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INTERDISCIPLINARY DESCRIPTION OF COMPLEX SYSTEMS

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INTERDISCIPLINARY ASPECTS OF EDUCATION – INTRODUCTION OF THEMATIC ISSUES

Dear readers,

education underlies virtually all aspects of our civilisation. It forms us from an early age, influences us during a large part of our lives, enables us to formulate and share our thoughts and visions, and to implement them into our environment for further specific development of our civilisation.

Education has important interdisciplinary aspects and related research contributions. It incorporates disciplinary education methodologies, context formed by other disciplines and societal requirements as well as specific qualities encountered within other fields.

In order to contribute more to analyses, and prospective development of the education theory and practices, journal INDECS has devoted the second issue of each of its volumes to the interdisciplinary approaches to education. Each issue devoted to interdisciplinary aspects of education will emphasise a particular topic. Each topic is described in more details in the corresponding call for papers. Naturally, all other topics within interdisciplinary aspects of education are welcome for any thematic issues.

Prospective authors, scholars and experts, working on interdisciplinary aspects of education, are welcome to submit their contributions to the journal INDECS. All manuscripts submitted to the journal INDECS, aimed for publishing in the specified thematic issues, will be processed in a regular manner.

Cordially,

Zagreb, 8th April 2013 Josip Stepanić

Interdisciplinary Description of Complex Systems 11(2), iii, 2013

ENGINEERING EDUCATION AND SOCIETY – CALL FOR PAPERS

Dear readers,

examinations of engineering as a profession and its various practices, as well as the scope and field of its scientific interest, emphasize the need for overcoming the idea of engineering as a mostly "technical exploit", and acknowledge the idea of engineering as a process that includes different and complex aspects of social reality. This is reflected in the analysis of the corresponding curriculum, especially in the intent of "opening" towards the arts and humanities. However, reforms undertaken with the objective of bringing engineering education and society/culture closer together have not developed uniformly and tend to show that the very nature of this relationship is far more complex than could have been expected from the perspective of positivist certainty. There is an obvious disproportion between the reform, as an institutional-ideological project, and reality, in which the intended change is only partially implemented, since it goes through numerous revisions and adjustments in the context of dominant culture of engineering educational institutions, cultural "lenses" and shared practices of parties involved. At the same time, there is a growing number of theoretical approaches and research that contribute to the development of the topic on engineering education and society with regards to dominant questions on the kind of social and humanistic awareness of engineering students, the extent to which this awareness should be included in the curriculum, and in the end in what ways the reform could or should be implemented, i. e. which learning methods and pedagogical approaches should be used.

This way, the topic on engineering education and society is continually being re-established, renewed, and re-confirmed. It is diverse and interdisciplinary in focus, and it witnesses important breakthroughs of scientists working in the fields of technical sciences and arts and humanities, and their theoretical generality. Finally, it is also established in the workings of key groups of actors, who directly or indirectly participate in the design of engineering educational programs, like national and international engineering associations, accreditation agencies, lecturers and scientists in engineering studies and the business sector. The character of a vast array of concepts with regards to engineering education and society is mediated by their very presence and influence, which often vary depending on the set goals, ideological differences, experience, interests and difference in social power.

Scholars and experts, as well as other interested authors, are invited to submit their contributions about different aspects of the relationship between engineering education and society. We particularly welcome "down to earth" articles that, by combining professional, scientific imagination, and the reality of engineering education can enable engineering students to deepen their understanding of their role in society.

Submissions are to be prepared in accordance with the Journal's instructions for authors.

Deadline for manuscript submission is 15th January 2014. Deadline for submission of final version of manuscripts is 15th March 2014. Issue is predicted to be published in April 2014.

Please prepare your paper following the "Instructions for Authors" available from the Interdisciplinary Description of Complex Systems web-site:

Cordially,

Zagreb, 8th April 2013

Guest Editor

Prof. Nikša Dubreta

EDITORIAL

Dear readers,

in November 2012 the University of Zagreb organised International workshop *Simulation modeling of research capacity at the University of Zagreb*, with particular emphasis on the role of, and professional perspectives for its younger researchers, i.e. Ph.D. students, thus one of the crucial aspects of the higher education institutions. The workshop was part of the research project *Simulation modeling of the Research Capacity of the University of Zagreb.*

This issue of the journal INDECS is the proceedings of the workshop, containing refereed versions of seven articles which were prepared based on the selected presentations held during the Workshop.

Additionally, this issue is the first thematic issue prepared as a realisation of the long-term orientation of the journal INDECS onto interdisciplinary aspects of education, as described on page ii of this issue.

First article, by H. Mataković, M. Pejić Bach and I. Radočaj Novak, provides readers with the current data regarding scientific productivity in transition countries. That is the context in which the work of young researchers is formed and channelled. Since the roots of the current situation span rather long period, scientific productivity is in fact related to the broader, societal transition. That article is to be contrasted with the second article, by M. Schatten, which treats in details the intensity and span of the areas covered in scientific articles (co)authored by Croatian scientists. These two articles provide the reader with the context, first in a longitudinal analysis and the second in a transversal analysis.

Third article, by J. Stepanić, M. Pejić Bach and J. Kasać, sets the agent-based simulation model aiming to reliably present the perspectives for the younger researchers. In its present phase the model is conceptually developed, applicable for a number of universities, with the details of a particular university to be straightforwardly incorporated. That article develops the simulation tool to be used as a support in future decision making regarding the scientific policies, presumably for younger researchers.

Fourth and fifth article tackles in broader sets in which younger researchers, and the very universities, function. The article by I. Marić clarifies the types and meanings of the stakeholders of the higher education institutions, rooting in that way the causes of the observed and/or planned dynamics of the universities with the relevant societal groups and their dynamics. The article by A. Protić, B. Runje and J. Stepanić focuses onto the, currently rather intensively researched aspect of scientific work, of choosing the proper, robust (i.e. as least depending on the environment as is possible) quantitatively expressible and straightforwardly determinable notion uniquely related to scientific productivity and other aspects of scientific work.

The article by M. Mulej et al. presents modern method for system approach to complex phenomena in a society. That article provides the readers with the useful tool for organising the longer-term work in a rather complex environment of modern societies. Finally, the article by M. Merkač Skok presents data related to life long learning, in particular the motivation of the employees for it.

Zagreb, 18th April 2013

Issue Editors
Prof. Mirjana Pejić Bach
Prof. Josip Stepanić

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SCIENTIFIC PRODUCTIVITY IN TRANSITION COUNTRIES: TRENDS AND OBSTACLES

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ABSTRACT

Scientific productivity is one of the engines of development in the 21st century. The most common way of its measurement is through publication in peer-review articles. Current research indicates that there is a strong connection between country's development and its share in the world publication of scientific articles. Transition countries are still catching-up with the most developed countries in terms of scientific productivity, which is especially evident in Western Balkan countries. As one of the rare attempts to assess obstacles to scientific productivity in transition countries, this study investigates different factors and their effects to the scientific productivity. The obstacles are the results of the historical reasons, inadequate systems for advancement in the scientific community, and problems with the development and/or implementation of strategies for scientific development of the particular country. In addition, without efficient measurement of scientific productivity, it is hard to analyse its behaviour. Papers written by authors from transition countries are often published in local journals that are covered insufficiently by the Web of Science. Therefore, up-to-date systems for tracking scientific publications in transition countries are of the highest importance.

KEY WORDS

scientific productivity, transition countries, obstacles, science, Web of Science

CLASSIFICATION

APA: 2960

JEL: O32, O38

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INTRODUCTION

Scientific productivity can be measured in different ways, among which the most common is to analyse the number of publications and citations of published papers – although "citation data provide only a limited and incomplete view of research quality" [1]. Such analyses are usually based on data from the Web of Science database since it covers more than 12 000 journals from all over the world and all fields of science (about 250 disciplines). Although this database does not include a large number of scientific journals, especially those not published in English and those who are more focused on national issues, it includes research publications relevant to the international level because of their "high standards of selectivity" [2], and is therefore the starting point for various analyses. Analysis based on the number of publications in Web of Science database could be extended with a variety of factors such as GERD (Gross domestic expenditure on R&D), and the number of researchers or residents in order to obtain comparable data for countries that differ in population size or level of wealth.

Scientific production is influenced by various factors that can encourage or discourage it. The most important of these factors are: (i) the system of research funding, (ii) patents, (iii) international collaboration and (iv) professional promotion system. Transition in countries of Central and Eastern Europe that began in the late 1980s was, according to some authors, "the largest natural experiment ever" [3]. The transition has, aside from the economy and politics, engulfed other social spheres such as science and research. Transformation of research (in general) in transition resulted in a reduction of institutional and financial resources of science, resulting with general backwardness in scientific and technological development [4], thus making the path to becoming a "knowledge society" significantly more difficult [5]. The transformation of the research systems also affected scientific productivity: in most countries, especially in the first few years of transition, a decline in the quantity and quality of scientific papers occurred. In our paper we shall concentrate on the causes of the fall in productivity.

In addition, research production in small countries is poorly monitored in international databases [6]. The main causes for this are the language barrier and a small scientific community, which means fewer scientists and fewer quality reviewers for local journals and this, in turn, results in lower overall quality of papers published in journals. Therefore, small countries cannot rely on international databases to gather information about their scientific productivity.

Based on the above points, we define following goals of the paper: (1) to compare the diversity of scientific productivity across countries, (2) to define obstacles to increase scientific productivity, (3) to identify obstacles to scientific productivity in transition countries, and (4) to evaluate bibliographic database usage in transition countries.

SCIENTIFIC PRODUCTIVITY AND ITS DIVERSITY ACROSS COUNTRIES

In this section, we focus on the quantitative analysis of the reported number of papers indexed in Web of Science. The qualitative analysis, which aside from the number of papers also includes citations, will be presented in the second part of this part of the paper.

In the analysis conducted for the year 2011 (shown in Table 1) we included all paper types indexed in Web of Science (article, meeting abstract, and proceedings paper). We covered 34 countries to display the characteristics of scientific production in different parts of the world. The majority of the countries included are among the most economically and scientifically advanced countries of the world: 16 countries of Western Europe, USA, Canada, Australia and Japan. We included 7 former communist countries and also the countries that are on a good way to become a scientific superpower (China and India). From Asia and Africa we listed Israel and South Africa.

Table 1. Published papers in selected countries in 2011, dased on data from Web of Science and Eurostat.

Country	Number of papers	% world	Number of papers per number of researchers (FTE)	Number of papers per population, mil	GERD per number of papers, mil €	Research area (percentage)	Country most collaborated with (percentage)
United States	509 958	28,64	0,36	1 636	0,56	Chemistry (7,34 %)	China (3,80 %)
China	172 439	9,68	0,08	127	0,35	Chemistry (19,20 %)	USA (11,27 %)
United Kingdom	141 477	7,95		2 316	0,22	Physics (5,51 %)	USA (14,50 %)
Germany	119 295	6,70	0,36	1 433	0,62	Physics (11,64 %)	USA (14,20 %)
Japan	91 515	5,14	0,14	723	1,33	Physics (13,11 %)	USA (9,23 %)
France	81 197	4,56	0,34	1 285	0,55	Physics (11,53 %)	USA (13,63 %)
Canada	74 943	4,20	0,31	2 232	0,00	Engineering (8,02 %)	USA (21,98 %)
Italy	69 454	3,90	0,65	1 182	0,28	Physics (8,76 %)	USA (13,94 %)
Spain	61 345	3,44	0,47	1 361	0,23	Chemistry (10,52 %)	USA (11,70 %)
Australia	56 905	3,19	0,41	2 584	0,00	Engineering (6,45 %)	USA (14,30 %)
India	51 707	2,90	0,13	43	0,00	Chemistry (18,49 %)	USA (7,18 %)
South Korea	51 116	2,87	0,15	1 046	0,56	Chemistry (14,21 %)	USA (14,65 %)
Netherlands	42 474	2,39	0,79	2 604	0,29	Neurosciences neurology (6,11 %)	USA (16,15 %)
Brazil	41 188	2,31	0,16	211	0,00	Agriculture (8,48 %)	USA (10,44 %)
Russia	31 261	1,76	0,04	220	0,48	Physics (26,22 %)	Germany (8,83 %)
Switzerland	30 284	1,70	0,49	4 038	0,34	Physics (10,32 %)	USA (20,64 %)
Sweden	25 464	1,43	0,56	2 801	0,51	Physics (8,21 %)	USA (16,89 %)
Poland	23 502	1,32	0,37	609	0,12	Chemistry (13,44 %)	USA (9,23 %)
Belgium	23 130	1,30	0,57	2 103	0,33	Physics (7,79 %)	USA (15,28 %)
Denmark	16 283	0,91	0,43	2 929	0,46	Chemistry (6,54 %)	USA (16,92 %)
Austria	16 232	0,91	0,44	1 989	0,51	Physics (9,27 %)	Germany (24,56 %)
Israel	14 840	0,83		1 955	0,00	Physics (8,96 %)	USA (35,75 %)
Greece	13 385	0,75	0,64	1 258	0,10	Engineering (9,46 %)	USA (13,89 %)
Portugal	12 868	0,72	0,27	1 237	0,20	Chemistry (11,54 %)	Spain (13,10 %)
Norway	12 457	0,70	0,34	2 486	0,48	Engineering (7,40 %)	USA (15,69 %)
Finland	12 193	0,68	0,30	2 368	0,59	Physics (8,86 %)	USA (15,25 %)
Singapore	11 306	0,63	0,31	2 113	0,00	Engineering (16,61 %)	USA (17,52 %)
South Africa	11 079	0,62	0,36	214	0,00	Chemistry, Plant sciences (6,00 %)	USA (16,47 %)
Ireland	9 895	0,56	0,64	2 339	0,28	Chemistry (7,68 %)	North Ireland (23,57 %)
Romania	7 853	0,44	0,49	362	0,08	Physics (15,23 %)	France (8,04 %)
Serbia	5 228	0,29	0,29	734	0,00	Engineering (12,68 %)	USA (7,08 %)
Croatia	4 392	0,25	0,64	991	0,08	Chemistry (8,33 %)	USA (9,75 %)
Slovenia	4 220	0,24	0,48	2 059	0,21	Engineering (11,89 %)	USA (9,97 %)
Bulgaria	2 482	0,14	0,21	326	0,09	Chemistry (15,26 %)	Germany (17,03 %)

The country with the largest number of papers is the USA with 28,64 % of the global scientific production. The comparison made by May [7] on a sample of 31 countries over the period 1981 to 1994 has shown that the five largest global economies were also the five countries with the largest number of papers (U.S.A. 34,6 %, UK 8 %, Japan 7,3 %, Germany had 7 % and France 5,2 % of total world production). These five countries were again in the top by the number of papers in 2011. However, the largest newcomer is China which is in the second position with 9,78 % of global production, which is, among other things, the result of strong government investment in research and development [8]. In the same time, the biggest drop in the number of papers in relation to the first half of the '80s and '90s occurred in the United States – from 34,6 % to 28,64 %. On the other side, drop in other countries it is relatively small (between 1 and 2 % in respect to the period from 1981 to 1994). The only country of the top 7 in the period from 1981 to 1994 that had an increase in publications in 2011 is Italy – its share rose from 2,7 % to 3,9 % of the world production.

The ratio of number of papers and number of researchers in full time equivalents (FTE) can give a more realistic picture of productivity than the total number of papers per country. Such approach avoids the bias created by the size of the country since, as a rule, larger countries publish a bigger number of papers. This perspective shows that the best results are achieved mainly by smaller European countries – most papers were published by the Netherlands (0,79 per researcher), Ireland, Greece and Croatia (0,64), Sweden (0,59) and Belgium (0,57). To obtain leading positions in this ranking is a dubious success, since many researchers in economically developed countries are working in the industry producing applied research, and their research efforts mostly will not result with published.

Comparison among the countries can also be made by looking at the number of papers per million inhabitants. Here the smallest proportion has the most populous countries like India and China, and the largest proportion have Switzerland and the Scandinavian countries which are relatively small countries with a large number of papers.

Alternative way to assess productivity is the ratio of governmental expenses for research and development (GERD) and the number of papers. Papers with the smallest budget are produced by poorer countries with low GERD and with a small investment in science and research, such as Croatia, Romania and Bulgaria (Table 1). One should take into account that certain countries focus more on specific areas and consequently publish a larger number of papers in these research areas. Such examples are Denmark, Sweden and Switzerland that are focused on biomedicine, while Asian countries are more focused on engineering, computer science and chemistry [7]. This focus also affects the budget of published papers because some areas of science are associated with high costs. For example, a paper in biomedicine, which includes lab work, will be more expensive to produce than, a paper in philosophy.

Research areas in which analysed countries published most papers were physics, chemistry and engineering, which is not surprising since in 2011 the largest number of papers in general were published in those categories (9,463 % in Chemistry, 7,701 % in Engineering and 7,317 % in Physics). The only surprise is Brazil with most papers (8,47 %) published in agriculture, an area in which only 1,793 % papers were published in total.

An increasing number of papers involve international collaboration. May [7] states that, for example, in 1994 only 26 % of papers whose first authors were from the UK were the result of international cooperation and today these figures are much higher. The country with which the majority of countries in this analysis had collaborated most intensively (by number of publications) were the United States, and only few countries most intensively worked mainly with geographically close countries (e.g. Austria with Germany, Portugal with Spain, and Ireland with Northern Ireland).

SCIENTIFIC PRODUCTIVITY OF TRANSITION COUNTRIES

Term transition countries refer to those countries that experienced change from the socialism to the capitalism in the early '90s [3], and it influenced not only economy and politics, but also science and research. Funding for the scientific research in most of the countries decreased, which resulted also in decrease of scientific publications [4]. In the following analysis we shall concentrate on the trends in the fall in productivity. First, we shall analyse the scientific productivity of selected EU countries and Central European transition countries. Second, we shall focus to selected Western Balkan countries and Russia.

Citation analysis of selected EU and Central European transitional countries for 1981-1988, 1989-96, 1997-2004 and 2005-2012 is presented in Table 2, and is based on an analysis conducted by Kutlača [9], complemented by the latest data on papers and citations from the database Web of Science. The two periods (1981-1988 and 1989-1996) were initially studied by Kutlača, and are supplemented in this paper with two additional periods (1997-2004 and 2005-2012).

Table 2 reveals following conclusions for the number of papers in Web of Science that are cited. If we compare the percentage of cited papers from the first transition period (1989-1996) and the pre-transition period, it is obvious that Poland has the lowest growth but differences in growth among countries are not very large. Considering the number of citations in all three periods comparisons, biggest growth is seen in Romania, which had significantly lower scores than other countries in the pre-transition period. All transitional countries show a rise in the number of papers, except in the first period of transition, although it is far lower than the rise in Spain and Portugal, where the number of papers published in the period of twenty years has increased by more than 7 times. Among former communist countries, in the pre-transition period best results are seen in Poland – the percentage of cited papers (74,32 %) are almost equal to Finland (75,72 %). In other categories, such as the number of citations and the number of papers, Poland also shows better results than other post-communist countries which is, partly, probably due to the fact that Poland has the largest population of all four countries (Figure 1).

In order to assess the scientific productivity of selected Western Balkan countries (mostly former Yugoslavian countries) and Russia, we firstly examined the number of papers published per year (Table 3). When analysing the data, it should be taken into account that the first period was affected by the war between Croatia, Bosnia and Herzegovina and Serbia and Montenegro, and that the second period was affected by the war between Kosovo Albanians and Serbia and military conflict between Macedonians and Albanians in Macedonia.

