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University networks in the context of their academic excellence and openness: A comparative study of leading Czech and German universities

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Abstract

A simple methodology of multi-dimensional vector analysis for the comparison of the academic performance and the openness of university networks of the identical dimension was developed, which is illustrated by the example of the leading universities in the Czech Republic and Germany. In order to make this comparison, proximity measures were introduced with an arbitrary normalized vector of indicators to standard unit vectors that can be found with the aid of the normalized Euclidean distance. As an example of the indicators of academic performance and openness, the number of universities included in known global university rankings and having open access repositories and English versions of the university's website, and participating in Berlin Declaration of Open Access, SINAPSE platform, European University Association and the Magna Charter is considered.

Keywords

Introduction

In the current conditions of globalization, competition among universities increases and plays an important role. Universities compete among themselves at global level for the best students and researchers, for acquisition of contracts on Research and Development from the governments, businesses and public funds.

The capability of the university to compete at global level with other universities is known as its *global academic competitiveness*. For its quantitative assessment, different university ratings are offered that allow to compare different universities, based on the degree of academic excellence.

Apart from the indicators of academic excellence, which are taken into consideration in global university rankings, we can also consider the openness indicators of the universities, which also promotes growth of their global academic competitiveness; that is, OA (open access) repositories, English websites, and membership of the universities in other academic and university unions that allows to exchange knowledge and best university practice. If desired, indicators of openness could be introduced into the system of indicators of global university rankings.

Besides, comparing among themselves of separate universities on the basis of academic excellence and openness indicators, that determines their global academic competitiveness in the form of aggregated university ratings, it is possible to compare country sets of universities based on the same indicators. It is obvious that for such comparisons, country sets have to be in the same dimensions. In the capacity of such sets, we can select TOP-N universities in every country of research, on any wide university rating. Where N is the number of universities under study.

The problem of comparative analysis of university networks with the same dimensions (N) in the context of their academic excellence and openness, is based on the calculation of the occurrence of universities included in TOP-N, in various global university rankings and university and academic associations, calculation of existence of platforms of open access to them (OA-repositories, English websites) and also introductions of a measure of proximity to some ideal vector corresponding to the maximum number of the above-mentioned occurrences and the presence of platforms of open access.

At present, the formulation of this kind of problem is not available. This can be proved by means of testing relevant scientific terms on Google Scholar and the content analysis of the received responses. Usually, when dealing with comparative analysis of different networks, the emphasis is put on the interaction of network nodes, instead of occurrence nodes into set of any features.

[Cooper and Barahon](#) (2011) proposed a new measure of similarity between nodes in different networks. Here the matrix of similarity related to the distance between feature vectors that contain input and output paths of all the segments for each node.

A research by [Varga and Parag](#) (2009), performed within FP7, was done on the basis of classical works in the area of building a concept of a National Innovation System ([Lundvall](#), 1992; [Nelson](#), 1993) and the following conclusion can be made. The efficiency of research networks in producing new knowledge can be approached by three features: the number of actors involved in the system (the size of the network), the knowledge those actors have accumulated and the intensity of knowledge-related interactions among the actors during knowledge creation. If we consider the actors in the system or network as universities, then in analogy with the above-mentioned paper, we can conclude that the size of the university network, the knowledge level of the universities and the intensity of knowledge related linkage characterize the university network connection quality. If the paper ([Varga & Parag](#), 2009) looks at the international co-publication networks of different sizes that are generated by the University of Peos academic unit, we will examine and compare Czech and German university networks of the same size and abstracting from interactions in these networks. We study the reputation (accumulated knowledge) of the members of these networks (separate universities).

