the instruments. The calculation is done on the basis of the developed method for 133 countries

Keywords: Open access; Involvement of countries in open access; Budapest initiative; Berlin declaration; ROAR; Open DOAR; DOAJ; SHERPA / RoMEO; ROAR Map; Webometrics.

1. Introduction

A fair number of scientific works are devoted to the problem of movement of the open access to scientific knowledge launched at the turn of the century. In the advanced search “Google Scholar” we find 394 responses to the request of the term “Open access to scientific knowledge” in the exact word combination line (8 June, 2017). At the same time there are very few works dedicated to the quantitative analysis of involvement of countries in this movement. Among the above-mentioned responses we managed to single out five articles which considered the distribution of the open access repositories and journals on a country-by-country basis. The work (Wani *et al.*, 2009). gives the distribution of OAR (Open Access Repositories) in the Open DOAR register across the leading countries of the world (Tab. 1).

Table-1. Distribution of the OAR in the Open DOAR across the countries of the world (7-8 October, 2008)

Country	OAR	
	Number	%
USA	317	25,36
United Kingdom	136	10,88
Germany	129	10,32
Japan	69	5,52
Australia	68	5,44
Netherlands	45	3,60
Canada	44	3,52
Italy	42	3,36
68 other countries	400	32,00
Total	1250	100

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More up-to-date data on the OAR distribution in the Open DOAR and ROAR registers are shown in the Table 2

Table-2. Distribution of the OAR in the Open DOAR across the countries of the world (11th March, 2013)

Country	OAR	
	Open DOAR	ROAR
USA	395	547
Great Britain	209	249
Germany	165	193
Japan	138	166
Spain	98	153
Poland	75	106
France	71	82
Italy	70	88
Canada	58	85
India	54	94

Having compared these tables, we see what fold the OAR has increased in the Open DOAR for four and a half years. The greatest increase of the OAR has been observed for the USA. Also this article describes the growth dynamics of the number of the OA-journals (OAJ) in the DOAJ register for the period from 2002 to 2013. Let's give the data obtained at the ends of this time interval (Sokolov and Sungatullina, 2015). (Tab.3).

Table-3. Top five countries according to the number of the OAJ in the DOAJ register (17 January, 2013)

Country	OA-Journals in DOAJ	
	2002	2013
USA	16	1270
Brazil	0	804
Great Britain	5	575
India	0	471
Spain	0	444

As we can see from the built tables, the number of the OAJ grows much faster than of the OAR. The work provides the OAR distribution across 11 leading countries distinguishing those of them which function within the frameworks of the Open Archives Initiative Protocol for Metadata Harvesting (PMH OAI), and the work gives the distribution of a wider set of the open access resources and instruments for the Sub-Saharan African countries. The work describes the data of distribution of the OAR and OAJ number across the CIS countries (Roy *et al.*, 2013; Sizyoongo *et al.*, 2014; Zakharyan *et al.*, 2015).

Table-4. Distribution of the OAR and OAJ, 2009

Country	OAR	OAJ
Ukraine	13	15
Russia	29	14
Armenia	0	2
Azerbaijan	2	1
Belarus	1	0
Georgia	1	3
Kazakhstan	1	0
Kyrgyzstan	2	0
Moldova	1	1

2. Materials and Methods

We will characterize the involvement of countries in the international open access movement by statistic data from registers of the largest open access initiatives and instruments. We will consider Budapest initiative "Open access" (2002) and Berlin Declaration of the open access to scientific and humanities knowledge (2003) as such initiatives, and the international registers ROAR, Open DOAR, SHERPA/RoMEO, ROAR MAP, DOAJ and Webometrics ranking for the OA-repositories as instruments. In total, we will use 8 quantitative indicators (a number of organisations which have signed Budapest initiative and Berlin declaration shall be taken for the first two). Values of these eight indicators are also recorded in a form of a matrix (table) for fifteen ex-USSR countries and based on it the average values for each index per one country and the total quantitative potential of the open access initiatives and instruments on a country-by-country basis shall be calculated by summation of lines of this matrix. As far as all these indicators are not equal worth, and some of them replicate each other, so we will offer the following procedure for more precise calculation of the quantitative potential of involvement of countries in the open access. Let's choose one most essential index out of three indicators which relate to the OA-repositories. It should be understood here that organisations usually register their OA-repositories simultaneously in two registers – ROAR and Open DOAR,