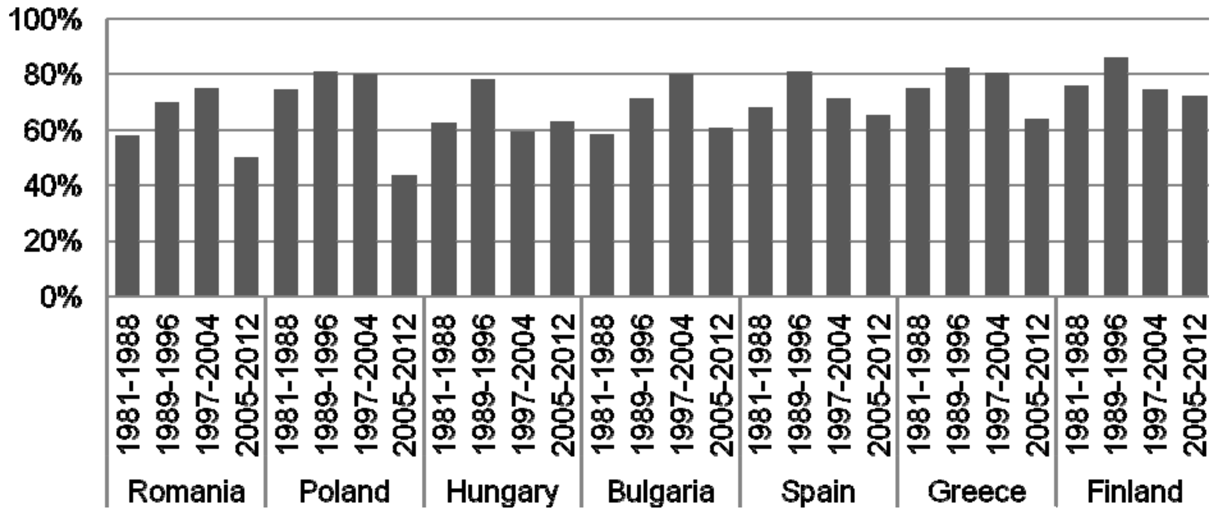

Figure 1. Percentage of papers in Web of Science that are cited of selected EU and Central European transitional countries for 1981-1988, 1989-96, 1997-2004 and 2005-2012 [9].

Table 2. Citation analysis of selected EU and Central European transitional countries for 1981-1988, 1989-96, 1997-2004 and 2005-2012 [9].

Pe-riod	Country	# of papers in WoS	Share of papers in WoS	# of cited papers	% cited papers	# of citations	Impact[(1)]	World-total number of papers in WoS
P1: 1981-1988	Finland	33 391	0,48%	25.285	75,72%	575 699	17,24	6 977 991
	Greece	13 314	0,19%	9.998	75,09%	137 280	10,31	
	Spain	56 784	0,81%	38.704	68,16%	559 153	9,85	
	Bulgaria	11 531	0,17%	6.746	58,50%	62 569	5,43	
	Hungary	29 108	0,42%	18.207	62,55%	250 098	8,59	
	Poland	45 244	0,65%	33.625	74,32%	395 403	8,74	
	Romania	8 713	0,12%	5.057	58,04%	42 484	4,88	
P2: 1989-1996	Finland	44 727	0,58%	38.514	86,11%	1120 642	25,06	7 748 178
	Greece	24 701	0,32%	20.297	82,17%	374 227	15,15	
	Spain	121 882	1,57%	98.476	80,80%	1989 284	16,32	
	Bulgaria	13 238	0,17%	9.430	71,23%	111 510	8,42	
	Hungary	26 928	0,35%	21.011	78,03%	157 682	5,86	
	Poland	54 759	0,71%	44.357	81,00%	657 610	12,01	
	Romania	8 446	0,11%	5.899	69,84%	63 229	7,49	
P3: 1997-2004	Finland	70 140	0,72%	52.160	74,37%	1560 972	22,26	9 760 789
	Greece	52 260	0,54%	42.035	80,43%	817 756	15,65	
	Spain	225 415	2,31%	160.973	71,41%	3 783 321	16,78	
	Bulgaria	13 913	0,14%	11.154	80,17%	161 993	11,64	
	Hungary	39 479	0,40%	23.363	59,18%	489 436	12,4	
	Poland	95 668	0,98%	76.670	80,14%	1214 467	12,69	
	Romania	17 399	0,18%	13.032	74,90%	175 152	10,07	
P4: 2005-2012	Finland	90 874	0,69%	65.510	72,09%	923 806	10,17	13 092 930
	Greece	101 930	0,78%	65.318	64,08%	707 999	6,95	
	Spain	413 361	3,16%	269.781	65,27%	3264 489	7,9	
	Bulgaria	19 375	0,15%	11.707	60,42%	109 651	5,66	
	Hungary	54 597	0,42%	34.278	62,78%	401 540	7,35	
	Poland	168 696	1,29%	73.548	43,60%	905 867	5,37	
	Romania	49 307	0,38%	24.725	50,15%	174 629	3,54	
Index P2/P1	Finland	1,34	1,21	1,52	1,14	1,95	1,45	1,11
	Greece	1,86	1,67	2,03	1,09	2,73	1,47	
	Spain	2,15	1,93	2,54	1,19	3,56	1,66	
	Bulgaria	1,15	1,03	1,4	1,22	1,78	1,55	
	Hungary	0,93	0,83	1,15	1,25	0,63	0,68	
	Poland	1,21	1,09	1,32	1,09	1,66	1,37	
	Romania	0,97	0,87	1,17	1,2	12,5	12,9	
Index P3/P1	Finland	2,1	1,5	2,06	0,98	2,71	1,29	1,40
	Greece	3,93	2,81	4,2	1,07	5,96	1,52	
	Spain	3,97	2,84	4,16	1,05	6,77	1,7	
	Bulgaria	1,21	0,86	1,65	1,37	2,59	2,15	
	Hungary	1,36	0,97	1,28	0,95	1,96	1,44	
	Poland	2,11	1,51	2,28	1,08	3,07	1,45	
	Romania	2	1,43	2,58	1,29	34,64	17,34	
Index P4/P1	Finland	2,72	1,45	2,59	0,95	1,6	0,59	1,88
	Greece	7,66	4,08	6,53	0,85	5,16	0,67	
	Spain	7,28	3,88	6,97	0,96	5,84	0,8	
	Bulgaria	1,68	0,9	1,74	1,03	1,75	1,04	
	Hungary	1,88	1	1,88	1	1,61	0,86	
	Poland	3,73	1,99	2,19	0,59	2,29	0,61	
	Romania	5,66	3,02	4,89	0,86	34,53	6,1	

(1)Impact is number of citations divided by number of papers.

Table 3. Number of published papers per year for countries of selected Western Balkan Countries and Russia, from 1993 to 2010. Source: Web of Science.

Year	Croatia	Bosnia and Herzegovina	Slovenia	Macedonia	Albania	Yugoslavia/Serbia			Russia
1993	931	28	693	62	29	837			25 830
1994	904	28	837	60	44	854			26 671
1995	1085	24	887	82	41	979			28 317
1996	1164	30	1010	94	49	1232			28 848
1997	1148	27	1189	109	37	1146			29 854
1998	1315	29	1201	116	42	1564			29 408
1993-1998	**6 547**	**166**	**5 817**	**523**	**242**	**6 612**			**168 928**
1999	1379	37	1457	115	40	1285			29 020
2000	1451	35	1723	156	40	1219			28 962
2001	1466	61	1708	153	32	1175			26 884
2002	1606	61	1849	171	58	1335			27 809
2003	1731	75	2 017	156	52	1428			26 758
2004	1975	98	2 120	203	45	1948			27 276
1999-2004	**9 608**	**367**	**10 874**	**954**	**267**	**8 390**			**166 709**
2005	2 262	139	2 398	216	68	2.223			27 125
2006	2 427	165	2 490	281	81	2 315		Montenegro 55	26 576
2007	2 994	365	3 070	309	101	3 025		77	28 018
2008	3 586	427	3 597	364	113	3 608	Kosovo 24	125	30 257
2009	4 073	469	3 678	390	133	4 247	21	140	30 743
2010	4 131	601	3 812	437	188	4 798	43	174	30 086
2005-2010	**19 473**	**2 166**	**19 045**	**1.997**	**684**	**20 216**	**88**	**571**	**172 805**
1993-2010	**35 628**	**2 699**	**35 736**	**3.474**	**1.193**	**35 218**	**88**	**571**	**508 442**

During the observed period of 18 years, Croatia and Slovenia show a continuous increase in the number of papers. Serbia (together with Montenegro) showed continued growth until 1998, which was followed by a 5 year period of stagnation. In Russia, the situation is even more serious – a stagnation period lasted from 1997 up until 2008. Looking at the three most developed countries of former Yugoslavia (Slovenia, Croatia and Serbia), we notice that in the period of 1993-2010 years all three countries published a roughly similar number of papers (about 35 000). If we consider the ratio of papers and population size, Slovenia would have the best result since Slovenia's population is about half of Croatia, and Croatia's is almost half as large as Serbia's. However, the analysis will be more accurate when we take quality into account, which is presented through a number of citations and cited papers (Table 4).

In Table 4, we have also used Kutlača's [9] approach, but we have changed the structure of the periods observed, since Web of Science does not distinguish papers published in selected Western Balkan countries (mostly former Yugoslavian countries) and Russia before 1993. Thus, we looked at three periods: 1993-1998, 1999-2004 and 2005-2010.

Comparing the two later periods with the first transition period, almost all countries had continuous growth in the number of citations and papers - with the exception of countries that started with modest results (e.g. Bosnia and Herzegovina). In the second, but especially the third period, the largest increase in the number of papers and citations occured in Slovenia. Russia showed a significant decline in the third period, especially in the number of citations which has decreased by almost a third from the second to the third period, regardless of the number of published papers being approximately the same.

Former Yugoslavia, consisting of Serbia, Montenegro and Kosovo in the 1990s, had the largest production in the first transition period, while Croatia's production was slightly smaller.

Table 4. Citation analysis of selected Western-Balkan transitional countries and Russia in 1993-1998, 1999-2004, and 2005-2010. Source: Web of Science.

Period	Country	Number of papers in WoS	Share of papers in WoS, %	Number of cited papers	Cited papers, %	Number of citations	Impact(1)
P1:1993-1998	Croatia	6 547	0,10	5.156	78,75	73 128	11,17
	Bosnia and Herzegovina	166	0,00	121	72,89	1743	10,50
	Slovenia	5 817	0,09	4.665	80,20	86 310	14,84
	Macedonia	523	0,01	362	69,22	6 059	11,59
	Albania	242	0,00	181	74,79	2 210	9,13
	Federal republic of Yugoslavia	6 612	0,10	4.708	71,20	56 726	8,58
	Russia	168 930	2,59	104.602	61,92	1276 478	7,56
P2:1999-2004	Croatia	9 608	0,13	7.400	77,02	101 961	10,61
	Bosnia and Herzegovina	367	0,00	239	65,12	3 884	10,58
	Slovenia	10 874	0,15	8.863	81,51	151 128	13,90
	Macedonia	954	0,01	615	64,47	7 942	8,32
	Albania	267	0,00	190	71,16	2 561	9,59
	Federal republic of Yugoslavia/ Serbia and Montenegro	8 390	0,11	5.955	70,98	70197	8,37
	Russia	166 707	2,24	113.928	68,34	1448 673	8,69
P3:2005-2010	Croatia	19 473	0,20	12.237	62,84	116 825	6,00
	Bosnia and Herzegovina	2 168	0,02	1.087	50,14	7 670	3,54
	Slovenia	19 045	0,20	13.865	72,80	153 627	8,07
	Macedonia	1 997	0,02	882	44,17	7 471	3,74
	Albania	684	0,01	252	36,84	2 129	3,11
	Serbia and Montenegro/Serbia/ Montenegro/Kosovo	20 227	0,21	12.663	62,60	99 690	4,93
	Russia	172 805	1,81	108.011	62,50	919 279	5,32
Index P2/P1	Croatia	1,47	1,28	1,44	0,98	1,39	0,95
	Bosnia and Herzegovina	2,21	1,93	1,98	0,89	2,23	1,01
	Slovenia	1,87	1,64	1,9	1,02	1,75	0,94
	Macedonia	1,82	1,6	1,7	0,93	1,31	0,72
	Albania	1,10	0,97	1,05	0,95	1,16	1,05
	Federal republic of Yugoslavia/ Serbia and Montenegro	1,27	1,11	1,26	0,99	1,24	0,98
	Russia	0,99	0,86	1,09	1,10	1,13	1,15
Index P3/P1	Croatia	2,97	2,03	2,37	0,80	1,6	0,54
	Bosnia and Herzegovina	13,06	8,9	8,98	0,69	4,4	0,34
	Slovenia	3,27	2,23	2,97	0,91	1,78	0,54
	Macedonia	3,82	2,6	2,44	0,64	1,23	0,32
	Albania	2,83	1,93	1,39	0,49	0,96	0,34
	Serbia and Montenegro/Serbia/ Montenegro/Kosovo	3,06	2,08	2,69	0,88	1,76	0,57
	Russia	1,02	0,7	1,03	1,01	0,72	0,71

(1)Impact is number of citations divided by number of papers

However, despite the small number of papers, Slovenia had the largest number of citations (Figure 2). In the second period, Slovenia published the highest number of papers and also had the largest number of citations. It is interesting that Slovenia has 80 000 citations more than Yugoslavia but only 2 500 more published papers. In the third period, Serbia had again published the largest number of papers, but Slovenia had 54 000 more citations than Serbia, even though its researchers published 1000 papers less.

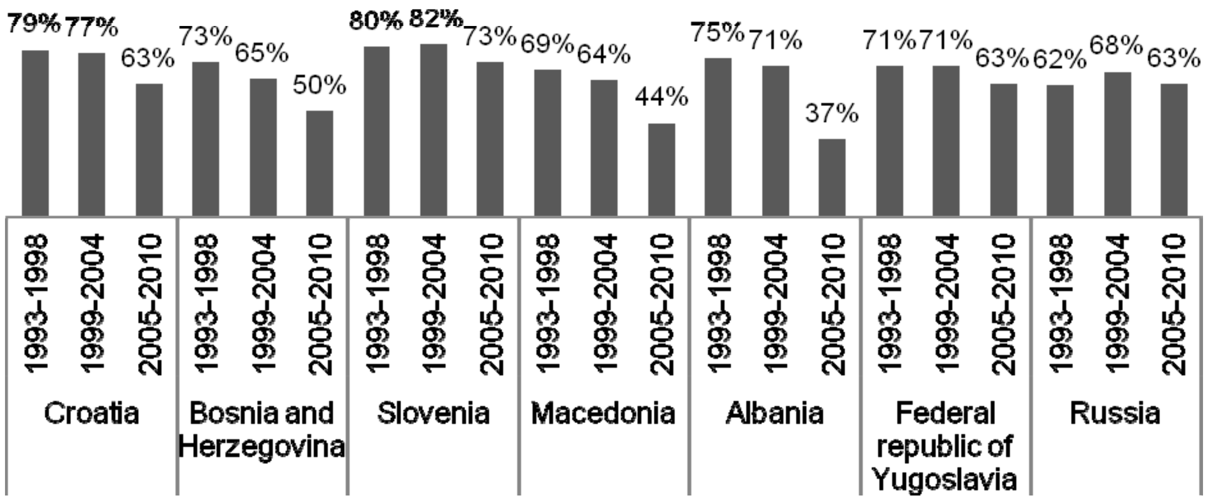

Figure 2. Percentage of papers in Web of Science that are cited or of selected Western-Balkan transitional countries and Russia during 1993-1998, 1999-2004, and 2005-2010. Source: Web of Science.

OBSTACLES TO DEVELOPMENT OF SCIENTIFIC PRODUCTIVITY

Economic development of a given country that has the strongest impact on the scientific productivity of a given country. By analysing 95 countries and observing various factors and their impact on scientific production, Cole and Phelan [10] demonstrated that GDP is moderate to strongly correlated with the production of "high-quality science", and this title was given to articles with more than 40 citations. Schofer [11] observed the scientific production in the period from 1970 to 1990 and found that the number of papers on a global level doubled in that period, with the highest level of growth in the industrialised West, but also in the other parts of the world. The most important factor that contributed to this growth is again GDP [11]. Therefore, we can conclude that economic development is the strongest incentive, but at the same time obstacle to the development of scientific productivity.

The reason for the strongest impact of economic development is the fact that in most countries the government is the main funding source for scientific inquiry, especially for basic research since the results of basic research is often unpredictable and unknowable [12]. Therefore, it cannot be expected that the market will be a "vehicle for capturing the value of innovation" generated as the result of basic research [13]. Although richer countries generally spend more budget funds on scientific research, spending trends are changing over time. In the early 1990s Japan and Sweden were the countries with the largest investment in science (compared to GDP), outpacing the US and Germany. Since a significant portion of research funds was spent on defence purposes, with the end of the Cold War, but also the budgetary cut policies of Ronald Reagan and Margaret Thatcher, USA and United Kingdom significantly reduced public funding of research in the early '90s [12].

Private investment in scientific research sector significantly increased since 1985 [14]. At the turn of '80s to '90s the largest private sector investments in science were made in Japan, the United Kingdom and Sweden [12]. At the turn of '90s to the 21st century, Japan remains in the lead with private funds invested in public research, followed by the US, Germany and France [15]. The largest increase in private investment had the countries that introduced tax credits during the '90s [12].

It could be expected that this increase in investment will have a negative or neutral effect on scientific productivity measured in terms of scientific articles since the reward system is very different in the industry than in the academic community for each of these sectors has different goals, i.e. different expectations of the conducted research [14]. While in the academic community, in addition to the new discoveries, it is expected that the final result will be a published paper, the business sector expects new solutions that will be marketable and thus gain profits. However, various studies (e.g., [12, 16]) have shown that intensive research collaboration with industry, in addition to applicable solutions such as patents, results in high scientific production. Indeed, Van Looy [16] argues that "both publication and patenting activities are not very different in terms of their intellectual challenge and nature. In both instances, creativity, originality and novelty are key factors contributing to effectiveness".

Of course, there are some limitations. Based on an analysis of Canadian publications in the field of nanotechnology in the period 1985-2005, Beaudry and Allaoui [14] concluded that patenting has a positive and significant effect on the number of published articles. The first patents intensify scientific production and strengthen the reputation of the researchers. However, the reversal occurs at about 30 patents in three years – for those researchers who have more than 20 to 40 patents in 3 years, a decline occurs in the number of papers, as researchers are giving priority to applied research and patenting, and that, in a way, becomes their career choice. Thus, it could be concluded that moderate cooperation with the economy leads to increase in productivity measured in terms of published papers, while orientation towards patenting (more than 30 patents in 3 years) reduces productivity.