In the research by [Larivière, Gingras and Archambault](#) (2006), which was on the basis of UCINET ([Borgatti, Everett & Freeman](#), 2002) and NETDRAW ([Borgatti](#), 2002) a network analysis software programs was built by the Canadian inter-institutional Collaborative networks (English-speaking and French-speaking universities with 30 or more joint publications, 1980-2002) on the social sciences (SS) and natural sciences and engineering (NSE). It was shown that almost all articles on the NSE are jointly published, compared to two thirds on the SS and about 10% in the humanities, as well as, the bibliometrics mapping of collaborative networks gives a very good idea of overall trends in collaboration and highlight the gaps between the humanities, SS and NSE. Comparative analysis of inter-institutional networks shows that SS are probably nearer to the NSE than to the humanities.

The study by [Cromwell et al.](#) (2011) examines an instrument that contains five online modules, that latter one was Research Portfolio: a tool to examine the metrics of research productivity and building research networks for NIH grant acquisition. This tool is used by six institutions with Clinical and Translational Science Awards (CTSA) for building Biometrical Resource Ontology (BRO) search terms. A distribution matrix for BRO research terms for six universities that are included in CTSA was built.

In general, the existing approaches used in formalized analysis for the comparison of networks are based on graph and matrix theory and network planning, in which the interaction between network nodes play a significant role. At the same time, there are no articles available that compare networks with the same dimensions in relation to their occurring nodes (in current case universities) in space of any features.

Materials and Methods

When formulating any scientific problem, it is necessary to understand the degree and level of scrutiny of this issue. To do this, we need to choose adequate English terms that are to be included in the conceptual apparatus of the given task. In the capacity of such terms were selected: university network, university networks, university networking, comparison of networks, research network, research networks, research networking, comparative analysis of networks, and mathematical analysis of networks. Such terms will be tested with the help of Google Scholar in advanced research mode in the line "with exact phrase" for two cases: "anywhere in the article" (two options: include citations; at least summaries) and "in the title of the article" (same option). Such experiments allows to prove or refute, the hypothesis done in the Introduction part about the absence of formulation of the problem on comparative analysis of university networks with the same dimensions in the context of their academic excellence and openness.

We will consider a set of networks in the amount of M of the same dimension N, where N is the amount of network nodes. For such networks, we introduce n - dimensional vector of indicators (features): $\vec{V} = (V_1, V_2, \ldots, V_i \ldots, V_n)$, as well as normalized vector $\bar{\vec{V}} = (\bar{V}_1, \bar{V}_2, \ldots, \bar{V}_i \ldots, \bar{V}_n)$, where $\bar{V}_i = V_i/N$. We assume that V_i satisfies the inequality $0 \leq V_i \leq N$, which implies the inequality $0 \leq \bar{V}_i \leq 1$. The proximity of an arbitrary vector $\bar{\vec{V}}$ to the standard unit vector that we find with the aid of the normalized Euclidean distance:

$$d = \sqrt{\sum_{i==1}^{n} (1 - \overline{V_i})^2} / \sqrt{n}$$

, (1)

where $0 \leq d \leq 1$.

The smaller d is, the closer the $\vec{\vec{v}}$ is to the standard unit vector. Thus we can rank all M networks with the same dimensions depending on their proximity to the standard unit vector in n - dimensional feature space.

We present an example of this simple methodology for two university networks, the Czech Republic and Germany, consisting of 45 universities (M = 2, N = 45). This is the number of universities which correspond to the number of ranked universities in Czech Republic with aid of the Webometric ranking in July 2010 (www.webometrics.info).

For a comparative analysis of the leading Czech and German university networks with the same dimensions (N = 45) we introduced the following system of indicators: the quantity of universities in the Top-1000 World Web Rank, Top-1000 Scholar Rank, Top-200 British Times Rank, Top-500 Shanghai Rank, Top-500 Taiwan Rank, the amount of university OA-repositories and English versions of university sites, participants in the Berlin Declaration of Open Access, SINAPSE platform, European University Association and the Magna Charter (n =11). Note that proposed academic and openness indicators, along with others (living conditions and safety on college and university campuses, scholarship and grant support, cost of living in cities where universities are located, etc.), can be used in constructing a simulation expert system of choosing universities for training and research (Moskovkin, 2009).