provided that the first register is more popular. Besides, the actual number of records in these registers usually exceeds the real number of functioning OA-repositories. Replication of records takes place, for examples, due to the change of an OA-repository name or its re-registration. At the same time, the real number of functioning OA-repositories which data is indexed by search engines is disclosed reliably in the Webometrics ranking. We will take this index as a basis. Let's break down six selected indicators into three groups in order of importance with assignment weighting coefficients to them (Tab. 5).

Table-5. Quantitative indicators of involvement of countries in the international open access movement: their groups, designations and weighting coefficients

Group name	**indicators included in the group**		**weighting coefficient**
	Name	**Designation**	
OA repositories and journals	number of OA-repositories included in Webometrics	I_1	1/4
	number of OA journals included in DOAJ	I_2	1/4
OA-policy	number of publishing OA policies on self-archiving and copyright in SHERRA/ROMEO	I_3	1/6
	number of institutional OA mandates in ROAR MAP	I_4	1/6
OA initiatives	number of signatories-organization of the Budapest initiative	I_5	1/12
	Number of signatories-organization of the Berlin Declaration	I_6	1/12

When distributing weighs for these six indicators, we proceeded from the following considerations. Groups were chosen with the uniform indicators (carriers of the OA-results, OA-policy, OA-initiatives), that is why there were taken equal weighting coefficients among indicators of one group. The significance of the very groups (summary weighting coefficient for a group) was supposed to be increasing with the uniform interval according to the procedure specified in the table 5. Herewith the sum of group weighting coefficients was taken to be equal to one. Thus, the integrated index of involvement of countries in the international open access movement can be calculated using the weighted average value.

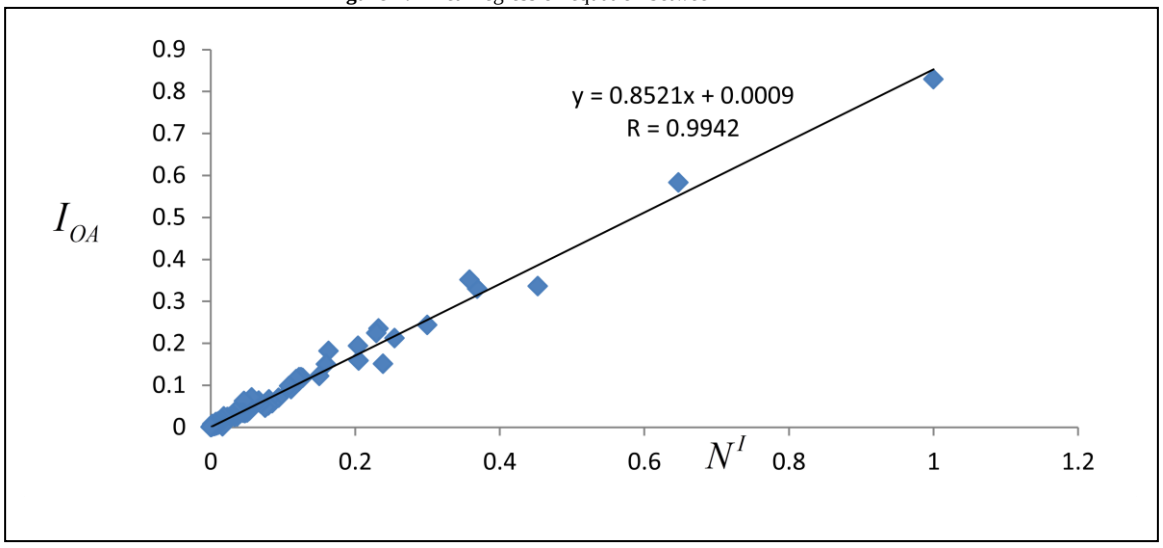
$$IOA = 1/4\,(I1/I1max + I2/I2max) + 1/6\,(I3/I3max + I4/I4max) + 1/12\,(I5/I5max + I6/I6max), \quad (1)$$

Where, Ii max – maximum value of i index over the whole sampling of countries. There is carried out the correlation analysis between IOA and indicators normalized to the maximum value according to the sampling of countries N´=N/Nmax. The total number of estimated countries turned out to be 133.