Collaboration and networking also have a strong effect on scientific productivity [17]. The probability that a scientist will get involved in new cooperation increases with the number of his previous collaborations. Also, the likelihood that a pair of scientists will start collaborating depends on the number of common collaborators they have [14]. Future cooperation will be easier for scientists who come from the networks with similar views that overlap intellectually, although this would partly limit the breadth of knowledge within the network [18]. DeFazio et al. [17] analysed the impact of funding on the relationships within the collaborative networks and scientific productivity, on a sample of 296 researchers who participated in research networks within the EU funded projects from the Fourth Framework Programme. Based on the analysis, it was concluded that financing has a stronger effect on productivity than cooperation within the network and that the effect of collaboration within the network is positively related to productivity in the period after the stop of funding. The authors summarize that "although the structure of collaboration changes in relation to the funding, it requires time to develop structures of collaboration that are effective in enhancing researcher productivity" [17]. We could conclude that funding is important because it allows the creation of new collaborations, but cannot, by itself, create effective cooperation.

Legislation that defines the criteria for professional promotion has a direct impact on the productivity of scientists [4], but it can be both positive and negative. For example, publishing in international journals with higher impact factor is currently strongly encouraged in Croatia [2]. However, although quality is stimulated, researcher structure shows that the overall criteria are too weak. A study conducted at the University of Zagreb (largest scientific institution in Croatia) showed that the majority of scientists advance from title to title within five years of previous advancement, with the result that most scientists spend more than 10 years in tenure, i.e. more than 15 years of service as a full professor. This is confirmed on a national level by the analysis in the draft amendments to the Law on Higher Education and Scientific Research [19]. The study showed that currently the largest proportion of scientists in Croatia is in the position of scientific adviser and at the same time the above-average number of scientific advisers had not resulted with outstanding productivity.

OBSTACLES TO DEVELOPMENT OF SCIENTIFIC PRODUCTIVITY IN TRANSITION COUNTRIES

Scientists from Eastern European (EE) countries, especially those from the social sciences and humanities, face a number of barriers towards publication [20].

First, social sciences and humanities research in capitalist and communist/socialist societies was different due to ideological reasons up in the early ‘90s when the perestroika caused the breakup of the former Soviet Union, uprisings in EE countries, and termination of the Cold War [21]. However, even in these systems there were prominent individuals such as the Croatian economic theorists Branko Horvat, who was a guest lecturer at a number of scientific institutions around the world, and a candidate for the Nobel prize in economics in 1983. However, such examples were more an exception than a rule. In addition, researchers from EE countries had a hard time catching up with their colleagues from developed countries, due to the diverse institutional milieu of scientific research [22] and to the fact that authoritarian regimes do not represent an enticing environments for scientific production [23].

Second, language issues are important barriers for authors from non-English speaking countries, especially in the social sciences [24]. For example, people whose first language is Russian are sometimes perceived as hyperbolic when they write in English. People whose first language is Spanish seem to be reluctant to be sufficiently critical of other people's work and with their own contribution is not always clear enough [25]. Journals that publish articles in local languages have undeniable necessity and importance but most of the best journals are published in English [6]. To avoid the language barrier, reach a wider audience and achieve recognition of global scientific community mainstream, many smaller national journals began to publish papers in English [26].

Third, future professionals are rarely instructed in scientific writing and manuscript preparation [27]. In Croatia, for example, one of the few positive examples is the course “Principles of Scientific Research in Medicine” that has been taught at the University of Zagreb Medical School [28] since 1995. Others, who do not have access to such a systematic introduction to the basics of scientific work, learn “only through the painstaking process of trials and errors” on four important issues: (1) choice of the relevant topic for publication, (2) choice of the journal for possible publication, (3) organization of the paper according to IMRAD outline, and (4) writing a paper with a high level of proficiency.

Fourth, scientific productivity is usually measured by the use of Web of Science and Scopus. Bibliographic databases are essential for searching relevant scientific results in the field of interest of scientists. They contain a detailed description of the work, information about the authors, their home institutions and the journal in which the paper is published. Most databases specialise in a particular field of science, whereas research on general scientific productivity is possible by using databases like Web of Science and Scopus which, as well as covering all fields of science, also index the citations, which further distinguish significant results and also makes large-scale citation analyses possible. This, and the aforementioned high standards of selectivity, gives them the status of most relevant scientific databases. New to the world of citation databases is Google Scholar, which indexes all papers whose bibliographic information is available on the Internet, without question of selectivity. Each author and/or journal publisher has the ability to tailor its website in a way that it is recognised by Google Scholar as a source of scientific material. On the other hand, Google Scholar excludes some types of papers that are typically included in Web of Science (e.g. book reviews, editorials etc.). However, although the Google Scholar is basically a citation database, it is not suitable for general research productivity at the level of an institution or a country [29], allowing Web of Science to retain a leading position in the area of measuring scientific productivity with the Scopus is catching-up. At the moment (March 2013), 57 Croatian journals are indexed in Web of Science, which is 17,6 % of all Croatian journals (indexed in the Portal of Scientific Journals of Croatia http://hrcak.srce.hr). Analysis of papers in Croatian language indexed in Web of Science shows a significant rise since year 2007, which coincides with the expansion of Web of Science with regional materials during the period 2007-2009, when about 1600 journals of regional type was added to Web of Science, after having the same rigorous quality evaluation like all other journals indexed in Web of Science [30].

Fifth, systems of tracking scientific publications in transition countries are still developing. In Croatia, published scientific papers are recorded in the Croatian Scientific Bibliography (CROSBI), part of the Croatian Science Portal (www.znanstvenici.hr) under the patronage of the Ministry of Science, Education and Sports (MSES), in which scientists who are registered in the Register of Scientists of MSES should enter bibliographic data about their published papers by themselves using their electronic academic identity. Therefore, CROSBI is the official source of information on the scientific productivity of Croatian scientists. . It is possible to search according to scientist, institution, project and field of science, and access to all the data is free. Most publications in Croatian journals are available in the sister service “Portal of scientific journals of Croatia” (hrcak.srce.hr), where the full text of 89,000 papers from 326 Croatian scientific journals are available. The main drawback of CROSBI is the fact that the data in the database are entered by the authors themselves, so errors such as repeated or incomplete entries are possible. Except for Croatia, among the countries of former Yugoslavia, Slovenia and Bosna and Herzegovina also have a national virtual library. Both countries use a system called COBISS (Cooperative Online Bibliographic System and Services – cobiss.si and cobiss.ba), which links all the libraries at the national level. Scientific papers are recorded in “Current Research Information System” (CRIS), which is a service within Cobiss. In Bosnia and Herzegovina CRIS is still in an experimental phase, while in Slovenia there are precise information on scientific institutions, projects and researchers, but without a broad overview of annual scientific publications and relevant statistics. CROSBI contains bibliographic data on nearly 300 000 publications of Croatian scientists.

CONCLUDING REMARKS

The goals of our paper were to investigate current trends in scientific productivity in transition countries and to discuss obstacles to its development. The main conclusion is that scientific productivity exhibits different patterns in Central European countries compared to Western Balkan countries and Russia. Scientific production is substantially higher in Central European countries, which is probably the result of differnt factors ranging from the level of economic development, criteria for scientific advancement and the war that occurred in the number of Western Balkan countries, slowing down scientific productivity.

However, if we take a closer look at publication trends Croatia, some positive trends are present (Figure 3). Throughout the last 10 years, percentage of Croatian publications included in the Web of Science continues to grow so far, reaching a record of 26 % in 2012. During the same period, the Croatian share in the total contents of the Web of Science rises, although it is still at the very low level, ranging from 0,10 % in 1996 to 0,25 % in 2011. Such increase is probably the result of a Croatian promotion system where scientists from the fields other than social and human sciences are obliged to publish in journals with an impact factor [4].

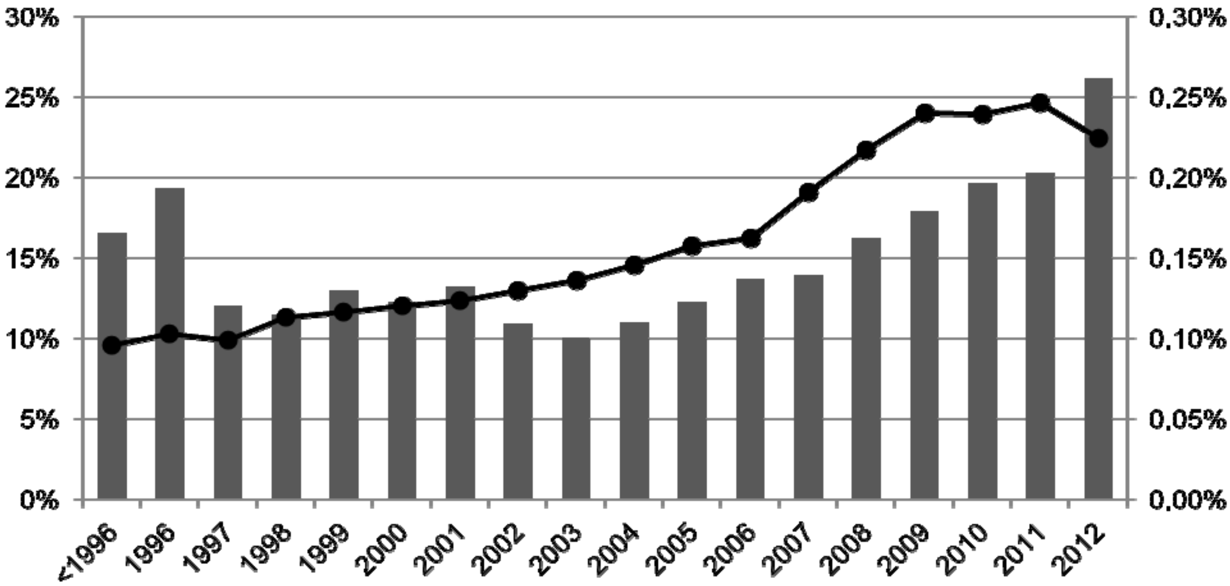

Figure 3. Percentage of Croatian publications included in Web of Science (histogram) and Croatian share of total papers in Web of Science (solid line), based on data from Web of Science.

Our research has also some limitations. We have focused only on selected transition countries, papers published in journals covered by the Web of Science and secondary data available in public databases. Deeper understanding would have been attained by the analysis of the large number of transition countries, based also on the national journals, and with the support of primary research, that would collect the perceptions of individual researchers.

Future research should also be devoted to incentives of scientific productivity in transition countries, that should embrace not only increase in governmental investments in scientific research, but also to more sophisticated instruments that are present in leading institutions and countries. Such instruments range from the direct financial support to individuals that publish heavily in leading journals to breading of research-supported environment within universities. McGrail et al. [31] found out also following interventions to be effective: writing courses, writing support groups and writing coaches.

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PREPREKE RAZVOJU ZNANSTVENE PRODUKTIVNOSTI TRANZICIJSKIH ZEMALJA

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SAŽETAK

Znanstvena produktivnost je jedan od glavnih pokretača razvoja u 21. stoljeću. Najčešći način mjerenja znanstvene produktivnosti je kroz publiciranje u obliku recenziranih članaka. Tekuća istraživanja ukazuju kako postoji jaka povezanost između razvijenosti zemlje i njezinog udjela u svjetskom publiciranju znanstvenih članaka. Tranzicijske zemlje još uvijek hvataju korak sa najrazvijenijim zemljama u području znanstvene produktivnosti, što je posebno razvidno za zemlje Zapadnog Balkana. Ovaj rad je jedan od rijetkih pokušaja analize prepreka znanstvenoj produktivnosti u tranzicijskim zemljama, te istražuje različite čimbenike i njihov utjecaj na znanstvenu produktivnosti. Prepreke proizlaze iz povijesnih razloga, ciljeva koji se postavljaju pred znanstvenike kao uvjeta za napredovanja, te postojanja i implementacija strategija razvoja znanosti. Također, bez efikasnog mjerenja znanstvene produktivnosti, teško se može analizirati njezino kretanje. Dio prepreka također proizlazi iz nedostataka u evidenciji znanstvenih publikacija. Autori iz tranzicijskih zemalja često objavljuju svoje radove u lokalnim časopisima, koji nisu dovoljno zastupljeni u znanstvenoj bazi *Web of Science*. Prema tome, ažurni sustavi za praćenje znanstvenih publikacija u tranzicijskim zemljama su od najveće važnosti.

KLJUČNE RIJEČI

znanstvena produktivnost,tranzicijske zemlje, prepreke, znanost, *Web of Science*

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WHAT DO CROATIAN SCIENTIST WRITE ABOUT? A SOCIAL AND CONCEPTUAL NETWORK ANALYSIS OF THE CROATIAN SCIENTIFIC BIBLIOGRAPHY

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ABSTRACT

This article analyses the Croatian Scientific Bibliography (CROSBI) as a social application using a number of different approaches. By analysing and visualizing the conceptual network the core of keywords is determined for each scientific field: biomedical sciences, biotechnology, social sciences, humanities, natural sciences and technical sciences. Through the interpretation of core concepts by meta-data from another social application (Wikipedia) it is concluded about the disproportion of interpretative capabilities of two social systems: the Croatian scientific community and the public. Additionally through a social network analysis between scientific areas according to a social (scientific collaboration) and conceptual (keyword co-affiliation) another disproportion is revealed regarding interdisciplinary research.

KEY WORDS

Croatian scientific bibliography, social network analysis, conceptual network analysis, visualization, Wikipedia, system theory

CLASSIFICATION

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INTRODUCTION

The Croatian Scientific Bibliography[1] – CROSBI (in Croatian: *Hrvatska znanstvena bibliografija*) allowed anyone with Internet connectivity a detailed insight into the production of Croatian scientists. An interesting feature of the CROSBI project, which we want to point out here is that the bibliography is being populated by the authors them self, which makes it a social application in its own right. Hence, it represents a reflection of a social system that can be analysed by analysing the reflection [1, 2]. Particularly, if we define a social system as an autopoietic system [3] in a broader environment (whereby the social application is part of the environment) the process by which the system leaves trails in the environment by transforming it can be viewed as the process of structural coupling [4].

According to this view, the social system exchanges components of its structure with the environment (in our case written communication which is in accordance with the semantics and syntax of the social system). On the other hand, since social systems are meaning processing systems, one might ask the question if it is possible to interpret the left trails by other social systems?

To further justify the approach, consider analyses of two (human) autopoietic systems, Humberto Maturana and Niklas Luhmann. They both structurally coupled with publishing technology (alopoietic systems) and left trails in form of their published writings. That allowed us (and other researchers) to perform an analysis of their thoughts like in [4] by actually interpreting their trails. The analysis allowed us to interpret concepts like structure and organization by using the definitions of one and the other. As it is in detail elaborated in [1], we can use autopoietic theory as a framework to understand complex systems, regardless of their origin (biological, social, information system), an this article is just an invocation of this principle.

In the following research we will try to analyse a social system (the Croatian scientific community) through an attempt of interpreting its trails through another social system (the public). As a reflection of the public as a social system we will use the Wikipedia system, the free on-line encyclopedia, which besides its (most profound) English version has versions for most world languages, including Croatian.

The core of this research is thus a comparative analysis of two social systems through their reflections: the Croatian scientific community (with CROSBI as the reflection) and the public (with Wikipedia as the reflection). The Croatian scientific community will be analysed particularly within for its social and conceptual connections as well. In accordance with that we establish the following two hypotheses: (H1) there is a disproportion between the topics the Croatian scientific community deals with and the understanding of these topics by the public, and (H2) there is a disproportion among the conceptual interconnection between scientific fields and the level of collaboration between them.

We will consider the first hypothesis as confirmed if at least 50 % of core concepts from the Croatian scientific community social system are not interpretable in the reflection of the public social system. The second hypothesis shall be considered confirmed if there is a disproportion between social and conceptual interconnection of at least 50 %. Both of these values are not arbitrary since they indicate misunderstanding in the former, and irrational behaviour in the letter case.

To analyse the semantics (meaning and conceptual interconnection) of a system, a number of numerical and logical methods exist coming from different fields like data-mining and knowledge discovery [5], the semantic Web [6], social Web mining [7, 8], etc. Herein we will focus on the ACI (actor-concept-instance) method which was initially used by Mika to analyse social applications [9]. In accordance with the needs of the research at hand we will extend the method from tripartite to n-partite graphs, as shall be described in the following.

In the end of this introduction, we need to point out that analysing Croatian scientific bibliography is not a new thing and there are recent studies which provide different advances in the bibliometric and/or scientometric analysis of individual journals [10, 11], scientific subjects [12], scientific fields [13], or even further [14]. Without diminishing the importance of these studies, in this article I will for the first time provide a conceptual and social network analysis of the Croatian scientific bibliography, as well as a visualization of the acquired networks in order to gain insight into the main subjects (concepts) Croatian scientists wrote about in the past decade (2000-2010), as well as understand their mutual interconnections.

METHODOLOGY

Network theory, or, as Barabasi calls it [15], the new science of networks, studies social, biological, transport, technological, physical, semantic and other types of networks. The field of social network analysis has a long tradition, but only after the emergence of the Internet and contemporary information and communication technology it gained a huge impetus.

A network can be defined as a mathematical abstraction which consists of two parts: (1) nodes (which can represent people, organization, countries, but also computers, species, molecules or concepts), and (2) links (which may represent any recognizable connection between nodes like friendship among people, collaboration among organizations, geographic neighbourhood between countries, a wireless computer network, food chains in an ecosystem, connections between molecules or the essencial semantic connection between concepts in a language). If the links are directed (e.g. communication with messages, the spreading of a virus, influence of power etc.) then the network is directed. If the connection is measurable, then the network is weighted.

Formally, networks are represented in form of mathematical graph structures which are ordered pairs $G = (N, E)$, whereby $N = \{ n_1, n_2, ..., n_m \}$ is the set of nodes, and $E = \{ (n_i, n_j) \mid n_i, n_j \in N \}$ a set of edges or links. If the pairs in E are ordered, we call G a directed graph or digraph.

Networks are often due to simplicity of computation, represented in the form of the adjecency matrix $A = [a_{ij} \mid a_{ij} \in \{0,1\}]$ which is of size m × m where m is the number of nodes in the network. The elements equal to 1 if there exists a connection between the corresponding two nodes, 0 otherwise. If the network is undirected, the matrix is symetric. If the network is weighted, instead of 1, one can write the actual weight of a given connection.

For the current research the concepts of bipartite, tripartite and later on n-partite graph are of special importance. A bipartite graph is a special graph $G = (N_1 \cup N_2, E)$ in which there exists a partition of the node set such that if an edge has one end in N_1 then the other end of the edge is in N_2, which means that there are no connections between nodes inside any of the sets in the partition, only between them. In a tripartite graph there are three such sets, while in a n-partite graph there are n-such sets.

An example of a bipartite graph is a network of authors (A) and publications (P), in which nodes are autors and publications (there is a partition of the node set into two distinct sets), while the connections are the essential authorship relation. As one can see, there will never be a connection between authors (e.g. authors do not write other autors), nor among publications (e.g. publications are not written by other publications). An example of a tripartite graph can be the network of authors (A), publications (P) and keywords used on publications (K). In the following we shall analyze the 4-partite graph of authors (A), publications (P),keywords (K) and scientific fields (F).

Another characteristic of n-partite graphs that needs to be pointed out here is the possibility to represent it by n (n –1)-partite graphs (e.g. a 4-partite graph can be represented by 4 tripartite graphs, a tripartite by 3 bipartite graphs etc.). Lower level graphs are constructed by ommitting all nodes from a given partition together with all edges the nodes participate in. The bipartite graph representation is more practical then the 4-partite and tripartite since bipartite graphs can be represented in simple matrix form. For example the graph AP can be represented in a matrix in which columns are authors (elements from A) and rows are publications (elements from P) while we put a 1 in each element of the matrix if the corresponding author wrote the corresponding publication, or 0 otherwise.