When we talk about academic excellence, we mean powerful research universities, the competence that is reflected in their publication activity and the citation of their scholars' articles as well as the volume and quality of training of their scientific personnel (PhDs).

To the indicators of academic excellence, we will assign Spanish (Webometric), British, Shanghai and Taiwan rankings as well as Scholar index of the Spanish Webometric ranking.

The remaining indicators characterize, to a greater extent, the openness of universities, which is connected to the integration of these universities into the international movement of open access to scientific knowledge and higher education. From the point of view of Varga and Parag (2009) we can conclude that separate universities are included into the network of partner universities and academic establishments for which we can offer a measure of network connection quality in analogy with the above-mentioned article. But that is a task to be examined in another research.

The above suggested eleven indicators in varying degrees are responsible for the academic excellence and the openness of the universities.

Results and Discussions

Above-mentioned terms were tested with the help of Google Scholar and the results are presented in Table 1.

Table 1. Testing terms with keywords network, networks and networking with the help of Google Scholar, 01.06.2012.

No.	Terms	Anywhere in the article		In the title of the article	
		Include citations	At least summaries	Include citations	At least summaries
1	University network	14,800	11,800	368	203
2	University networks	2760	2330	53	32
3	University networking	710	651	21	7

4	Comparison of networks	773	725	27	21
5	Comparison networks	277	263	9	8
6	Research network	403,000	319,000	4,030	2,030
7	Research networks	33,000	30,700	911	552
8	Research networking	3,970	3,680	124	78
9	Comparative analysis of networks	60	60	6	6
10	Mathematical analysis of networks	69	64	1	0

The most relevant publications were found in the publication clusters generated by the terms "comparison networks" and "research networks". This consists of the following works (Cooper & Barahon, 2011; Varga & Parag, 2009).

In the "comparative analysis of networks" cluster, we found an article by Larivière, Gingras and Archambault (2006). In the "research networking" cluster, we found an article by Cromwell et al. (2011). All the above-mentioned articles are presented in the Introduction. In the remaining publication clusters, we found no articles that are related to the formalized quantitative analysis of university networks.

Now we will consider comparative analysis of Czech and Germany university networks, consisting of 45 universities, on the basis of 11 indicators that are selected for the academic excellence and openness of the universities.

All values of the quantitative and qualitative indicators for the Czech universities are listed in Table 2 and 3, and for universities in Germany in Table 4 and 5. Universities in these tables are ranked in descending order according to the webometric rankings (July 2010).

For the Czech universities only Charles University had Shanghai and Taiwan ranks that correlated with the Scholar rank indicator. According to the latest indicators, the University of Masaryk has very high World rank which can be connected to their large exemplary collection of scientific papers.

But not all publications belong to the scholars of this university. For example, such situations occur when web representations of articles in scientific journals are published on the basis of the university. Note that the placement of other scholar's articles in the University Open Access (OA)-repository is considered as bad practice, which can be penalized by the Spanish Cybermetric Laboratory when they calculate the Webometric ranking of universities. There were only two of these OA-repositories recorded in the universities of the Czech Republic at the end of September 2010 - at the Technical University of Ostrava and the University of Pardubice. The first university raises questions of inconsistencies in the amount of documents placed in the OA-repository with Scholar Rank value. Our inquiry on Google Scholar 06.10.2010, with the help of the operator site: URL-address showed that the Technical University of Ostrava had 1570 documents on their site. Consequently, Google Scholar did not index the bulk of the university's OA-repository documents (the total number of documents at the end of September 2010 amounted to 46 339 (Table 2).

If a good software is used to create the OA-repository (e.g., DSpace, Eprint, etc.), and if the collection of documents and bibliographic description (metadata) is properly done, then Google Scholar is very fast at indexing it, thanks to the OAI-PMH interface (Open Archives Initiative Protocol for Metadata Harvesting).