3. Results and Discussion

Initial values of eight indicators of involvement of fifteen ex-USSR countries in the international open access movements, which were collected by us on 24-26 June, 2017 from the OA - initiatives and OA- instruments Websites are shown in the Table 6. This table shows calculated values of N, N´=N /Nmax and IOA. Countries in the table are ranked by values of the index N (N´). There has been obtained a good correlation relationship between N´ and IOA (Fig. 1).

Figure-1. Linear regression equation between N^I и I_{OA}



76.5% of the total number of the OA-initiatives and OA-instruments is accounted for by 20% of countries (27 countries) (Tab. 6), i.e. we obtained the distribution closed to Pareto distribution.

If we break all countries into 5 groups, accordingto the five-level uniform classification scale by N´ index, so we can see their very non-uniform distribution. Only USA will fall into a group of countries with very high level of involvement in the OA-movement ($0.8 < N' \leq 1.0$), the United Kingdom will fall into a group of countries with a

high level ($0.6 < N' \leq 0.8$), Brazil will fall into a group of countries with the average level ($0.4 < N' \leq 0.6$), Spain, Germany, Indonesia, Japan, Poland, Italy, India, Egypt, France will fall into a group of countries with a low level ($0.2 < N' \leq 0.4$). The rest of countries (121 countries) falls into a group with a very low level of involvement in the OA-movement, which amounts to 91% of their total number (Ike and Lee, 2014; Usova, 2009).

Table-6. Quantitative indicators of involvement of countries of the world in the international open access movement, 24-26 June, 2017