Graph folding [16] is a mapping that maps from one graph to another by always je mapping nodes into nodes and edges into edges. For our investigation it is sufficient to state that by a special kind of graph folding we can acquire unipartite from bipartite graphs by matrix multiplication with the transposed matrix. Let |AK| be the matrix of authors and keywords used by them on some publications, then by folding the graph with the operation $|AK||AK|^T$ we acquire a matrix that represents the social network of authors which used the same keyword, e.g. two authors will be connected if they used the same keyword on some of their publications. The dual matrix |AK|T|AK| is the conceptual network of keywords in which to keywords are connected if they were used by the same author.

We will use this procedure quite intensively for the construction of a number of conceptual and social networks. Mika [9] used a very similar procedure with tripartite graphs to define a folksonomy (the ACI model) of the social tagging application Delicious[2]. Hereafter we will construct the following graphs:

- $|AK|^T|AK|$ – the conceptual network of keywords for each scientific field (biomedical, biotechnical, social, natural, technical sciences and the humanities),
- $|AF|^T|AF|$ – social network of scientific fields according to the collaboration of scientists (e.g. two fields are connected if a scientist published in both fields),
- $|KF|^T|KF|$ – social network of scientific fields according to conceptual connections (e.g. two fields are connected if the same keyword has been published in both of them).

Since some of the analysed conceptual networks are complex, an adequate visualization algorithm is needed. Herein we decided to use the k-core decomposition algorithm described in [17]. The description of this algorithm goes beyond the objectives of this article and has thus been omitted. For our purposes it is enough to state that the algorithm finds cores that represent mutually well connected nodes.

DATA HARVESTING AND IMPLEMENTATION

Since all data about CROSBI was available on the Web it was neccessary to implement an adequate spider program that would harvest the data. To achieve that the programming language Python[3] and specifically the module Scrapy[4] was used which tremendeously simplified the implementation. To extract the semistructured data xPath and regular expressions were used. For each publication the following data was gathered:

- author's name and surname,
- year of publication,
- scientific fields of publication,
- keywords,
- CROSBI key (for unique identification and later analysis),
- type of publication.

The harvesting was conducted in November 2010 and data about a total of 285 234 scientific publications were collected. Since CROSBI is a social application where authors by themselves entered the data, there was need for clensing (wrong syntax, duplicates, special characters, wrong encoding etc.). The cleaned data was stored in a PostgreSQL database[5] for later analysis.

By using a number of queries conceptual networks for each scientific field was constructed for the period 2000-2010. Due to a large number of keywords, combinatoric explosion and limited hardware capabilities only those keywords which were used more than 200 times were used for further computation (there was a total of 368 378 keywords, while 651 were used more than 200 times). The constructed networks were visualized using the LaNet-vi[6] tool.

To categorize the keywords identified in the cores of each conceptual network for each scientific field, the Wikipedia[7] application programming interface was used, especially its coratian[8], english[9] and german[10] version. Wikipedia allows its users in addition to hypertextual data to enter metadata about each term like categories which apply to a given term. These meta-data are shown at the top of each page (standard categories like "Article which need additional citations" or "Articles which should be merged") as well as on the bottom of it (user-defined categories). For the purpose of categorizing keywords across publications only user-defined categories were used since these, as opposed to standard categories, reflect certain semantics provided by the social system of users. In accordance with this again Python was used to collect the adequate categories for identified keywords, and XSB Prolog[11] was later used to implement a logic program that connected similar concepts into clusters. The logic program consisted of a number of simple rules. One of the most important rules was that two concepts will fall into the same cluster if they have at least one common category according to the categorization of Wikipedia users.

By using additional queries the social networks of scientific fields based on scientific collaboration and conceptual connection were constructed and stored in a ZODB object-base[12] for later processing and analysis. The Python module[13] NetworkX was used to visualize the networks.

ANALYSIS

The analysis in divided into two parts: firstly we analyse the conceptual networks of particular scientific fields ($|AK|^T|AK|$ graphs), and secondly the social networks based on scientific collaboration (graph $|AF|^T|AF|$) and conceptual connection (graph $|KF|^T|KF|$).

CONCEPTUAL NETWORK ANALYSIS

Figure **1** shows the conceptual graph of biomedical sciences[14]. The size of the nodes denotes the number of connections the node participates in, while the color of the node simbolizes the number of connections of the node in the given graph. The nodes shown in the middle of the graph represent the best connected nodes, mutually as well as to other nodes in the network. One could state that these are the core concepts of croatian publications in biomedical research of the observed period.

Of special importance is the topology of the conceptual network. Since we can observe one main, one secondary (in the upper left of the middle) and one marginal (in the lower left) core, we can conclude that biomedical research is quite well focuse on a small number of well-connected research areas.

The conceptual core of biomedical research contians 76 concepts, 44 (57,89 %) in the English language and 32 (42,11 %) in Croatian. By using the previously mentioned logic program based on the analysis of Wikipedia categories, conceptual clusters were obtained and are summarized in Table **1**. Uncategorized concepts are concpts for which there is no applicable

Table 1. Conceptual clusters of biomedical sciences.

Category	Keywords
Aging Gerontology	aging, elderly
Aging-associated diseases	hypertension, stroke
Cardiology	atherosclerosis, hypertension
Diabetes	diabetes, diabetes mellitus
Epidemiology	epidemiology, prevalence, risk factors
Gender	gender, women
Greek loanwords	diagnosis, epilepsy, genetics, pain
Medical conditions related to obesity	diabetes, diabetes mellitus, hypertension
Medical statistics	prevalence, risk factors
Medical terms	diagnosis, epilepsy, prognosis
Nutrition	cholesterol, diabetes, diabetes mellitus, obesity
Sociology	elderly, gender
Antropologija	*dijete, djeca*
Bolesti živčanoga sustava	*epilepsija, moždani udar*
Medicina	*dijagnostika, dijagnoza, terapija, zdravlje*
Medicinska dijagnostika	*dijagnostika, dijagnoza*
U izradi, Bolesti i poremećaji	*epilepsija, moždani udar*
U izradi, Medicina	*terapija, zdravlje*
Čovjek	*dijete, djeca, žene*
Uncategorized concepts	*ateroskleroza, edukacija, etiologija, liječenje, prevencija, rehabilitacija, starenje, starije osobe*
Unaligned concepts	Croatia, Europe, *Hrvatska*, PTSD, PTSP, Zagreb, apoptosis, breast cancer, children, *depresija*, Doppler, depression, education, *epidemiologija*, *etika*, gender differences, *genetika*, *hipertenzija*, incidence, knowledge, *kvaliteta života*, management, mortality, multiple sclerosis, oxidative stress, pregnancy, prevention, *pušenje*, quality of life, rat, screening, stres, stress, therapy, treatment, *trudnoća*, ultrasound, *ultrazvuk*, war, *šećerna bolest*

category on Wikipedia, while unaligned concepts are thode for which there is at least one category, but there are no other concepts that have any mutual category and thus those concepts cannot be alignet into any cluster. These two groups of concepts are of special importance for our investigation since they indicate misalignement between the two observed social systems. We should also state here that categories denoted in Croatian as *U izradi* (eng. Under construction), are categories which are not yet fully finished on Wikipedia, which means that not all relevant concepts have been categorized into them.

From Table 1 one can read that the croatian biomedical sciences in the observed period mostly dealt with aging, different types of diseases and epidemics, the relationship between people and health condition, nutrition, and generally medicine and connected terms.

According to the interpretation, we can observe that the public as a social system perceives a connection between this field and sociology, anthropology and the usage of Greek terms.

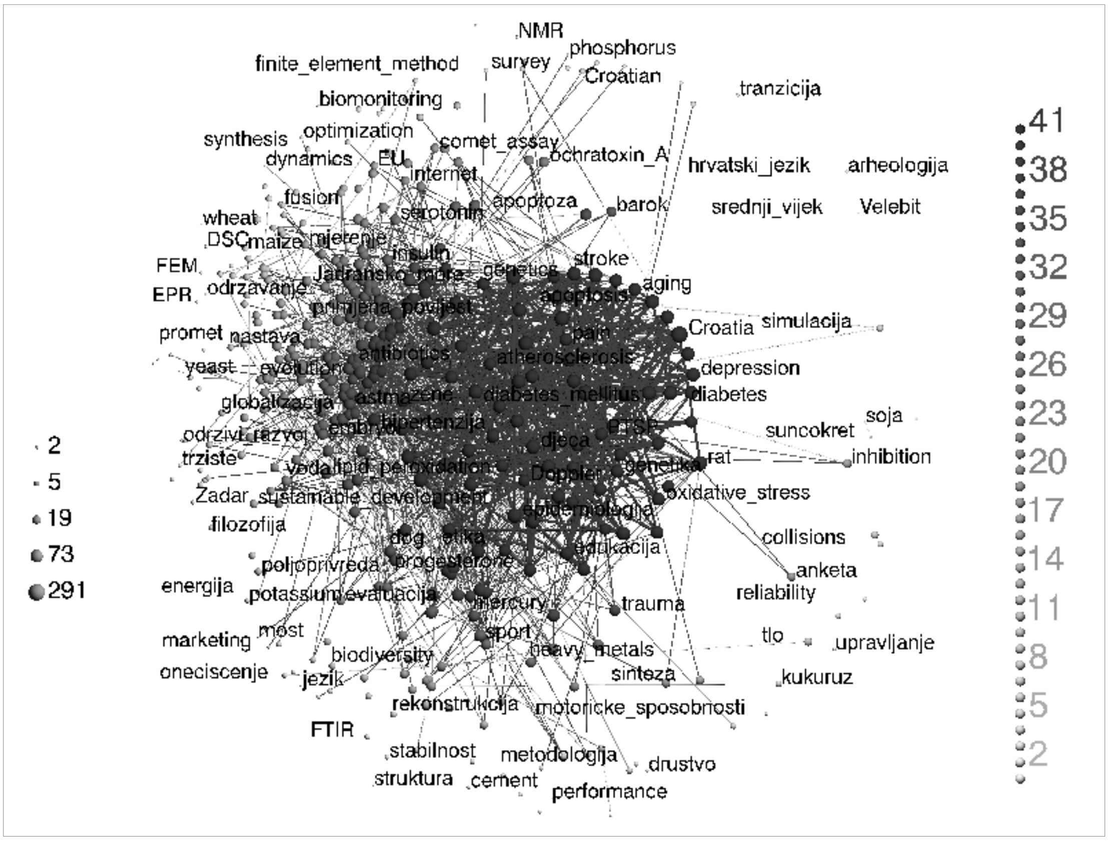

Figure 1. Conceptual network of croatian biomedical sciences 2000-2010.

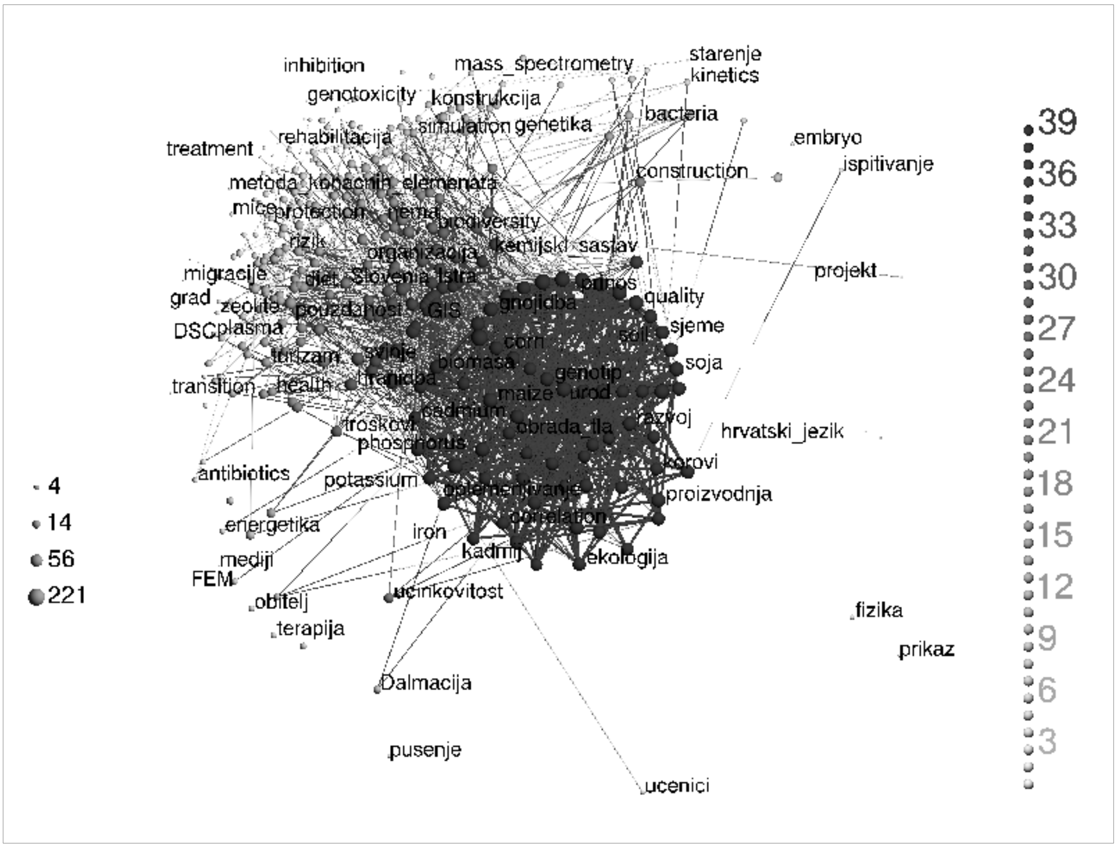

Figure 2. Conceptual network of croatian biotechnical sciences 2000-2010.

Table 2. Conceptual clusters of biotechnical sciences.

Categories	Keywords
Agriculture in Mesoamerica, Crops originating from Mexico, Crops originating from the Americas, Demulcents, Flora of Guatemala, Flora of Mexico, Fruit vegetables, Grasses of Mexico, Maize, Mexican ingredients, Model organisms, Native American cuisine, Plants described in 1753, Tropical agriculture, Zea	corn, maize
Biology and pharmacology of chemical elements	cadmium, iron, nitrogen, phosphorus, potassium, zinc
Chemical elements	cadmium, calcium, iron, nitrogen, phosphorus, potassium, zinc
Dietary minerals	calcium, iron, phosphorus, potassium, zinc
Energy crops	corn, maize, soybean, wheat
Nonmetals, Pnictogens	nitrogen, phosphorus
Pyrotechnic fuels	iron, phosphorus, zinc
Reducing agents	calcium, potassium, zinc
Sequenced genomes	corn, maize, soybean
Staple foods	corn, maize, wheat
Transition metals	cadmium, iron, zinc
Wheat	wheat, winter wheat
Fizikalne veličine	*energija*, *temperatura*
Industrijske biljke	*soja*, *šećerna repa*
Kemijski elementi *U izradi, Kemijski elementi*	*dušik*, *kadmij*
Poljoprivreda	*navodnjavanje*, *poljoprivreda*
Trave, *Žitarice*	*kukuruz*, *pšenica*
U izradi, *Botanika*	*kukuruz*, *pšenica*, *šećerna repa*
Uncategorized concepts	*bolesti*, *genotip*, *gnojidba*, grain yield, *hibridi*, *kakvoća*, *kultivar*, *obrada tla*, *oplemenjivanje*, *ozima pšenica*, *prinos*, *prinos zrna*, *razvoj*, *sorta*, *sorte*, *stabilnost*, *teški metali*, *urod*, *urod zrna*
Unaligned concepts	Croatia, *Hrvatska*, *biomasa*, correlation, *ekologija*, fertilization, *korovi*, *kvaliteta*, precipitation, pH, *proizvodnja*, protein, quality, resistance, *sjeme*, soil, stability, *suncokret*, temperature, *tlo*, *vinova loza*, yield

Figure 2 shows the visualization of the conceptual network of the biotechnical sciences in the observed period. As we can see from the analysis of the topology of the network, there is one main (middle of figure), and one secondary (upper left of the middle) core. This indicates even greater focus of researc if compared to the biomedical sciences. The conceptual core consists of 63 keywords, 25 (39,68 %) in English and 38 (60,32 %) in Croatian.

The public as a social system can best interpret concepts from the biotechnical sciences regarding various agricultures (corn, maize, soybean, wheat, and cro. *šećerna repa* – sugar beet), as well as various chemical elements. Another important interpreted subject is agriculture (cro. *poljoprivreda*). There are indications that a connection to physics and chemistry is anticipated.

Figure 3 shows the conceptual network of the social sciences. Besides the main core, we can observe at least two secondary and a number of marginal cores. These scattered concepts indicate less focus in research as well as a broadness of the investigated subjects in the social sciences. The main core contains 73 concepts, 21 (28,77 %) in English and 52 (71,23 %) in Croatian.

By using the logic program the clustering as in Table 3 is obtained. As can be seen from Table 3, from the perspective of the public, the social sciences mostly investigated the relationship between Croatia and the European Union, a number of concepts bound to economy, culture, nurture and education, politics, as well as tertiary activities. It is interesting to observe that this field of research is also connected with the very concept of science itself as well as with the human which is at its centre. The public also anticipates the connection of the social sciences with ecology and applied sciences.

Figure 4 shows the conceptual network of the croatian humanities. Except for a maim core, we can observe an outstanding secondary as well as a number of marginal which are all well connected. Thus the humanities seem to be quite focused with a number of well connected boundary areas. The core of the humanities includes 52 keywords, with only two in English (3,85 %), 49 (94,23 %) in Croatian and one (1,92 %) in German. This focus on croatian publishing does not come as a surprise, since some of the main concerns of these sciences exclusively deal with Croatia and its heritage.

The clusters obtained through the logic program are shown in Table 4.

The humanities, as from the perspective of the public, mostly dealt with Slavonia and Dalmatia (two great regions of Croatia), philsophy (cro. *filozofija*), culture (cro. *kultura*), history (cro. *povijest*), heritage (cro. *baština*), literature (cro. *književnost*) and arts (cro. *umjetnost*). The public seems to anticipate a connection between the humanities and the social sciences as well as geography. Especially interesting is the wrong interpretation (at least what croatian scientific classification concerns) that archaeology is part of the social sciences. Also, as with the social sciences, the humanities are being connected to the very concept of science.

Figure 5 shows the conceptual network of the natural sciences of Croatia. As opposed to other conceptual networks, besides the main core, we see quite a number of secondary and marginal cores, which are visually hardly to differentiate. This situation is expected since the natural sciences consist of a number of essentially quite different sciences. The main core consists of a total of 52 keywords, 30 (57,69 %) in English and 22 (42,31 %) in Croatian.

Table 5 provides the results of applying the logic program to the natural sciences core concepts.

When it comes to the natural sciences, the public seems to mostly anticipate concepts from biology and geography as well as their connected areas. There is an indication that the natural sciences might be connected to (geo)politics (e.g. categories European countries, Member states of the Union for the Mediterranean, Liberal democracies, Members of the North Atlantic Treaty Organization) and ecology.