Table 2. Indicators of academic excellence for the leading Czech universities

	University	World Web Rank	World Scholar Rank	British Times Rank	Shanghai's Rank	Taiwan Rank
1	Charles University/Univerzita Karlova v Praze	124	285	-	201-300	226
2	Masaryk University/Masarykova Univerzita	191	10			
3	Czech Technical University/ české vysoké učení technické v praze	300	414			
4	University of West Bohemia/Západočeská Univerzita v Plzni	497	639			
5	University of Technology Brno/Vysoké učení technické v Brně	521	576			
6	Palacky University/Univerzita Palackého v Olomouci	606	445			
7	University of Economics Prague/Vysoká škola economická v Praze	738	772			
8	University of South Bohemia/Jihočeská Univerzita	929	952			
9	Technical University Ostrava/Technická Univerzita Ostrava	952	821			
10	Institute of Chemical Technology Prague/Vysoká škola chemicko-technologická v Praze	1289	1130			
11	Mendel University of Agriculture and Forestry Brno/Mendelova univerzita v Brně	1461	1862			
12	Czech University of Agriculture/česká zemědělská univerzita v Praze	1591	1294			
13	Ostrava University/Ostravská univerzita v Ostravě	1816	1822			
14	University of Pardubice/Univerzita Pardubice	1834	611			
15	Silesian University/Slezská univerzita v Opavě	2000	1907			
16	University of Hradec Kralove/Univerzita Hradec Králové	2147	3252			
17	Tomas Bata University/Univerzita Tomáše Bati ve Zlíně	2193	2685			
18	Purkyne University/Univerzita Jana Evangelisty Purkyně	2196	2548			

19	Technical University of Liberec/Technická univerzita v Liberci	2322	2946			
20	University of Veterinary and Pharmaceutical Sciences Brno/Veterinární a farmaceutická univerzita Brno	2471	869			
21	College of Finance and Administration Prague/Vysoká škola finanční a správní	3397	4790			
22	Academy of Arts Architecture and Design Prague/Vysoká škola uměleckoprumyslová v Praze	3728	7329			
23	Academy of Performing Arts in Prague /Akademie múzických umění v Praze	3880	3717			
24	Academy of Fine Arts Prague/Akademie výtvarných umění v Praze	4725	8258			
25	Janaceck Academy of Music and Dramatic Arts Brno/Janáčkova akademie múzických umění v Brně	5182	8570			
26	College of Banking Prague/Bankovní institut vysoká škola	5228	5349			
27	University of Defence Czech Republic/Univerzity obrany	5353	2572			
28	Prague College	5425	10216			
29	University of the Defence Faculty of Military Health Sciences/Fakulta vojenského zdravotnictví Univerzity obrany	5832	5005			
30	Business School Ostrava/Vysoká škola podnikání	6217	6780			
31	Police Academy of the Czech Republic/Policejní akademie české republiky v Praze	6296	10216			
32	Metropolitan University Prague/Metropolitní univerzita Praha	6400	5298			
33	Moravian College Olomouc/Moravská vysoká škola Olomouc	8266	4602			
34	Jan Amos Komensky University/Univerzity Jana Amose Komenského Praha	8563	10216			
35	College of Information Management & Business Administration /Vysoká škola manažerské informatiky a ekonomiky	8623	9063			

	Univerzita v Plzni				
5	University of Technology Brno/Vysoké učení technické v BrnÄ•		*	*		*
6	Palacky University/Univerzita Palackého v Olomouci		*	*		*
7	University of Economics Prague/Vysoká škola economická v Praze		*			*
8	University of South Bohemia/Jihočeská Univerzita					*
9	Technical University Ostrava/Technická Univerzita Ostrava		*		46339/23.03.06	*
10	Institute of Chemical Technology Prague/Vysoká škola chemicko-technologická v Praze		*			*
11	Mendel University of Agriculture and Forestry Brno/Mendelova univerzita v Brně		*	*		*
12	Czech University of Agriculture/česká zemědělská univerzita v Praze		*			*
13	Ostrava University/Ostravská univerzita v Ostravě		*			*
14	University of Pardubice/Univerzita Pardubice		*		17823/30.09.07	*
15	Silesian University/Slezská univerzita v Opavě		*			*
16	University of Hradec Kralove/Univerzita Hradec Králové					*
17	Tomas Bata University/Univerzita Tomáše Bati ve Zlíně		*	*		*
18	Purkyne University/Univerzita Jana Evangelisty Purkyně					*
19	Technical University of Liberec/Technická univerzita v Liberci		*			*
20	University of		*	*		*