Country	SHERPA /RoMEO	DOAJ	ROAR	DOAR	ROAR MAP	Webometrics, OA-Repositories	Berlin Declaration	Budapest Open Acc Initiative	*N*	*N´*	I_{OA}
I_{max} , N_{max}	558	987	808	498	137	391	98	98	3063		
United States	558	544	808	498	137	391	37	90	3063	1	0.8291
United Kingdom	280	886	258	252	120	141	1	44	1982	0.6471	0.5825
Brazil	67	987	158	92	20	52	1	9	1386	0.4525	0.3361
Spain	93	539	178	125	38	67	52	38	1130	0.3689	0.3299
Germany	96	262	239	195	58	116	98	33	1097	0.3581	0.3512
Indonesia	28	613	111	62	16	69	1	18	918	0.2997	0.2434
Japan	19	18	228	211	6	276	0	21	779	0.2543	0.2119
Poland	29	449	120	92	3	32	0	5	730	0.2383	0.1508
Italy	47	282	93	110	23	53	83	20	711	0.2321	0.2349
India	118	233	118	76	16	39	3	98	701	0.2289	0.2245
Egypt	3	602	11	5	0	1	2	3	627	0.2047	0.1583
France	45	191	96	119	23	115	23	13	625	0.2040	0.1939
Turkey	28	203	62	75	45	31	0	55	499	0.1629	0.1811
Canada	75	122	96	81	27	48	13	26	488	0.1593	0.1500
Colombia	31	255	65	44	5	43	1	16	460	0.1502	0.1219
Portugal	129	77	59	55	22	35	7	5	389	0.1270	0.1174
Russian Federatio	31	187	61	28	6	23	1	46	383	0.1250	0.1186
Switzerland	28	257	19	18	10	11	27	4	374	0.1221	0.1190
Ukraine	19	81	94	75	15	54	3	32	373	0.1218	0.1087
Australia	44	83	86	57	33	51	0	9	363	0.1185	0.1146
Iran	17	290	9	10	0	4	0	11	341	0.1113	0.0904
Romania	26	286	13	3	1	2	1	9	341	0.1113	0.0912
Netherlands	23	178	44	35	12	15	20	6	333	0.1087	0.0983
Argentina	17	145	49	41	5	22	0	9	288	0.0940	0.0696
China	10	71	92	39	4	31	2	11	260	0.0849	0.0567
Sweden	19	50	75	42	12	40	6	3	247	0.0806	0.0662
Norway	51	57	59	53	10	9	5	0	244	0.0797	0.0518
Taiwan	1	28	83	60	1	57	1	0	231	0.0754	0.0459
Mexico	7	98	41	30	3	13	1	19	212	0.0692	0.0559
South Africa	17	63	49	24	9	21	18	3	204	0.0666	0.0633
31	**Belgium**	**18**	**33**	**35**	**25**	**19**	**14**	**17**	**12**	**173**	**0.0565**	**0.0705**
32	Hungary	32	26	40	36	4	19	2	4	163	0.0532	0.0383
33	Peru	6	33	43	42	7	20	0	4	155	0,0506	0,0349
34	Austria	23	37	19	28	8	8	23	4	150	0.0490	0.0540
35	Chile	9	76	22	20	0	15	1	3	146	0.0477	0.0349
36	Greece	16	29	39	35	4	13	6	3	145	0.0473	0.0330
37	Czech Republic	15	75	13	17	4	10	7	2	143	0.0467	0.0424
38	Finland	41	20	22	16	31	11	0	0	141	0.0460	0.0621
39	Malaysia	8	41	37	21	1	28	0	2	138	0.0451	0.0336
40	Serbia	11	91	9	9	2	2	4	0	128	0.0418	0.0334
41	Croatia	10	69	7	21	2	3	1	5	118	0.0385	0.0299
42	Ecuador	5	25	30	26	0	23	0	4	113	0.0369	0.0259
43	Denmark	27	23	17	12	8	8	7	4	106	0.0346	0.0381
44	Korea, Republic of	8	45	0	33	0	15	0	1	102	0.0333	0.0242
45	Slovenia	7	47	10	11	8	5	2	1	91	0.0297	0.0295
46	Ireland	6	13	24	22	10	14	1	0	90	0.0294	0.0271
47	Belarus	3	5	23	24	3	18	1	2	79	0.0258	0.0199
48	New Zealand	11	15	21	12	7	10		2	78	0.0255	0.0237
49	Venezuela	1	18	21	16	4	8	2	7	77	0.0251	0.0225
50	Cuba	9	39	11	10	0	2	1	2	74	0.0242	0.0164
51	Pakistan	12	40	4	3	1	0	1	10	71	0.0232	0.0243
52	Bulgaria	9	33	9	8	1	6	2	3	71	0.0232	0.0204
53	Costa Rica	4	44	9	6	0	6	1	1	71	0.0232	0.0179
54	Lithuania	3	27	11	11	9	4	0	1	66	0.0215	0.0221
55	Kenya	1	2	19	26	5	8	3	1	65	0.0212	0.0154
56	Nigeria	6	8	15	15	1		1	12	58	0.0189	0.0161
57	Thailand	2	21	11	12	0	10	0	1	57	0.0186	0.0132
58	Moldova	2	16	9	7	8	1	1	11	55	0.0180	0.0252
59	Bangladesh	7	16	10	10	0	4	0	6	53	0.0173	0.0138
60	Korea, Democratic People's Republic	1	5	44	0	0	0	0	0	50	0.0163	0.0016
61	Algeria	3	12	8	13	4	7	0	3	50	0.0163	0.0158
62	Hong Kong	2	28		4	4	6	1	1	46	0.0150	0.0181
63	Slovakia	5	34	0	0	1	0	0	0	40	0.0131	0.0113