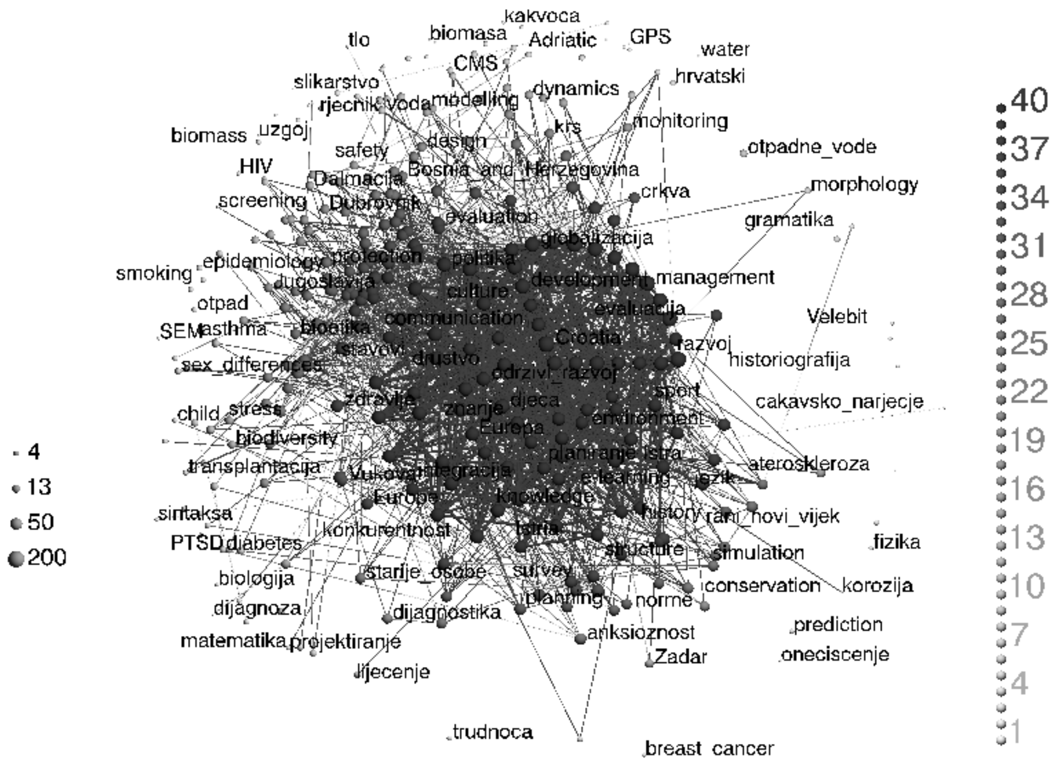

Figure 3. Conceptual network of croatian social sciences 2000-2010.

Table 3. Conceptual clusters of social sciences.

Categories	**Keywords**
1993 establishments, European Union, Federalism, International organizations of Europe, Political system	EU, European Union
Države u Europi, *Hrvatska*	*Hrvatska*, *Republika Hrvatska*
Ekologija	*ekologija*, *zaštita okoliša*
Ekonomski pojmovi	*globalizacija*, *gospodarstvo*, *tranzicija*, *tržište*
Kultura	*kultura*, *mediji*, *turizam*
Menadžment	*kvaliteta*, *menadžment*, *poduzetništvo*
Odgoj i obrazovanje	*obrazovanje*, *odgoj*, *škola*
Politika	*demokracija*, *globalizacija*, *politika*, *tranzicija*
Primijenjene znanosti	*komunikacija*, *mediji*, *promet*, *tehnologija*
Tercijarne djelatnosti	*promet*, *turizam*
Znanost	*istraživanje*, *metodologija*, *znanost*
Čovjek	*djeca*, *žene*
Uncategorized concepts	*konkurentnost*, *mladi*, *model*, *modernizacija*, *održivi razvoj*, *razvoj*, *studenti*, *upravljanje*, *učinkovitost*, *zaštita*
Unaligned concepts	Croatia, *Europa*, *Europska unija*, Internet, Istria, communication, competitiveness, culture, development, *društvo*, education, *etika*, globalization, *identitet*, integration, knowledge, management, *marketing*, *obitelj*, *okoliš*, *organizacija*, *planiranje*, *povijest*, quality, *religija*, research, *sigurnost*, *strategija*, sustainable development, *šport*, technology, tourism, transition, *znanje*

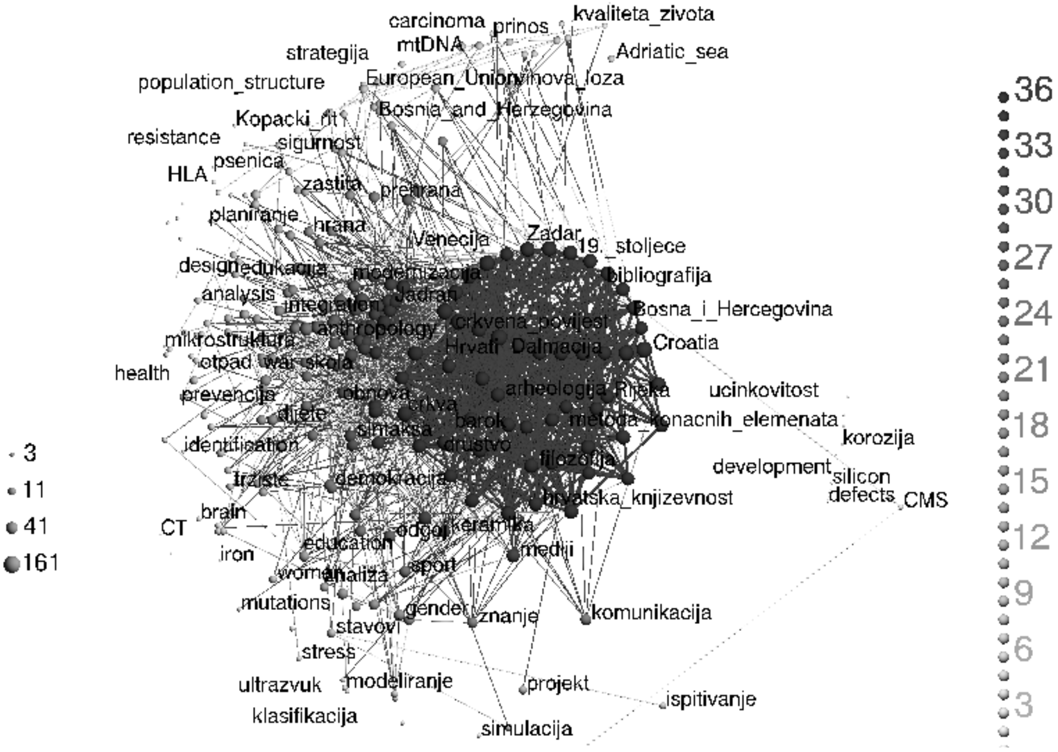

Figure 4. Conceptual network of croatian humanities 2000-2010.

Table 4. Conceptual clusters of humanities.

Categories	**Keywords**
Baranjski leksikon, Osijek	Osijek, *Slavonija*
Društvene znanosti	*arheologija*, *politika*
Filozofska terminologija	*politika*, *umjetnost*
Kultura	*književnost*, *kultura*
Povijesna znanost	*historiografija*, *povijest*, *rat*
Povijest književnosti, *Renesansa i novi vijek*, *Umjetnička razdoblja*	*barok*, *renesansa*
Svjetska baština u Hrvatskoj	Dubrovnik, Split
Zemljopis Hrvatske	*Dalmacija*, *Slavonija*
Znanost	*istraživanje*, *metodologija*, *znanost*
Uncategorized concepts	*crkvena povijest*, *migracije*, *prikaz*, *rani novi vijek*, *rani srednji vijek*
Unaligned concepts	19. *stoljeće*, *Bosna i Hercegovina*, Croatia, Dalmatia, *Europa*, *Hrvati*, *Hrvatska*, *Istra*, *Jugoslavija*, Kroatien, *Rijeka*, *Venecija*, Zadar, Zagreb, *arhitektura*, *bibliografija*, *biografija*, *crkva*, *društvo*, *filozofija*, *gospodarstvo*, *grad*, *hrvatska književnost*, *hrvatski jezik*, *identitet*, *jezik*, *religija*, *slikarstvo*, *srednji vijek*

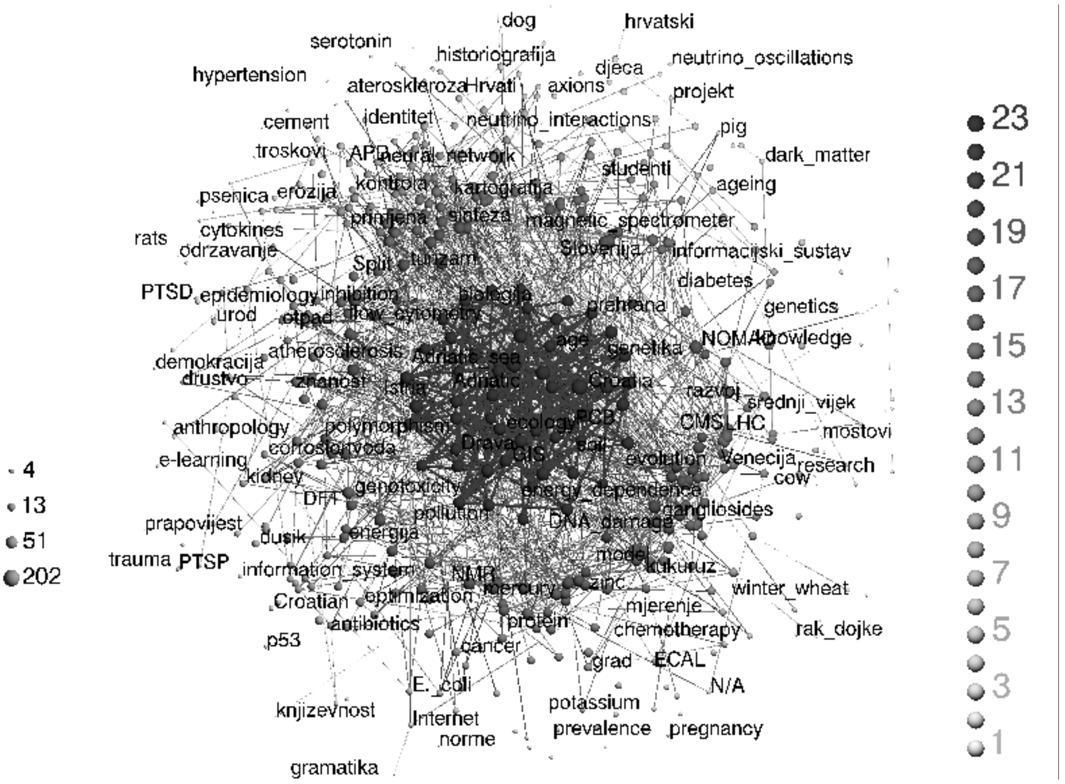

Figure 5. Conceptual network of croatian natural sciences 2000-2010.

Table 5. Conceptual clusters of natural sciences.

Categories	**Keywords**
Adriatic Sea	Adriatic, Adriatic sea
Aquatic ecology	fish, phytoplankton
Countries of the Mediterranean Sea, European countries, Member states of the Union for the Mediterranean, Slavic countries	Bosnia and Herzegovina, Croatia, Slovenia
European seas	Adriatic, Adriatic sea, Mediterranean
Liberal democracies, Members of the North Atlantic Treaty Organization, States and territories established in 1991, Serbo-Croatian-speaking countries	Croatia, Slovenia Bosnia and Herzegovina, Croatia
Jadransko more, *Mora*	*Jadran*, *Jadransko more*
Planine Hrvatske	Medvednica, Velebit
Zemljopis Hrvatske	Dalmacija, *krš*
Uncategorized concepts	*rast*, *zaštita*, *zooplankton*
Unaligned concepts	*Bosna i Hercegovina*, Dalmatia, Dinarides, Drava, Dubrovnik, Europe, GIS, *Hrvatska*, *Istra*, Istria, PCB, Zagreb, age, biodiversity, *biologija*, conservation, distribution, ecology, *ekologija*, environment, fauna, *fitoplankton*, flora, geochemistry, growth, karst, monitoring, *morfologija*, morphology, mortality, pollution, *sediment*, soil, temperature, *tlo*

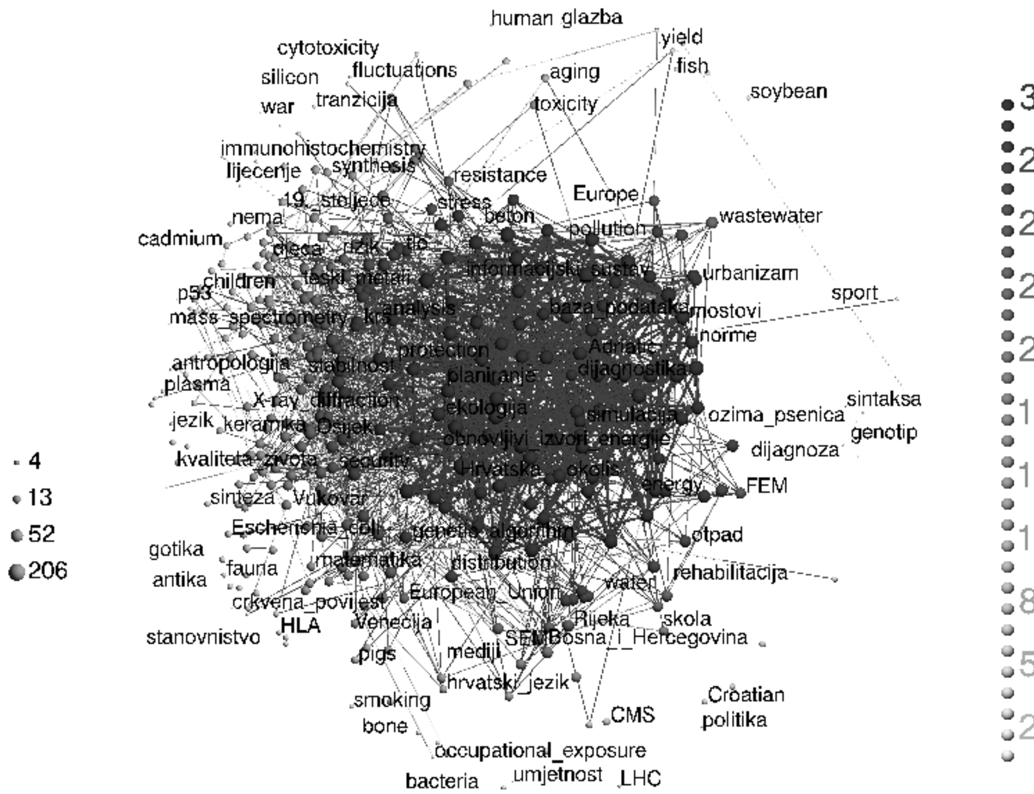

Figure 6. Conceptual network of croatian technical sciences 2000-2010.

In the end of the conceptual analysis in Figure 6 the conceptual network of the technical sciences are shown. In this case we have a main, one distinct secondary and four marginal cores. From these results one may conclude that the technical sciences were less focused and investigated a broad spectrum of various fields. The main core consists of 86 concepts, 36 (41,86 %) in English and 50 (58,14 %) in Croatian.

The logic program resulted with the clusters of concepts as in Table 6.

Based on Table 6 one can deduce that the technical sciences are the least understood by the public as a social system. The best understood concepts deal with construction engineering and computer science (in which we can include the category American inventions). The public connects the technical sciences more than all other fields with various concepts regarding science and technology (research methods, thought, as well as cro. *tehnologija i znanost* – technology and science). The public also connects these core concepts with various fields like control (cro. *upravljanje*), operations research (cro. *operacijska istraživanja*), ecology (cro. *ekologija*), physics (cro. *fizika*), chemistry (cro. *kemija*), medicine (cro. *medicina*) and applied sciences (cro. *primjenjene znanosti*). An interesting contextual semantic error is also that the word *modelling* (British English) and *modeling* (American English) are categorized into surnames.

SOCIAL NETWORK ANALYSIS

Figure 7 depicts the social network of the scientific fields according to the criteria of scientific collaboration. The size of the nodes implies the total number of publications in the given field, while the wideness of the link implies the number of authors which published in both connected fields. The annotated connection weights are the percentage of the total number of connections in the graph whereby all recursive connections (connections from the node to itself) are omitted.

Table 6. Conceptual clusters of technical sciences.

Categories	**Keywords**
American inventions	GPS, Internet
Computational neuroscience, Data mining, Econometrics, Network architecture, Networks, Neural networks, Information, knowledge and uncertainty	neural network, neural networks
Management	management, planning
Operations research	mathematical model, simulation
Research methods	analysis, research
Surnames	modeling, modelling
Thought	analysis, planning
Ekologija	*ekologija*, *zaštita okoliša*
Fizikalne veličine	*energija*, *temperatura*
Građevinarstvo, *Mostovi*, *U izradi*, *Promet*	*most*, *mostovi*
Građevinski materijali	*beton*, *cement*
Kemija	*korozija*, *zaštita okoliša*
Medicina	*dijagnostika*, *zaštita okoliša*
Menadžment	*kvaliteta*, *proračun*
Primijenjene znanosti	*promet*, *tehnologija*
Tehnologija	*struktura*, *tehnologija*
Znanost	*istraživanje*, *mjerenje*
Uncategorized concepts	*konstrukcija*, mechanical properties, *mehanička svojstva*, *metoda konačnih elemenata*, *model*, *modeliranje*, *norme*, *obnova*, *održivi razvoj*, *pouzdanost*, *primjena*, *projektiranje*, *razvoj*, *sanacija*, *simulacija*, *trajnost*, *troškovi*, *upravljanje*, *zaštita*
Unaligned concepts	Adriatic, Croatia, GIS, *Hrvatska*, Zagreb, *analiza*, *baza podataka*, concrete, construction, corrosion, design, development, education, environment, finite element method, maintenance, measurement, monitoring, *obrazovanje*, *održavanje*, *okoliš*, *optimizacija*, optimization, *planiranje*, povijest, prediction, *proizvodnja*, *projekt*, protection, quality, reliability, safety, *sigurnost*, structure, sustainable development, temperature, *urbanizam*, *voda*

From Figure 7 one can see that the natural sciences are, as expected, most well connected, while the humanities are the least well connected with the other fields. Additionally the strongest connection is between the natural and the technical sciences, then among the natural and the biotechnical and then the natural and biomedical sciences. The weakest connection is between the humanities and the biotechnical sciences.