	Veterinary and Pharmaceutical Sciences Brno/Veterinární a farmaceutická univerzita Brno					
21	College of Finance and Administration Prague/Vysoká škola finanční a správní					*
22	Academy of Arts Architecture and Design Prague/Vysoká škola uměleckoprÅ¯myslová v Praze					*
23	Academy of Performing Arts in Prague /Akademie múzických umění v Praze					*
24	Academy of Fine Arts Prague/Akademie výtvarných umění v Praze					
25	Janaceck Academy of Music and Dramatic Arts Brno/Janáčkova akademie múzických umění v Brně					*
26	College of Banking Prague/Bankovní institut vysoká škola					*(ua, sk)
27	University of Defence Czech Republic/Univerzity obrany					*
28	Prague College					*
29	University of the Defence Faculty of Military Health Sciences/Fakulta vojenského zdravotnictví Univerzity obrany					*
30	Business School Ostrava/Vysoká škola podnikání					*
31	Police Academy of the Czech Republic/Policejní akademie české republiky v Praze					
32	Metropolitan University					* (ru,de,fr)

	Prague/Metropolitní univerzita Praha					
33	Moravian College Olomouc/Moravská vysoká škola Olomouc					*(ru)
34	Jan Amos Komensky University/Univerzity Jana Amose Komenského Praha		*			*
35	College of Information Management & Business Administration /Vysoká škola manažerské informatiky a ekonomiky					*
36	Polytechnic College in Jihlava/Vysoká škola polytechnická Jihlava					*
37	University of New York at Prague/University of New York in Prague Vysoká škola					*
38	Hotel College Prague/Vysoká škola hotelová v Praze					*(ru)
39	University Karlovy Vary/Vysoká škola Karlovy Vary					
40	Institute of Technology and Business in Ceske Budejovice/ Vysoká škola technická a ekonomická v českých Budějovicích					
41	Private College of Economic Studies/Soukromá vysoká škola ekonomických studií					*
42	Prague International University					(ru)
43	Net University					
44	Private College of Economic Studies/Znojmo Soukromá vysoká škola ekonomická Znojmo					*(de)
45	Prague College of Psychosocial Studies/Pražská vysoká škola psychosociálních studií					*

Note:
* - No university has yet signed Berlin declaration on Open Access.

Table 4. Indicators of academic excellence for the leading German universities

	University	World Web Rank	World Scholar Rank	British Times Rank	Shanghai's Rank	Taiwan Rank
1	Freie Universität Berlin	100	49			120
2	Ludwig Maximilians Universität München	111	6	61	52	44
3	Ruprecht Karls Universität Heidelberg	114	69	83	63	63
4	Universität Trier **	115	997			
5	Humboldt Universität zu Berlin	116	123	178		99
6	Universität Leipzig	124	363		201-300	264
7	Universität Hamburg	131	207		151-200	165
8	Technische Universität Chemnitz	148	627			
9	Universität Münster	154	296		101-150	168
10	Universität Freiburg	163	170	132	101-150	148
11	Universität zu Köln	167	274		151-200	157
12	Universität Stuttgart	180	217		201-300	364
13	Rheinische Friedrich Wilhelms Universität Bonn	181	211	178	93	149
14	Technische Universität Berlin	183	258		201-300	412
15	Universität Karlsruhe (Karlsruhe Institute of Technology)	193	449	187	301-400	275
16	Technische Universität München	194	315		56	91
17	Universität Bielefeld	195	272	173	301-400	394
18	Rheinisch Westfalische Technische Hochschule Aachen	210	171	182	201-300	200
19	Universität Tubingen	212	252	189	101-150	122
20	Technische Universität Dresden	217	405		301-400	247
21	Friedrich Alexander Universität Erlangen Nürnberg	224	364		201-300	142
22	Universität Regensburg	225	87		301-400	285
23	Johann Wolfgang Goethe Universität Frankfurt am Main	229	375	172	101-150	144
24	Universität Bremen	243	351		301-400	404
25	Universität Kassel	251	454			
26	Technische Universität Darmstadt	252	52		301-400	461