64	**Estonia**	**1**	**14**	**4**	**7**	**3**	**3**	**1**	**0**	**33**	**0.0108**	**0.0103**
65	Philippines	2	9	11	7	0	2		2	33	0.0108	0.0059
66	Zimbabwe	0	0	9	9	0	6	7	1	32	0.0104	0.0106
67	Sri Lanka	2	8	1	12	0	6	3		32	0.0104	0.0090
68	Macedonia	8	9	1	3	0	1	1	8	31	0.0101	0.0130
69	Bosnia and Herzegovina	6	13	3	2	0	2	1	3	30	0.0098	0.0098
70	Sudan	0	0	10	8	0	8	0	1	27	0.0088	0.0060
71	Tanzania	0	0	9	10	0	5	1		25	0.0082	0.0040
72	Iraq	3	15	1	1	0	4	0	1	25	0.0082	0.0081
73	Ghana	2	4	6	4	1	2	3	2	24	0.0078	0.0084
74	Cyprus	1	4	7	4	0	4	2	0	22	0.0072	0.0056
75	Uruguay	2	15	2	3	0	0	0	0	22	0.0072	0.0044
76	Iceland	1	5	2	3	5	1	4	0	21	0.0069	0.0117
77	Nepal	3	13	3	1	0	0	1	0	21	0.0069	0.0050
78	Kazakhstan	1	1	5	5	1	7	0	0	20	0.0065	0.0062
79	Singapore	3	0	6	4	3	3	0	0	19	0.0062	0.0065
80	Morocco	1	10	3	2	0	1	1	1	19	0.0062	0.0052
81	Kyrgyzstan	0	2	4	9	2	0	0	0	17	0.0056	0.0029
82	Latvia	0	0	11	0	2	3	0	0	16	0.0052	0.0044
83	Georgia	1	3	2	2	0	1	0	7	16	0.0052	0.0077
84	Azerbaijan	0	0	4	2	2	2	1	3	14	0.0046	0.0071
85	Bolivia	1	4	3	2	1	1	0	2	14	0.0046	0.0049
86	Nicaragua	1	4	3	3	0	2	0	0	13	0.0042	0.0026
87	Ethiopia	0	4	2	2	0	1	2	0	11	0.0036	0.0034
88	Albania	3	3	1	2	0	1	0	1	11	0.0036	0.0031
89	Qatar	1	6	1	1	0	1	0	0	10	0.0033	0.0025
90	Israel	2	5	1	0	0	0	2	0	10	0.0033	0,0036
91	Armenia	1	1	2	2	0	0	0	3	9	0,0029	0.0031
92	Senegal	1	0	2	2	0	0	0	3	8	0.0026	0.0028
93	United Arab Emirates	2	6	0	0	0	0	0	0	8	0.0026	0.0021
94	Tunisia	0	4	2	1	0	1	0	0	8	0.0026	0.0017
95	Jordan	1	3	0		0	3	0	1	8	0,0026	0,0038
96	Botswana	0	0	3	2	0	1	0	1	7	0.0023	0.0015
97	Namibia	0	0	2	2	0	1	0	2	7	0.0023	0.0023