Figure 8 shows the social network between scientific fields according to conceptual similarity. The size of the nodes again depicts the total number of publications in the given field, whilst the width of the links shows the number of shared keywords. Even if here the natural sciences are again most well connected, there is only a slight difference to the social sciences (0,05 %). Again, the least well connected are the humanities. This time the strongest

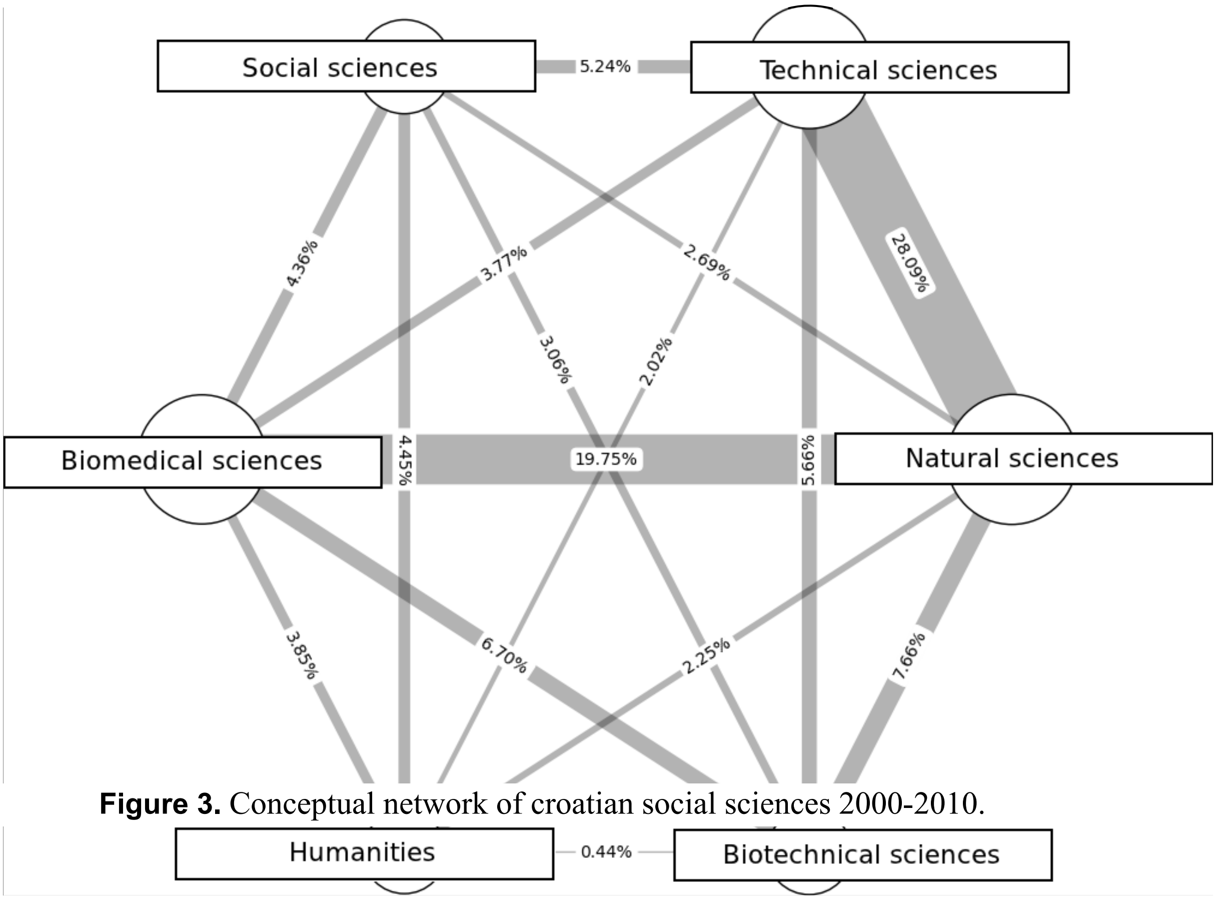

Figure 3. Conceptual network of croatian social sciences 2000-2010.

Figure 7. Connections among scientific fields in Croatia (social criteria) 2000-2010.

linkage is between the natural and the social sciences, then between the natural and the biomedical sciences, and then between the social and the biomedical sciences. The weakest connection is again between the humanities and the biotechnical sciences.

DISCUSSION

The uncategorized and unaligned concepts from the conceptual analyses need special attention. Table **7** summarizes the total number of such concepts. The uncategorized concepts indicate that the public as a social system do not anticipate a category in which the concept might be classified, e.g. the system is not able to interpret the given term. The unaligned concepts on the other hand, indicate that even if the social system is able to interpret these terms, it does not connect them with any other concept from the main core of a given scientific field. This inability of connecting is disturbing, since these are the most well connected concepts of each field.

From Table 7 we can conclude that the number of concepts the social system interprets only partially or not at all is quite high (on average over 60 %) which confirms hypothesis H1, e.g. there is a disproportion between the subjects the croatian scientific community investigates and the understanding of these subjects in the public. In order to address this problem there is need to intensify the transfer of knowledge from the scientific community to the public.

From the social network analyses from both the social and the conceptual perspective we can conclude about the disproportion between the conceptual interconnection of scientific fields and the collaboration between the fields. Table 8 gives a detailed overview of this disproportion and is calculated with the absolute difference between the adjacency matrices of both graphs.

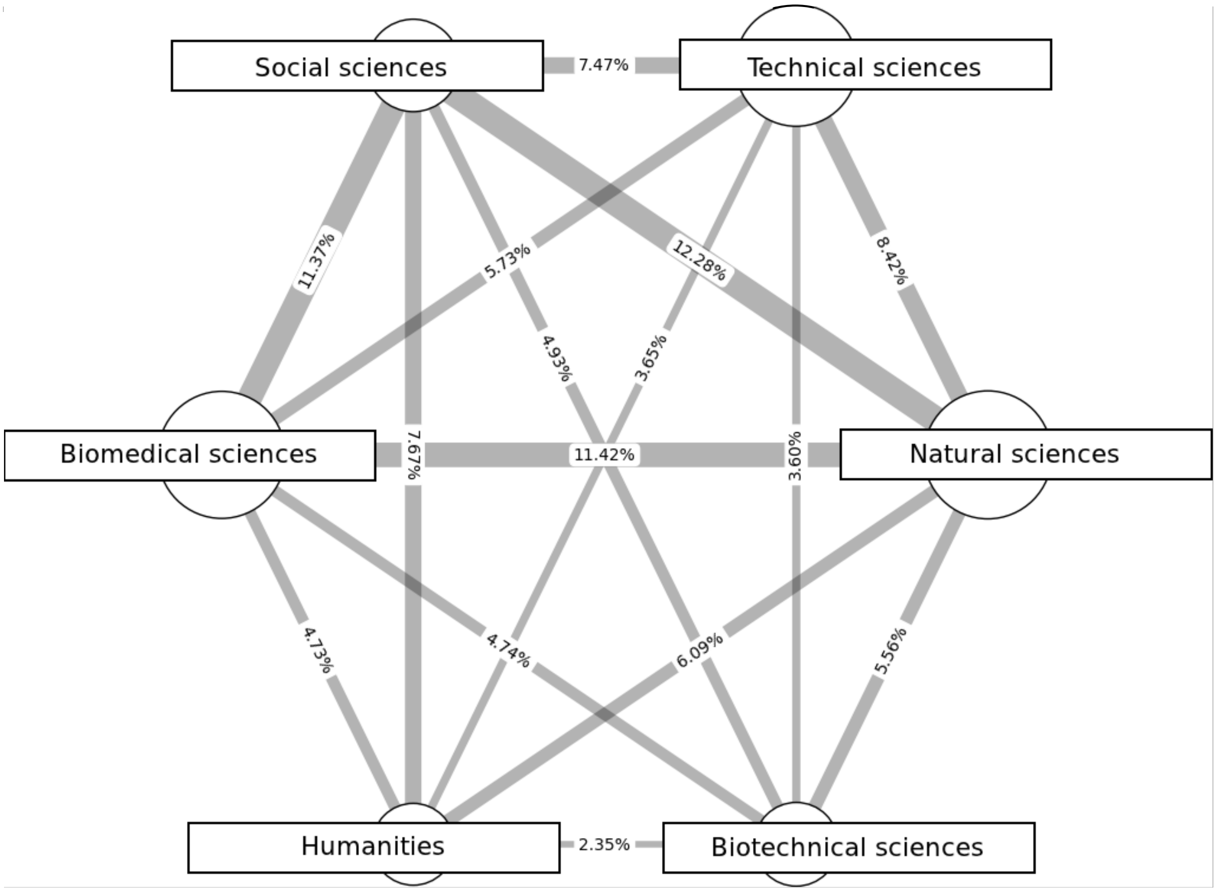

Figure 8. Connections among scientific fields in Croatia (conceptual criteria) 2000-2010.

Table 7. Uncategorized and unaligned concepts.

Concepts	Biomedical sciences	Biotechnical sciences	Social sciences	Humanities	Natural sciences	Technical sciences
Uncategorized concepts	8	19	10	5	3	19
Unaligned concepts	40	22	35	29	35	38
Total	48	41	45	34	38	57
Total, %	63,16	65,08	61,64	65,38	73,08	66,28

Table 8. Disproportion of social networks according to social and conceptual criteria.

Scientific areas	Biomedical sciences	Biotechnical sciences	Social sciences	Humanities	Natural sciences	
Biotechnical sciences	3,98 %					
Social sciences	**10,87** %	4,58 %				
Humanities	4,29 %	2,30 %	7,17 %			
Natural sciences	**9,17** %	4,69 %	**11,97** %	5,83 %		
Technical sciences	5,30 %	2,96 %	6,87 %	3,42 %	5,22 %	
Total						**88,61 %**

The total disproportion between these two networks is rather high, 88,61 % which confirms H2. This disproportion is in particular obvious between social, natural and biomedical sciences. In accordance with these results interdisciplinary research in the identified areas should be stimulated and encouraged.

CONCLUSIONS

This article provided a first conceptual and social network analysis of the croatian scientific bibliography. The obtained results were interpreted through the reflection (Wikipedia) of the public as a social system. By using a number of contemporary methods from network theory the conceptual networks of each scientific field were visualized which allowed us to reason about the focus and broadness of research. The field of the natural sciences should be analyzed in more detail, since it consists of a number, essentially quite different sciences. Such an analysis would provide better insight into the main concepts of the field.

By using a logic program the obtained core concepts of each field were interpreted by using user-defined categories from Wikipedia. This allowed us to gather all concepts that the public as a social system was not able to interpret adequately. The number of such concepts is quite high (on average over 60 %) which indicates a disproportion of the croatian scientific community and the public. It is thus necessary to stimulate and intensify the transfer of knowledge to the public through popular scientific publications and happenings, the social Web as well as more media presence of scientific themes.

Additionally an analysis of the disproportion between the social networks of scientific fields according to social and conceptual criteria was provided. The results show that there is a clear and surprisingly high disproportion between conceptually connected fields of research and actual interdisciplinary research. These results indicate the necessity of stimulation and encouragement of interdisciplinary research, especially between the biomedical, social and natural sciences.

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[3]http://www.python.org,
[4]http://scrapy.org,
[5]http://www.postgresql.org,
[6]http://xavier.informatics.indiana.edu/lanet-vi,
[7]http://www.wikipedia.org,
[8]http://hr.wikipedia.org/w/api.php,
[9]http://en.wikipedia.org/w/api.php,
[10]http://de.wikipedia.org/w/api.php,
[11]http://xsb.sourceforge.net,
[12]http://www.zodb.org,
[13]http://networkx.lanl.gov,
[14]All graphs in this article are given in low resolution and gray-scale. High resolution coloured graphs are available at http://autopoiesis.foi.hr/bib.

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O ČEMU PIŠU HRVATSKI ZNANSTVENICI? ANALIZA DRUŠTVENE I KONCEPTUALNE MREŽE HRVATSKE ZNANSTVENE BIBLIOGRAFIJE

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SAŽETAK

U radu se analizira Hrvatska znanstvena bibliografija (CROSBI) kao društvena aplikacija putem nekoliko različitih pristupa. Analizom i vizualizacijom konceptualne mreže utvrđuju se jezgra ključnih riječi za svako od znanstvenih područja: biomedicinske, biotehničke, društvene, humanističke, prirodne i tehničke znanosti. Interpretacijom koncepata iz tako definiranih jezgri putem metapodataka iz društvene aplikacije *Wikipedia* zaključuje se o nesrazmjeru između dvaju društvenih sustava: hrvatske znanstvene zajednice i javnosti. Analizom društvene mreže znanstvenih područja prema društvenom (znanstvena suradnja) i konceptualnom (povezane ključne riječi) kriterijima zaključuje se o neusklađenosti interdisciplinarnih istraživanja.

KLJUČNE RIJEČI

hrvatska znanstvena bibliografija, analiza društvene mreže, analiza konceptualne mreže, vizualizacija, *Wikipedia*, teorija sustava

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AGENT BASED MODEL OF YOUNG RESEARCHERS IN HIGHER EDUCATION INSTITUTIONS

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ABSTRACT

Group of young researchers in higher education institutions in general perform demandable tasks with relatively high contribution to institutions' and societies' innovation production. In order to analyse in more details interaction among young researchers and diverse institutions in society, we aim toward developing the numerical simulation, agent-based model.

This article presents foundations of the model, preliminary results of its simulation along with perspectives of its further development and improvements.

KEY WORDS

young researchers, innovation, higher education institutions, HEI, universities

CLASSIFICATION

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INTRODUCTION

The meaning of the universities in contemporary culture and in forming of fundaments of our civilisation, can hardly be overestimated. Since their importance continues, it is of interest to analyse processes underlying universities' dynamics. As a result, one may expect deepening the cause-consequence relationship among mutually interconnected processes, maximising the efficiency of the processes, along with the preservance of leading role that universities have in development of science, humanities and arts and shaping of our culture. In that sense, in triple helix approach, universities, government and industry are three elements of a system that is important for science and technology development in society. In other approaches, universities are considered responsible for the substantial part of innovations in science and technology, research and development, and overall they are the means for latency and development of scientific thought and values. Within a broader frame, universities should constantly adapt themselves [5, 6, 7] within the contemporary knowledge-based society [8, 9].

However, two general characteristics of university' dynamics prevent straightforward fulfilment of augmenting its efficiency and our understanding of it. First, being part of a social system the universities are unique, here in the strict sense of non-repeatability of their current state. While one may argue about repeating trends, about similarity of processes occurring in different countries and regions thus in different universities, such cases are completely separated from the notion of purposefully repeatable scientific experiment, one of the cornerstones of developing, testing and demonstrating the understanding of a system. Secondly, processes occurring in universities generally are manifestations of the complex system-character that is generally considered to be of a much slower dynamics than e.g. the dynamics of companies. In that sense even if some change, e.g. a newly formulated measure, is introduced experimentally in some part of a university, clear manifestation of its consequences will develop gradually. Usually the accompanied time scale is too long to utilise such an approach in defining university policy and predicting university dynamics. One may argue that methods such as *in silico* simulations, in particular the simulation modelling, overcome deficiencies presented by stated two characteristics.

Simulation modelling is a powerful means for deepening understanding of a simulated system. In particular, it makes possible both the virtual shortening of the time scale, and the repeatability of a modelled system. However, it introduces different problems, such as is a problem to formulate reliable model. Reliability of the model is demonstrated through its validation, so in short, uniqueness and slowness of the realistic system is exchanged for questionable validation of its model.

Stated characteristic of universities considered in total are manifest when its parts are considered. For example, young researchers in a university form a group that is unique, the dynamics of which develops slowly, yet who are important for the overall contribution to the mass of innovations that universities provide the society with [3, 4]. Here by young researchers we consider novices to universities which work toward obtaining their Ph.D. thesis. Before proceeding, let us emphasise the meaning of the slow dynamics of the group of young researchers, the slowness that may seem as an oxymoron having in mind the large number of professional requirements that young researchers have to fulfil during rather short time-period. The slowness refers to the set of norms, values, rules, laws and customs of the young researchers' professional life, since these are the defining frames of their work and in overall of their contribution to the universities' function in the society. These norms change rather gradually, and are usually unchanged during processing of several generations of young researchers in a given university.

The important contribution of the group of young researchers onto the overall innovation content of universities, as well as the importance of the status of young researchers onto the future carriers of all university lecturers and a lot of experts, point to the importance of developing the validated, thus reliable, simulation model for analysing their dynamics.

Such a model would clarify relative importance and interconnectedness, processes that are regularly encountered in complex systems, of a variety of observed processes. Moreover, the model could enable interested parties, such as government, university administration etc. to predict the consequences of possibly implemented changes in university policy, in a more reliable and complete way than today.

Having in mind the stated importance of the group of a university' young researchers, it came as a surprise to us that we were unable to find a lot of already conducted simulation modelling approaches to it. To the best of our knowledge, modelling related to universities presumably covered other segments, sometimes tackled or implicitly assumed young researchers, but did not put the focus onto it. To emphasise that point, since prevalent number of university lecturers are researchers, it is interesting to note that these researchers have extensively researched a myriad of topics but not themselves.

In this article we present basic considerations of an agent-based model of the group of university's young researchers, discuss its elements, analyse its preliminary results and present the near-future perspective of its further development.

Second section of this article defines the building elements of the model, third section presents preliminary results of simulations ran, while the fourth section concludes the article with analyse of its perspective.

ELEMENTS OF THE MODEL

Modelling in the context of this article means abstraction of reality which brings about formal prescription of conceptualisation, assumptions and conditions. It is a simplified representation of an extracted part. Simulation modelling is a modelling for observing (i.e. running) the model dynamics, and is prevalently numerical. Agent based modelling (ABM) is a particular kind of simulation modelling in which actions and interactions of autonomous agents are analysed [11, 12]. It has prescribed micro-level, linked by numerical simulation with observables at macro-level. While it is always of importance to bridge the micro-macro gap, in many occasions it would be more useful to reveal micro-level from observed macro-level than the other way around. However, in practice it is exactly that other way around in that one must prescribe micro-level and subsequently, through simulation modelling, obtain the macro-level. Thus, finding micro-level causes of previously observed macro-level dynamics is by no means simple, since it is in practice many times time consumable trial and error approach.

Let us summarise main characteristics of an agent based model. It consists of the agents, environment and rules. An agent is a software entity which interacts within virtual environment. Environment is a collection of data which are not about agents but are necessary for unique agent dynamics. An extracted part of environment, which agents collect part of the time, is called the resource. Rules are statements which relate states of agents and environment in different time units. There are agent-environment and agent-agent interactions.

In our model, an agent corresponds to individual young researcher. The environment corresponds to their affiliation and a broader society. Rules refer to activities at work and private activities of young researchers. Rules in realistic systems are realised either through their adoption by an individual or by other societal institutions. In particular regarding young researchers, much of the rules governing their work are implemented by actions of young researchers' supervisors. The supervisors are prevalently senior researchers from universities, such as are professors. Their individualities and methodologies represented influence the overall level of young researchers' achievements and a lot of research has been conducted in order to try to extract the effective corresponding supervision strategies [1] since the young researcher-supervisor relationship has the potential to be wonderfully enriching and productive, but it can also be extremely difficult and personally devastating [2]. In this model we aggregate the individualities of supervisors, and treat them implicitly as an unspecified source of rules. In that way, our approach resembles approaches originating in diverse contexts such as are mean field approach in theoretical physics or Lewin's force field approach and is insensitive to issues such as is (de)centralisation [10].

Young researchers are complete personalities, of unique characteristics in a number of dimensions. The model set includes young researchers' achievements and corresponding changes, in the following dimensions: scientific (to be denoted by index *s*), educational (denoted by index *e*) and additional (denoted by index *a*). The additional dimension includes popularisation, professional and private activities.