27	Philipps Universität Marburg	269	294		201-300	260
28	Johannes Gutenberg Universität Mainz	284	550		151-200	161
29	Universität Hannover	296	383		401-500	471
30	Ruhr Universität Bochum	314	517		201-300	236
31	Technische Universität Dortmund	315	486			
32	Universität Göttingen	316	492	43	93	152
33	Heinrich Heine Universität Düsseldorf	331	447		201-300	214
34	Christian Albrechts Universität zu Kiel	344	464		151-200	221
35	Universität des Saarlandes	345	451			361
36	Technische Universität Kaiserslautern	348	497			
37	Friedrich Schiller Universität Jena	353	470		301-400	263
38	Justus Liebig Universität Giessen	356	396		401-500	314
39	Universität Paderborn	363	602			
40	Universität Ulm	367	394		301-400	234
41	Universität Mannheim	381	402			
42	Otto Von Guericke Universität Magdeburg	396	397			462
43	Universität Potsdam	398	645			451
44	Universität Konstanz	405	281	186	301-400	442
45	Universität Würzburg	410	690	168	101-150	170

Table 5. Indicators of openness for the leading German universities

	University	Berlin Declaration on Open Access	SINAPSE Platform	European University Association	Magna Charter	ROAR *	English version of the site**
1	Freie Universität Berlin	*		*		04.08.09	*
2	Ludwig Maximilians Universität München			*	*	10661/13.04.05 6612/15.03.06	*
3	Ruprecht Karls Universität Heidelberg		*	*	*	29.01.08 1362/04.10.06	*
4	Universität Trier					379/20.04.04	* (fr)
5	Humboldt Universität zu Berlin	*	*	*	*	11532/23/07/02	*
6	Universität		*	*	*		*

	Leipzig						
7	Universität Hamburg			*	*	3699/01.12.95	*
8	Technische Universität Chemnitz			*		2065/04.05.06	*
9	Universität Münster			*	*	3994/22.10.02	*
10	Universität Freiburg			*	*	6776/27.07.00	*
11	Universität zu Köln			*	*	2206/10.06.03	* (cn)
12	Universität Stuttgart		*	*	*	5321/12.06.99	*
13	Rheinische Friedrich Wilhelms Universität Bonn						*(fr)
14	Technische Universität Berlin				*	22.02.06	*
15	Universität Karlsruhe (Karlsruhe Institute of Technology)			*		5159/31.10.02	*
16	Technische Universität München	*			*	22/27.06.05	*
17	Universität Bielefeld					330/04.05.06	*
18	Rheinisch Westfalische Technische Hochschule Aachen					2820/22.02.05	* (nl)
19	Universität Tubingen			*	*	4487/06.12.99	*
20	Technische Universität Dresden			*		5951/29.10.09	*
21	Friedrich Alexander Universität Erlangen Nürnberg			*			*(fr)
22	Universität Regensburg			*	*	1081/16.03.01 15003/02.06.06	
23	Johann Wolfgang Goethe Universität			*			*