100	Namibia	0	0	2	2	0	1	0	2	7	0.0023	0.0023
101	Cameroon	0	1	1	2	0	0	3	0	7	0.0023	0.0028
102	Uganda	0	1	0	2	0	1	2	0	6	0.0020	0.0026
103	Saudi Arabia	0	13	0	0	0	6	0	0	6	0.0020	0.0071
104	Puerto Rico	2	1	1	1	0	1	0	0	6	0.0020	0.0015
105	Vietnam	0	1	0	0	0	3	0	1	5	0.0016	0.0030
106	Montenegro	2	4	0	0	0	0	0	0	5	0.0016	0,0016
107	Guatemala	1	3	0	1	0	0	0	0	5	0.0016	0.0011
108	Lebanon	0	2	1	0	0	1	0	0	4	0.0013	0.0011
109	Lesotho	0	0	2	1	0	0	0	1	4	0.0013	0.0009
110	Libya	0	3	0	0	0	0	0	0	3	0.0010	0.0008
111	Rwanda	0	0	1	2	0	0	0	0	3	0.0010	0.0000
112	Palestinian Territories	0	1	1	0	0	2	0	0	3	0.0010	0.0015
113	Yemen	0	2	0	0	0	0	0	0	3	0.0010	0.0005
114	Burkina Faso	0	0	0	0	0	1	0	1	2	0.0007	0.0015
115	Cape Verde	0	0	0	2	0	0	0	0	2	0.0007	0.0000
116	Madagascar	0	1	0	0	0	0	0	1	2	0.0007	0.0011
117	Mauritius	1	1	0	0	0	0	0	0	2	0.0007	0.0006
118	Afghanistan	0	0	0	1	0	0	0	1	2	0.0007	0.0009
119	Oman	0	2	0	0	0	0	0	0	2	0.0007	0.0005
120	Syria	1	0	1	0	0	0	0	0	2	0.0007	0.0003
121	Angola	1	0	0	0	0	0	0	0	1	0.0003	0.0003
122	Côte D'Ivoire	0	0	0	0	0	0	0	1	1	0.0003	0.0009
123	Guinea	0	0	0	0	0	0	1	0	1	0.0003	0.0009
124	Liberia	0	0	0	0	0	0	0	1	1	0.0003	0.0009
125	Mali	0	0	0	0	0	0	0	1	1	0.0003	0.0009
126	Reunion	1	0	0	0	0	0	0	0	1	0.0003	0.0003
127	Somalia	0	0	0	0	0	0	0	1	1	0.0003	0.0009
128	Gambia	0	0	0	0	0	0	1	0	1	0.0003	0.0009
129	Bahrain	1	0	0	0	0	0	0	0	1	0.0003	0.0003
130	Macau	0	0	0	0	0	1	0	0	1	0.0003	0.0006

131	**Seychelles**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0.0003**	**0.0003**
132	Uzbekistan	0	0	0	0	0	0	0	1	1	0.0003	0.0009
133	Isle of Man	1	0	0	0	0	0	0	0	1	0.0003	0.0003
134	Kosovo	1	0	0	0	0	0	0	0	1	0.0003	0.0003
135	Luxembourg	0	0	0	0	0	1	0	0	1	0.0003	0.0006
136	Malawi	0	0	1	0	0	0	0	0	0	0	0.0000
	Summa	2342	9384	4201	3287	856	2250	529	820	23654	7.7224	6.7035
	Summa/133	17.609	70.556	31.586	24.71	6.436	16.917	3.977	6.165	177.849	0.058	0.050

4. Conclusion

Thus, this article presents the developed method of the quantitative evaluation of involvement of countries in the international open access movement which principle consists in the identification of indicators of involvement of countries in the open access, their weighing, normalization and aggregation on the weighted average value basis. Two global initiatives – Budapest initiative and Berlin declaration were considered as the OA-initiative, and particularly, databases according to their subscribers. The international registers according to the OA-repositories (ROAR, Open DOAR), OA-journals (DOAJ), OA-policies (SHERPA/RoMEO, ROAR MAP) and ranking of the OA-repositories in Webometrics were considered initially as the OA-instruments. During more strict selection of indicators we excluded from consideration the data of ROAR and Open DOAR registers due to their errors and duplication. Finally, six quantitative indicators were broken down into three groups (OA-carriers, OA-policies, OA-initiatives) with different weighting coefficients. Weighing and normalization of these indicators provided the opportunity to obtain the weighted average integrated index of involvement of countries in the open access which varies from 0 to 1. There has been obtained a high correlation relationship between values of this index and the total number of the OA-initiatives and OA-instruments. It is shown that 76.5% of the total number of these initiatives and instruments is accounted for by the first 20% of countries. Use of the uniform five-level classification scale according to N´ index shows that 91% of countries

(121 countries) falls into the group with very low level of involvement of countries in the OA-movement *(Shishkina et al., 2015)*.

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