Change of scientific achievement *s* is denoted as Δs. It is determined for a given time unit Δt as:

$$\Delta s = \eta_s r_s \Delta t, \tag{1}$$

where η_s is normalised amount of a change and r_s the probability of its realisation. As a representative time unit we chose $\Delta t = 1$ month. Similar equations are valid for achievements in the educational and additional dimensions. Before proceeding let us emphasise that η_s combines all the influences onto young researchers from environment, along with the efficiency of transforming these influences into experience, knowledge, skills and motivation change. All these changes in general manifest themselves in changes of the model's parameters. Therefore, in subsequent text we will refer to η as to efficiency.

Further assumption in the model is that young researchers constantly aim to rise their achievements maximally, and that overall time span of the simulation is rather small in that health, private and other behavioural characteristics of young researchers can be considered as constant, not influencing their total efficiency. Thus one has

$$\eta_s + \eta_e + \eta_a = 1 \tag{2}$$

The efficiency η is modelled as follows

$$\eta_s = f(s,e,a)\frac{1}{2}\left(1 + \frac{n}{1+n}\right), \tag{3}$$

in which *f(s, e, a)* is a function which asymptotically normalises efficiency and *n* is a randomly generated variable. Function $f(\cdot, \cdot, \cdot)$ is a measure of accumulation of achievements and is taken as strictly monotonically growing in time. It is modelled as a linear function of achievements

$$f(s,e,a) = c_0 + c_1(s + e + a), \tag{4}$$

in which $c_{0,1}$ are constant coefficients of linear growth. In expression (3), number 1 in parenthesis refers to periodic contribution to efficiency which is supposed to have period of one week. Since that periodic contribution is written after averaging during 1 month time unit, it turns into a constant. The other part of parentheses in (3) is aperiodic change in efficiency, the reasons for which are out of the scope of this model. Thus it is intuitively modelled as a smooth, finite function of one, random variable n. Variable n has the following probability density function $p(n)$

$$p(n) = \frac{\lambda^n}{n!} e^{-\lambda}, \qquad (5)$$

which is a Poisson distribution with expectation λ. Expectation λ is considered to be one order of the magnitude smaller than 1, so that prevalently during simulation, a value of the parentheses in (3) is 1, or 2. This accounts for the fact that in case of approaching deadline for a project, etc. efforts for achieving predicted results enlarges. In particular, in our model we took $\lambda = 1/6$ which accounts for average one deadline during half a year. Naturally, that does not exclude larger values of parentheses in (3), but makes them considerably rarer than values 0 and 1. Before proceeding, let us note that parentheses in (3) are not normalised so factor 1/2 accounts for normalising the periodic and aperiodic parts in (4).

Initial conditions are that all achievements all the young researchers are of equal value. While that is an artificial assumption, its transformation into equilibrated or stationary values makes possible inference about the time unit of propagating of the disturbances in the model.

Boundary conditions are that environment conditions are constant. That is implicitly included in the constant values of all coefficients introduced, i.e. of $c_{0,1}$ and λ. Moreover, agents are generated in every time unit during simulation in a constant number. Achievements of the agents range from 0 to 100. Within that interval all changes are considered quantitative, i.e. number of agents is constant and only their achievements change. After reaching value of 100 for any of the achievements, the qualitative change occurs in that the agent leaves the considered group, reflecting the fact that young researchers eventually change their status. That leaving the group has different meanings depending on the dimensions the achievement of which reached the value 100. We consider that scientific achievement equal 100 means promotion of a young researcher into the teacher status. Professional achievement equal 100 means transfer of a young researcher from a university into other social structures such as industry. Finally, additional achievement equal 100 means that corresponding young researcher started to work in non-scientific education institutions or other similar institutions such as are school or colleges.

RESULTS AND DISCUSSION

Simulations were conducted for initial number of 500 agents, with 15 new agents introduced in the model in every subsequent time unit. All agents had the initial scientific achievement equal to 20, initial educational achievement equal to 5 and additional achievement equal to 15. Parameters of the model were $r_s = 0{,}031$, $r_e = r_a = 0{,}026$, $c_0 = 0{,}125$, $c_1 = 0{,}1$ and $\lambda = 0{,}17$. Simulations were run during interval 240 time units, which corresponds to 12 years.

Based on the curves in Fig. 1, one may argue about the two different processes. First process or set of processes includes rapid change of achievements which is caused by equilibration of the initial distribution of achievements among agents. It is approximated to stop around 80$^{\text{th}}$ time unit. In that sense, in this model it is to be expected that consequences of a sudden change within a part of the system be equilibrated in approximately 60 months – 5 years. For the rest of the dynamics of distributions, one may argue that underlying processes are well balanced. All stated is applicable to results in Fig. 2: number of agents achieves stationary value after approximately 60 months, as a consequence of balanced number of agents entering and exiting the system. Note that stationary total number of young researchers in the system is consequence of the model set, in particular a consequence of the presumption that every agent, who achieves amount of 100 in any of dimensions, automatically is either promoted or transferred to other groups out of the modelled one.

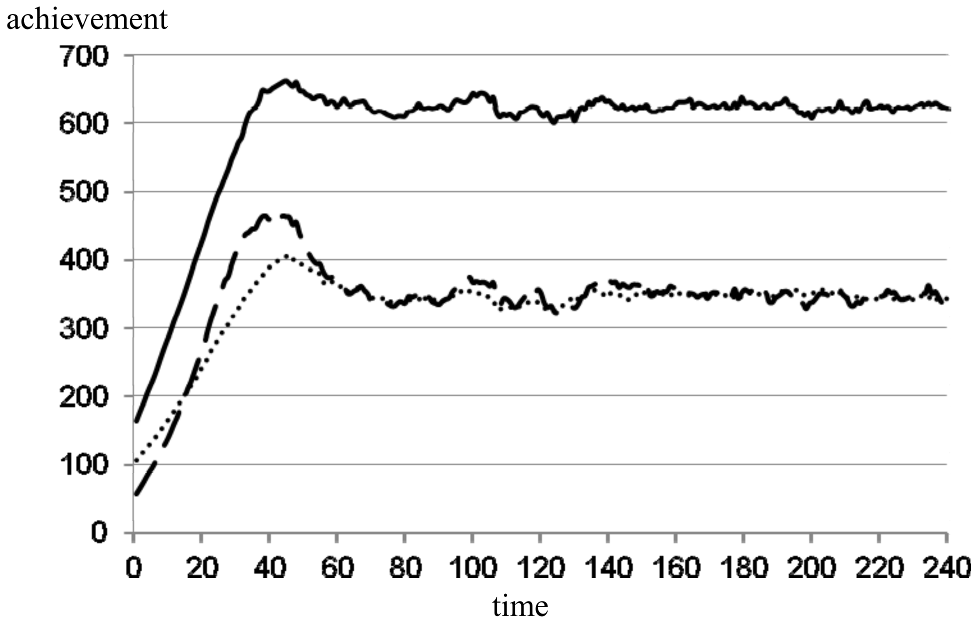

Figure 1. Average achievements as function of time. Solid line – scientific achievements, dashed line – educational achievements and dotted line – additional achievements.

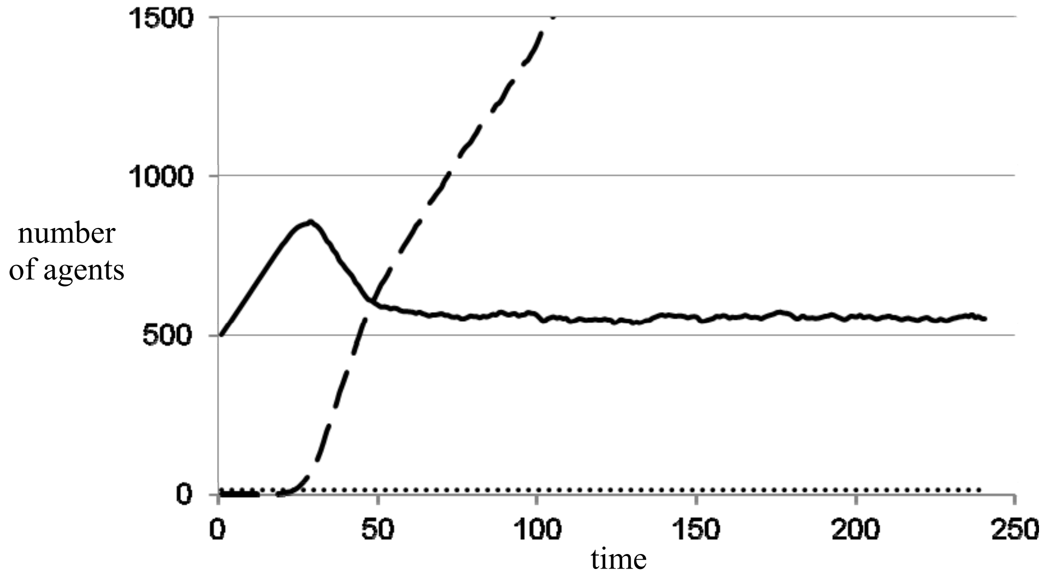

Figure 2. Number of young researchers as function of time. Solid line – total number of agents in a given time interval, dashed line – total number of agents who left their group and dotted line– total number of agents who were not initially in the group but were introduced during the simulation. Note the different character of quantities shown: agents who left the group are shown as cumulative quantity, while for other two groups of agents their changes in a given time unit are shown.

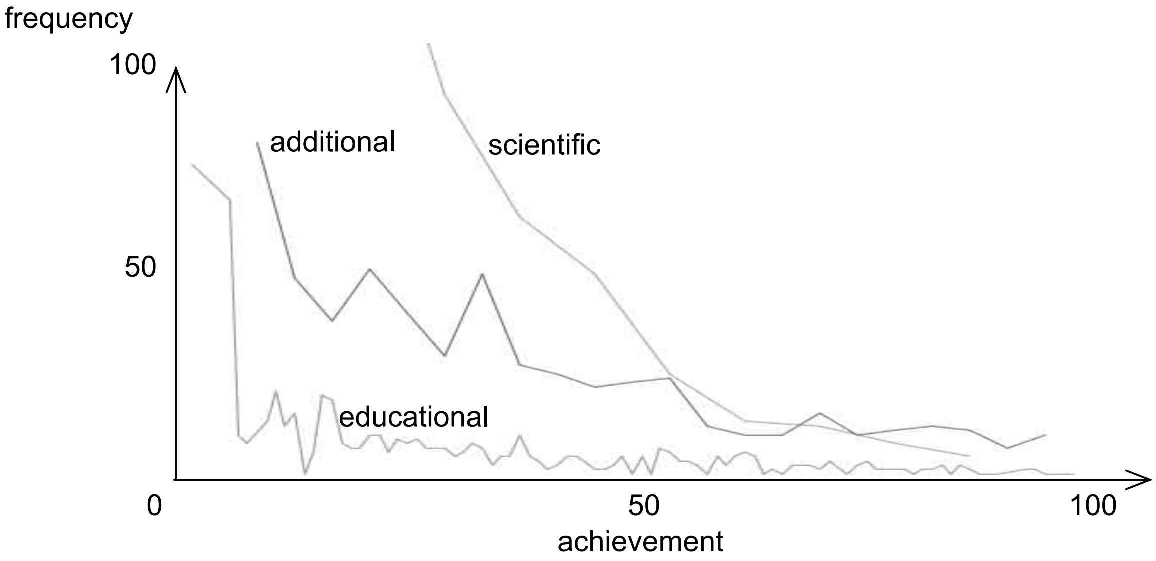

Figure 3. Typical distributions of achievements among agents at the end of simulation.

CONCLUSIONS AND PERSPECTIVES

The model presented is conceptually partially developed and partially implemented. The perspective is to simulate dynamics of more than one group (e.g. teachers, ...), cooperation of agents (both the cooperation solely among young researchers and the cooperation among different groups implemented). Indicators of achievement should be implemented in more details, e.g. differentiate amount of achievements brought about by published journal article, presentation held as a conference, doctoral study exams passed, etc. There are other assumptions of the model that will have to be changed in order to make the model more realistic. One of these is the assumption that young researchers automatically change their status after achieving 100 in any of dimensions. Realistically, promotions can be delayed, or impossible despite fulfilment of necessary conditions. Similarly, because for majority of young researchers it is to be expected that promotion it the most desired outcome, delaying of the status change can be caused either by the system or by the very young researcher considered.

We did not tackle the important question of how to measure some quantity relevant to the model. In addition, model should be validated.

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SIMULACIJSKI MODEL SKUPA ZNANSTVENIH NOVAKA NA INSTITUCIJAMA VISOKOG OBRAZOVANJA TEMELJEN NA AGENTIMA

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SAŽETAK

Mlađi istraživači u visokoškolskim institucijama općenito provode zahtjevne zadatke koji u znatnoj mjeri doprinose produkciji inovacija u institucijama i društvu. Kako bismo analizirali potankosti međudjelovanja mlađih istraživača i različitih institucija u društvu razvijamo model utemeljen na agentima za numeričku simulaciju.

Rad sadrži opis temelja modela, preliminarne rezultate simulacije i perspektive njegovog daljnjeg razvoja i unaprijeđivanja.

KLJUČNE RIJEČI

znanstveni novaci, inovacije, visokoškolske institucije, HEI, sveučilišta

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STAKEHOLDER ANALISYS OF HIGHER EDUCATION INSTITUTIONS

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ABSTRACT

In recent years, knowledge, the human capital, and learning organizations have become the key determinants of current global progress. Higher educational sector has been faced with globalization and strong competition. Therefore, the need has arisen for professional management structures and more entrepreneurial style of leadership. Organizations have been transformed to learning organizations by the life long learning concept, while the knowledge management has become the leading tool in building competitive advantages. High education organizations are being pushed forward by competitiveness. That pressure requires continuous improvement emphasizing the need for measuring outcomes and building excellence. The paradigm of stakeholder analysis, applied to specific determinations of the system of higher education institutions, could be a good way for comprehending and predicting interests, needs and requirements of all key players in the environment. The purpose of this paper is to enhance the possibility of understanding the connection between higher education institutions and its environment in context of stakeholder analysis. The paper uses literature as a basis in identifying critical parameters for stakeholder analysis and its implementation to higher education sector. The findings of the paper reveal that the concept of stakeholders is critical and difficult to implement everywhere and to everything. There is a clear attempt of all organizations, especially those that create and encourage knowledge, to understand the actions of all participants and predictions of interests and requirements of the changing environment.

KEY WORDS

higher education institutions, stakeholder analysis, knowledge management

CLASSIFICATION

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INTRODUCTION

The last decades have been defined by significant social, economic, political and cultural changes, while European higher education sector has been transforming, and above all those important chages affect the conceptualisation and functioning of universities [1]. Modern economy, organizations and workers are focused on and are determined by knowledge. Because knowledge is a key resource and a basic asset in this day and age, our society is being transformed by new skills, techniques and paradigms of knowledge, so new e-generations need 21st century skills: critical thinking/ communications, collaboration and creativity [2]. Our time has become known as the Knowledge Age, implying that we live in knowledge economy rather different from the Industrial Age and we shifting to 21st century thinking [3]. Knowledge Management (KM) is a new trend of management for modern global organizations. KM involves cultivating a learning culture [4; p.63] and this concept of developing new forms of organizational structures and knowledge workers including some applications of the philosophy of KM, is widely applicable, particularly in the field of education. Modern management is people-oriented emphasizing the importance of their role (skills, knowledge and commitment) in modern organizations. The function of human resources management becomes strategically important when providing organizational purpose in the highly competitive environment [5]. In that context, the managing of high education organizations means understanding the complexity of the environment, investing in capable people, developing research capacity through concept of knowledge management and increasing the competitive advantage from stakeholders perspective.

Purpose of this paper is to enhance the possibility of understanding the connection between organization and environment in the context of stakeholders determination. The paper is written mainly based on the literature review as a source for identification of critical parameters for stakeholder analysis and its implementation to heigher education sector. The results of the research demonstrate that the stakeholder analysis is a good starting point for improvement of modern HEI management.

TOWARD KNOWLEDGE SOCIETY

In view of the fact that the management is becoming increasingly aware of the role of education and development, it is obvious that the importance and meaning of modern high educational organizations are changing along with the importance of education in general [6]. Individuals, organizations, and entire economies are finding knowledge and investing in education to be a unique opportunity for developing personal, organizational, economic capabilities and potentials in achieving competitive advantage [7]. The process of transformation of economy and society in the era of knowledge is inevitably tied to the entire education system, especially to high education organizations. Consequently, a stakeholder analysis could be one of the successful tools when planning and managing such type of organizations in a highly changing environment. A dramatic shift of social, technological and economic values arriving in 21st century is transforming organizations through long life learning model [4]. Figure 1 shows that the levels of economy, organization and individuals get the dimension of knowledge philosophy. These changes are also mirrored in the field of education, and are especially true for high education organizations involving business perspective of thinking and operating.

The role of knowledge and education in the knowledge society is not the same as it was some time ago. It is dramatically changed, and it will continue to change in the years to come.

Figure 1. Concept of life long learning and learning organization.

Education is a key factor of progress, and investments in education are crucial for "knowledge economy" when referring to people and organizations, well-organized and innovative education system ensures overall economic growth [8]. All developed economies consider this learning potentials important for national development.

Education is a part of public sector. Its orientation is towards nonprofit goals, and its primary focus is social in providing education for all citizens at certain levels. Education institutions belong to nonprofit organizations, and are oriented towards society not market, being "servants to citizens". Finally, their results are social, unmeasurable and qualitative [9]. All this means that the theory of nonprofit management is applicable to managing high education institutions.

Firstly, these organizations must be aware of the distinction between profit and nonprofit sectors which is of particular importance when achieving the mission of managing nonprofit organizations. That is a specific starting point for understanding the concept of managing high educational organizations as specific nonprofit organizations described in Table 1.

THE ROLE OF HUMAN RESOURCES MANAGAMENT AT HEI

Human resource management (HRM) process involves the acquisition, retention and development of human resources, its basic dimensions are: (i) recruitment/selection, (ii) performance appraisal and (iii) training [10]. HRM is important for several reasons. First many studies have concluded that people are the most significant source of competitive advantage, second HRM is important part of organizational strategies and finally, the way organizations treat people has been found to significantly affect organizational performance [11]. In the age of human capital, human resource strategy means – a people centered approach which emphasizes the need to develop to their fullest potential all present and future employees [10].

Table 1. Differences between profit and nonprofit concept [9].

Dimension	Profit	Nonprofit
Starting point	Profit	General public good/service to the public or/and civil society
Arena	Market	Society
Focus	Consumer	Individual/citizen
Concept	Economic	Social
Results	Economic/measurable/ Quantitative	Social/unmeasurable/qualitative

People management, performance measurement and funding as well as social responsibility are some of the major problems common to all nonprofit organizations, including those in the public sector. The organizations in the area of education are in particular need of a good leadership, capable employees, good quality staff programs and work performance monitoring.

Globalization, demographic changes, IT revolution and Knowledge economy are drivers of contemporary changes determining the new knowledge society while simultaneously searching for new skills and knowledge [4].The organizations that recognize knowledge workers as the most valuable resource and an important competitive advantage in the knowledge economy have a chance to survive. The practice of human resources management is about implementation of knowledge management respecting the knowledge workers. Knowledge workers use and create new knowledge, and with their skills, abilities and ideas they make significant contribution to sucess and development of a company [12].

Higher education institutions are undergoing a process of transformation [13]. Modern European University faces new challenges in modifying its conduct and activites, questioning the role of modern management and leaders, encouraging significant innovations and developing investment in employees. It is necessary to provide quality concerns for students' and stakeholders' satisfaction and enable cooperation between Faculties and community ensuring the social benefit.