	Frankfurt am Main						
24	Universität Bremen			*	*	929/06.10.05	*
25	Universität Kassel	*		*		2091/01.02.06	
26	Technische Universität Darmstadt			*		13273/01.11.05 1486/17.10/08	*
27	Philipps Universität Marburg			*		2828/04.01.02	*
28	Johannes Gutenberg Universität Mainz			*		1845/01.01.00	*
29	Universität Hannover			*			*
30	Ruhr Universität Bochum			*		2589/03.11.03	*
31	Technische Universität Dortmund			*		20171/03.12.04	*
32	Universität Göttingen				*	17781/15.06.02	*
33	Heinrich Heine Universität Düsseldorf			*	*	6059/11.01.06	
34	Christian Albrechts Universität zu Kiel			*			*
35	Universität des Saarlandes				*	1966/19.08.04 2661/29.08.00	*(fr)
36	Technische Universität Kaiserslautern						*
37	Friedrich Schiller Universität Jena			*	*		*
38	Justus Liebig Universität Giessen		*	*		6763/15.01.03	*
39	Universität Paderborn				*		*(fr, es, ru, cn, tr)
40	Universität Ulm					523/28.05.08	*
41	Universität Mannheim						*

42	Otto Von Guericke Universität Magdeburg			*			*
43	Universität Potsdam					31/02.05.07 4606/04.02.05	
44	Universität Konstanz			*		10175/16.03.99	*
45	Universität Würzburg			*	*	4235/09.01.02	*

Notes:
* - The number of documents (11-15 October 2010) / date of registration of OA-repositories
** - The presence of English-language version of the site is shown with an asterisk, in parentheses are the availability of versions in other languages (nl - Dutch, fr - French, cn - China, ru - Russian, tr - Turkish, es - Spanish)
World rankings of universities are for 2010 (webometric ranking of universities given on July 2010)

The University of Pardubice has the best Scholar Rank indicator with a smaller number of documents in its OA-repository, when compared to the Technical University of Ostrava. In this case, Google Scholar has indexed on the 06.10.2010, a total of 14 000 documents which is comparable with the total number of documents (17 823) located in OA-repository of the University of Pardubice at the end of September 2010 (Table 1).

Almost all Czech universities, except for five, have English-language versions of their sites (Table 2). The Metropolitan University of Prague has the greatest (openness) transparency to the outside world, and in addition to having a Czech and English version of the site, it also has Russian, German and French versions. But their poor quality gives them a low university webometric rating (6400th place in the world). We are interested in the Czech universities that have Ukrainian and Russian language versions of their sites, which indicate their intent to attract students from Ukraine and Russia and to collaborate with universities in these countries. The Ukrainian language version of the site has a Banking College in Prague, the Russian-speaking - Metropolitan University of Prague, Moravian College Olomouc, Hospitality (Gotelny) College in Prague and the Prague International University.

Table 3 shows the participation (September-October 2010) of Czech universities in the university-wide and academic communities. None of them expressed interest in signing the Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities, which is reflected in the substantial absence of OA-repositories in the Czech universities and their low webometric ratings (Table 3). Only two Czech universities joined the European platform SINAPSE (Scientific Information for Policy Support in Europe): Karl and Masaryk Universities.

A relatively large number of Czech universities joined the European University Association (18 of 45), and about eight universities out of 45 joined the Magna Chapter (Bologna). The latter show that the relation to the Bologna Process in the Czech Republic is relatively modest, in contrast to the situation in Ukraine.

Table 4 is similar to Table 2 for Czech universities. Here we see that all the 45 German universities are in the TOP-500 Webometric ranking as well as in the TOP- 1000 according to Scholar Rank. The latter is due to the presence of OA-repositories in most German universities (only 11 out of 45 universities did not have OA-repositories). Several universities had two OA- repositories. The number of documents in these repositories do

not always correlated with the Scholar Rank. Most universities in Germany are included in the TOP-500 Shanghai and Taiwan rankings, 13 universities out of 45 are in the TOP-200 rankings of British Times Rankings.

Practically all German universities as of October 2010 had English versions of their sites (43 of 45); four universities had French-speaking versions, and some universities had Chinese, Dutch, Turkish, Russian and Spanish version of their site (Table 5).

In contrast to Czech universities, many German universities are members of the European Universities Association (32 of 45) and are signatories of the Magna Charter (20 of 45).

Only 5 universities have joined the SINAPSE platform. Against the background of good integration of German universities to the international movement of open access to scientific knowledge (34 out of 45 universities had their own OA-repositories), a surprisingly low percentage of universities have signed the Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities (3 of 45). Perhaps this is due to the fact that this declaration was not initiated by the university community, but by the academic community represented by the Max Planck Society (Table 5).

Thus, a comparison of two university networks of the Czech Republic and Germany (45 universities) of same dimension, shows a significant qualitative superiority of network of universities in Germany.

For carrying out calculations using formula (1), we have constructed Table 6 from Tables 2- 5.

Table 6. Comparative quantitative characteristics of university networks in Germany and the Czech Republic with the same dimensions (45 universities)

Indicators	Country	Czech	Germany
The number of universities in	TOP-1000 World Web Rank	9	45
	TOP-1000 Scholar Rank	11	45
	TOP-200 British Times Rank	0	13
	TOP-500 Shanghai's Rank	1	33
	TOP-500 Taiwan Rank	1	38
Amount	OA-repositories*	2	34
	English versions of the site	40	43
Participants	Berlin Declaration on Open Access	0	3
	SINAPSE platform	2	5
	European University Association	18	32
	The Magna Charter	8	20

* For each university taking into account only the OA-repository

On the basis of Table 6, the normalized vectors of Czech and German university network indicators are as follows: $\vec{\vec{v}}_{Czech}$= (0.20, 0.24, 0, 0.02, 0.02, 0.04, 0.89, 0, 0.04, 0.40, 0.18); $\vec{\vec{v}}_{Germany}$= (1, 1, 0.29, 0.73, 0.84, 0.76, 0.96, 0.07, 0.11, 0.71, 0.44).

Using formula 1 we obtain: d = 0.8542 for the Czech Republic, d= 0.4969 for Germany. Hence we see that $\vec{\vec{v}}_{Germany}$ is much closer to the standard unit vector than $\vec{\vec{v}}_{Czech}$, and therefore, the network of German universities developed significantly better with regard to

academic excellence and openness, than the comparative network of Czech universities in the same dimension.

Note that the top 20 Czech (Table 2) and German (Table 3) universities were used in the study by Moskovkin, Delux and Moskovkina (2012) for building university publication structures with the help of Google Scholar.

Conclusion

On the basis of a simple multi-dimensional vector analysis, we built a formalized quantitative procedure for the comparative analysis of the academic performance of universities and the openness of university networks of the same dimension as illustrated by the example of the leading universities in the Czech Republic and Germany. The suggested system indicators can be significantly expanded, for example, with the help of other global university ratings (Leiden, QS, URAP, SIR).

Comparison of university networks of the Czech Republic and Germany (45 universities) of same dimension, shows significant academic excellence and openness of network of universities in Germany. In order to make this comparison, proximity measures were introduced. This is represented by proximity of an arbitrary normalized vector of indicators to standard unit vectors that can be found with the aid of the normalized Euclidean distance.

As zero vector is separated from unit vector on d=1, then taking the distance for 100% from earlier calculations, we can see that the network of German universities is closer on 85.42% - 49.69% = 35.73% to the standard unit vector compared to the network of Czech Republic universities.

The proposed academic and openness indicators, along with others (living conditions and safety on college and university campuses, scholarship and grant support, cost of living in cities where universities are located, etc.), can be used in constructing a simulation expert system of choosing universities for training and research.

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Bibliographic information of this paper for citing:

Moskovkin, Vladimir M., Fraser, Jason K., & Moskovkina, Maria V. (2013).   "University networks in the context of their academic excellence and openness: A comparative study of leading Czech and German universities."   *Webology*, 10(1), Article 107. Available at: http://www.webology.org/2013/v10n1/a107.html

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