The final results are learning outcomes – new values, customer satisfaction and rich and balanced society [14]. Learning organizations emphasize the importance of human capital as a part of the intellectual capital referring to skills, knowledge, abilities, organization commitment and potentials for innovation, in other word, its creativity. Learning is key if organizations are to survive, compete and manage their surroundings [15].

Human Resources Management is the central part in management process relating to recruitment, training and development of people contributing to the development of organizational strength. It is up to managers to find the best people, motivate them and let them do the work in their own way. The management plays an important role in human resources management. It is responsible for successful encouragement of people in developing their potential and directing them to specific destinations, but also monitoring and rewarding their work and providing a stimulating and healthy working environment [5]. Some of the most important subfunctions of HRM, that are vital for organization, are shown in Figure 2 [4].

Good HRM practices refer to philosophy that shows the real interest in all the people within an organization that treats its employees as the only living organizational element. Further, there is a developed program of training, development and monitoring of people and good reward programs in such organizations [16]. A successful organization has the management dedicated to giving support to the people and the concept of knowledge management, the one that develops and encourages the participation of employees [1]. If we apply the paradigm of HRM to the Faculty we can see that it is possible to construct a model of learning organization with respect to the principles of knowledge management, as shown in Table 2.

THE PERSPECTIVE OF STAKEHOLDERS ANALYSIS IN HEI

Universities everywhere are being forced to carefully reconsider their role in the society and to evaluate the relationships with their various constitutions, stakeholder, communities. Modern European University is faced with new challenges. Improving the quality of the European society of knowledge generates certain expectations from European universities that need to fulfill the three key dimensions of essential university mission [17]: (i) Teaching and Education, (ii) Research and Innovation, and (iii) Knowledge transfer and community service.

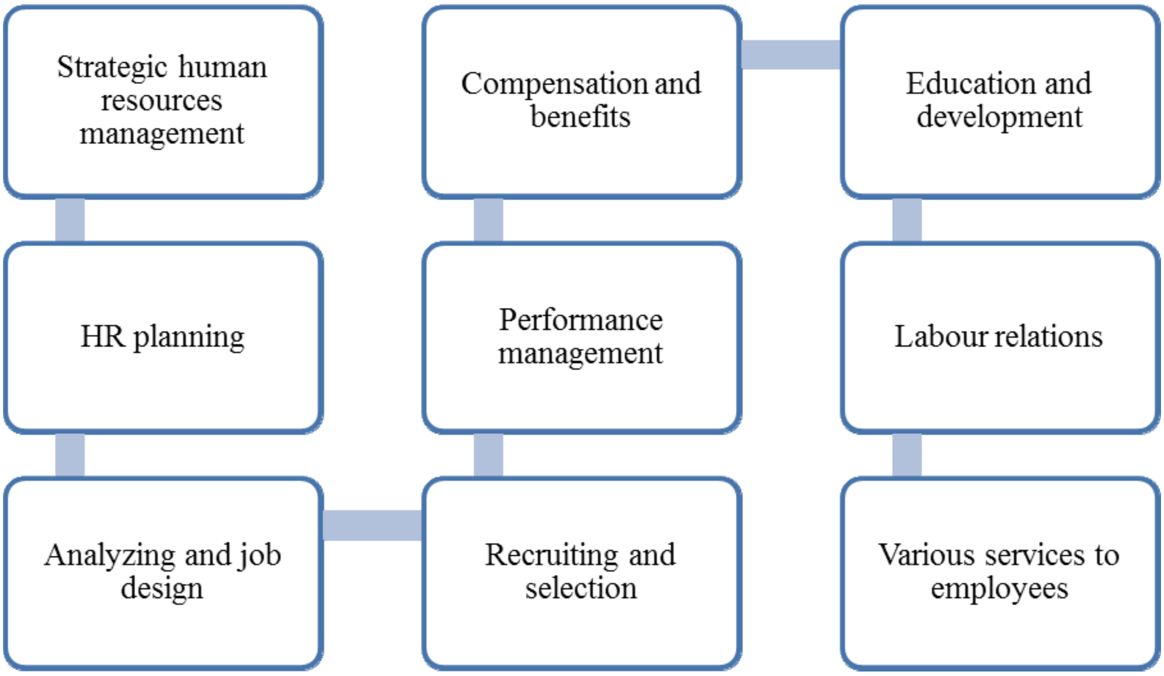

Figure 2. HRM activities [5].

Table 2. Implementation of HRM to a Faculty [5].

A successful organization	The Faculty as the learning organization
The real interest for the people. Employees are the only living organizational element, and the most valuable asset.	Interest for employees (professors, assistants and other staff) People are the most important resource Bearers of knowledge – a true competitive advantage.
Good training, development, monitoring and the opportunity for advancement.	Enables development, international experience, education and development of evaluation and provides conditions for promotion.
Good reward programmes.	Provides a system of promotion and career development, and allows the system criteria of excellence.
Being able to retain the best employees.	In the higher education system extracts and retains the best professionals.
Management is dedicated to giving support to the people.	Management recognizes people as true creators of knowledge, innovation and valuable organizational resources. Management supports the philosophy of knowledge management.
Develop and encourage the participation of employees.	Supports participating leadership style and the concept of knowledge management.

The essential purpose of University is teaching and education, but also research and innovation. The third part of the mission covers the knowledge management, the cooperation between sectors and questions the role and the position of knowledge and high education organization in the contemporary, turbulent times. The HEI mission was expanded to strech beyond teaching and reserch to include services to the community requiring partnerships be established.

The stakeholder perspective is questioning organization in the light of its environment, finding the best way in successfully managing opportunites in and out of organizations and recognizing all the participants included in the process of organizational activities [18]. The first step is trying to identify the key stakeholders, their goals and expectations. The second step is trying to fullfill their goals to their utmost satisfaction concurrently accomplishing the organizational mission.

Stakeholders are any group or an individual who can affect or is affected by the achivement of the organization objectives [7] any constituencies in the organization's external environment that are affected by the organisation's decisions and actions [11]. The main groups of stakeholders: are: customers, employees, local communities, suppliers and distributors, shareholders [19]. Stakeholder analysis can be used to generate knowledge about relevant actors so as to understand their behavior, intentions, interrelations, agendas, interests and the influence or recources they have [20].

The stakeholder theory illustrated for the University analyzes twelve categories of stakeholders and desribe them as constitutive groups, communities, stakeholders and clients, as shown in Table 3.

Table 3 presents various groups of stakeholders applied to high education institutions, and indicates a different pressure, influences reflected through actions, policies and the behaviour of each groups. Applying stakeholder analysis to University of Zagreb could be the first step in comprehension and conceptualization of stakeholder theory and its implementation on the high education institutions. Table 4 presents' primary and secondary stakeholders and explains their outcomes. The basic groups that provide performance of the core mission are: Government, Ministry of Science and Education, National Agency and Society. Other groups: students, employees, competition and other faculties are forming specific relations, have various demands, interests and build networks that need strong management and interactions among all sectors. This stakeholder analysis is the result of theoretical reflections and given the example of the one HEI.

Table 4 is a simplified framework for understanding stakeholder analysis applied to higher education. It presents key stakeholders and their implications. The next step must be further positioning of other relations that include groups' interconnections.

It is necessary to develop this model reviewing the third mission of universities that refers to engaging in interactions with industrial and regional partners, prevents mission overload and

Table 3. Stakeholder categories and constitutive groups [17].

Stakeholder category	Constitutive groups, communities, stakeholders, clients, etc.
Government entities	State & federal government; governing board, board of trustees, buffer organisations; sponsoring religious organizations
Administrattion	President (vice chancellor); senior administrators
Employees	Faculty; administrative staff; support staff
Clientele	Students, parents, service partners, employees
Suppliers	Secondary education providers; alumni; other colleges and universities; food purveyors
Competitors	Direct: private and public providers of post-secondary education Potential: distance providers; new ventures. Substitutes: employer-sponsored tranining programmes
Donors	Individuals
Communities	Neighbours; school systems, social services
Government regulators	Ministry of education, buffer organizations; state and federal financial agencies
Non-governmental regulators	Foundations; institutional and programmatic accrediting bodies; professional associations
Financial intermediaries	Banks; fund managers; analysts
Joint venture	Alliances & consortia; corporate

Table 4. One example of stakeholder analysis of the HEI.

Identification of stakeholders/users	Primary	Secondary	Outcome
Government	✓		The financial support of the national strategy
Ministry of Science and Education	✓		The financial support of the national strategy
The Education and Teacher Training Agency		✓	Evaluation and monitoring of the criteria for excellence
Faculties	✓		High level of knowledge is required
Students		✓	Satisfaction with study conditions, the level of required knowledge
Employees		✓	Satisfaction with working conditions,commitment
Competitors		✓	Knowledge transfer, collaboration Fair Competition
Society	✓		A balanced society Transfer of knowledge

questions the issues of governance, social responsibilities and research agenda along the lines of the model of entrepreneurial dynamism of higher education institutions [17].

DISCUSSION

The world is changing day by day, becoming smaller and more closely linked in many different ways. The role of education is a transformation of society and technological trends by redefinition of values and concept of knowledge. The education is becoming more

informal through modern technologies of the Internet and various social networks while formal education system takes new forms and structures using and applying models from business sector. Knowledge management finds people the most valuable asset in organization, and develops programmes for constant learning on individual, organizational and global levels. The key part of every management process (applied to high education organizations) is investing in people and providing successful HRM practice. Finally, managing organization in time of changes means being aware of the significance of setting the mission, finding resources (people, money, knowledge) and finally meriting outcomes. High education institutions are being dramatically transformed. They need to understand the power of change and the aspiration toward concept of knowledge management. Stakeholder analysis helps to realize who the key stakeholders are and what they want. The second phase is attempting to accomplish organizational goals and respect different stakeholders' requests providing organizational mission in the best possible way.

CONCLUSIONS

The paper shows the complexity of problems in managing higher educational organizations in context of dynamics and its relation to the environment. Organizations in field of higher education also need to build a quality management system that respects the philosophy of Knowledge management, and they have to deal with problems of Human Resource management in relation to appearance and development of knowledge workers. Furthermore, the modality of stakeholders indicates the diversity and multidimensional environment that defines and determines a modern organization. By organizing the model of lifelong learning and respecting the learning organization criteria we should be able to build organizations highly representative in our competitive era.

In recent years, the application of stakeholders analysis tool has become widespread. Therefore, the higher education institutions has started using it too, in order to improve their field of work. There are numerous researches on this subject, see e.g. [1, 13, 17].

Education sector is in the proces of tranformation in Croatia, while entrepreneurial approach for the management of universities is desirable [16], and at the same time stakeholder analysis as business techniques allows significant improvement in education system in theoretical and practical implications [21].

There are various options of stakeholders analysis applications in all areas, including education, higher education in particular, which is under continuous pressure of changes and demands to follow the global trends of technology innovations. At the same time, it is expected to promptly respond to demands of market and competition. Universities are, inherently, learning organizations familiar with the concept of lifelong learning and Knowledge management, so they value the perspective of changes and the adoption of environment observation from the stakeholders point of view.

This paper has tried to correlate the research of the stakeholder analysis application at universities and the role of knowledge workers along with the human resources potential. The ultimate goal is the building a model of learning organizations – organizations that have developed the capacity to learn, adapt and change continously [18], as a result of all the changes within the society. The article is merely attempting to indicate the value of knowledge, human potentials and the need for instilling the concept of stakeholder analysis in higher education institutions.

The world is changing daily, forcing the concept of knowledge and technology to become the key factor of modelling organizations and the entire society. Higher education institutions are changing and are in need of entrepreneurial style of leadership. They have to be capable of daily transforming and reacting to change, at the same time remaining true to their main mission, as well as being professionally and socially responsible. Since universities are the professionally managed institutions, carrying strategic weight in society development, this area of research is yet to witness defining new moments.

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STAKEHOLDER-ANALIZA INSTITUCIJA VISOKOG OBRAZOVANJA

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SAŽETAK

Posljednjih godina, znanje, ljudski kapital, te učeće organizacije su postali ključne odrednice globalnog napretka. Visoko obrazovanje je suočeno s globalizacijom i jakom konkurencijom. Dakle, postoji potreba za profesionalnim upravljačkim strukturama i poduzetničkim stilom vodstva. Suvremene organizacije su podložne konceptu cjeloživotnog učenja, dok je upravljanje znanjem postalo vodeća tehnika u izgradnji konkurentne prednosti. Organizacije u sustavu visokog obrazovanja su pritisnute konkurencijom što zahtijeva stalno unaprjeđenje poslovanja, što prati naglašena potreba za mjerenjem ishoda i izgradnjom izvrsnosti. Paradigma *stakeholder* može se primijeniti na redefiniranje i poboljšanje poslovanja visokoobrazovnih institucija što može biti dobar način za razumijevanje i predviđanje interesa, potreba i zahtjeva svih ključnih igrača u okruženju visokog obrazovanja. Svrha ovog rada je utvrditi mogućnost razumijevanja veza između visokoobrazovnih organizacija i njegove okoline u kontekstu analize *stakeholder*. Ovaj rad kreće od identificiranja kritičnih parametara odnosno teorije analize *stakeholder* i moguće primjene u domeni visokog obrazovanja. Nalazi ovog rada pokazuju da je zadani koncept teško provoditi te da zahtijeva dobru pripremu i razumijevanje svih interesno-utjecajnih skupina. Naravno to se osobito odnosi na one organizacije koje stvaraju i potiču razvoj znanja i učenja što dalje podrazumijeva poticanje i razvijanje svih sudionika i predviđanja njihovih interesa i zahtjeva u suvremenom promjenjivom okruženju.

KLJUČNE RIJEČI

institucije visokog obrazovanja, *stakeholder*-analiza, upravljanje znanjem

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DISTRIBUTION OF CITATIONS IN ONE VOLUME OF A JOURNAL

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ABSTRACT

Citations to published scientific articles are regularly collected and processed, bringing about the impact factor and a large number of other bibliometric indicators. We interpret the set of citations collected during fixed period as a characteristic statistical distribution of citations, argue about its properties and conjecture what statistical measures represent reliably such distributions. In that way we try to contribute to determining precisely the scope and level of suitability of impact factor if accompanied with a small set of additional indicators, all derived solely from the distribution function.

KEY WORDS

citation, bibliometric indicator, impact factor, distribution function, sensitivity

CLASSIFICATION

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INTRODUCTION

References and citations are two of necessary elements of scientific publications. Total number and other derivatives of citations of a scientific text are regularly used in diverse characterisations related to scientific publishing. Historical example is introduction of impact factor, a quantity determined annually for a given journal [1]. During times, use of impact factor both diffused and broadened. Nowadays, because of diffusion, the impact factor is important for careers of individual authors of scientific publications. Because of broadening, the use of impact factor is accompanied with the use of other bibliometric indicators, attributable more or less to individual authors. These processes were facilitated by the development of technologies for semi-automatic archiving and processing of scientific publications. In practice, the technologies enabled interested parties, such as librarians, scientists, governmental and non-governmental funding bodies, administrators of data-bases and search engines, etc. to develop their own indicators.

Moreover, a considerable number of studies of quantitative aspects of citation distributions have been undertaken, focusing onto different, still not completely clear aspects of citation distributions [2]. As a regular characteristic of a citation distribution they confirmed its skewness. The tail of citation distribution function is modelled as power-law [3-6], yet without consensus about its details. Eom and Fortunato [3] compare a lot of approaches to citation distributions and dynamics and extract shifted power-law as their underlying functional form. Golosovsky and Solomon [4] exhaustively treat citations to articles in physics journals in recent decades and show that heavy tail of the distribution is well described by power-law function, but that for extreme tail it is nevertheless improper, i.e. a runway behaviour is observed. In order to cover the skewness, or weightednedd, Wagner and Leydesdorf [5] discuss the integrated impact indicator. Leydesdorf [6], stressing that one is not allowed to compare impact factors even across neighbouring fields and subfields, discusses further aspects of intuitively simple indicator, aligned with the state-of-the-art and allowable for statistical testing.

Listed and similar studies were conducted for a rather large set of citations, spanning several decades and including many journals. In that sense they are representative of a given discipline, and are large enough to extract subtle effects, thus underlying distributions can be modelled in stringent details. In case of a smaller number of citations analysed, it was shown that indicators, introduced on the basis of large set of citations, show unpredicted effects [7]. In addition to citations analyses, indicators focused onto differently defined collection of articles have been developed. Rodríguez-Navarro [8] introduced x-index, a simple and precise indicator for high research performance related to countries and institutions, not the journals.

Radicchi and Castellano [9] concentrated on the problem that absolute values of some indicators systematically differ among various disciplines. In order to suppress that effect, they applied reverse engineering approach to study the citation patterns of millions of articles. As a result they derived transformations base on power-law function which suppress the disproportionate citation counts among scientific domains. Their result was further deepened with additional analyses conducted by Waltman, van Eck and van Raan [10] who concluded that although many fields indeed seem to have fairly similar citation distributions, there are quite some exceptions as well.

Stated references focus onto clarification of the scope and meaning of bibliometric indicators within the context of the traditional publishing, i.e. scientific journals. However, the digital age has brought about new forms for disseminating information, such as are web-based forms. Lozano, Larivière and Gingras [11] analyse different web-publishing forms and reach the conclusion that in the contemporary, digital age impact factor is less connected to articles' citations. Before the digital age, the citation rate of any given article and its journal's impact factor mutually reinforced each other. According to them, since 1990 and the advent of the digital age, the strength of the relation between impact factors and article citations has been decreasing [11]. In other words, since 1990, the proportion of highly cited papers coming from highly cited journals has been decreasing, and accordingly, the proportion of highly cited papers not coming from highly cited journals has also been increasing [11]. They project that such a trend will continue, and "should this pattern continue, it might bring forth the end to the use of the impact factor as a way to evaluate the quality of journals, papers and researchers and have interesting implications for the future of scientific literature" [11]. Similarly, Evans, Hopkins and Kaube analyse different publishing forms [12] and propose new bibliometric indicator that counts both citations and references. They apply such an indicator to set of publications from several, qualitatively different, well defined institutions and in addition to an internet archive. Attempts to resolve problems with improper use of existing bibliometric indices motivated Frittelli and Peri [13] to formulate scientific research measures, which originate from the more recent developments in the theory of risk measures. In particular, they are based on the Coherent Risk Measures.

While interdisciplinarity suppressed the use of impact factor as universal measures, along with other proposals to overcome it, e.g. [6, 9], Silva et al. [14] confirmed quantitatively that science fields are becoming increasingly interdisciplinary, with the degree of interdisciplinarity (for which they exploit entropy) correlating strongly with the in-strength of journals and with the impact factor. Albarrán, Ortuño and Ruiz-Castillo [15] analyse low-impact and high-impact measures as distinct measures to be applied for comparing the citation distributions of research units working in the same homogeneous field. They suggest using two real valued indicators to describe the shape of any distribution: a high-impact and a low-impact measure defined over the set of articles with citations above or below the critical citation level. The key to this methodology is the identification of a citation distribution with an income distribution [15].

There are two general characteristics of diverse bibliometric indicators, thus quantitative measures used for bibliometric characterisation of some entity, no matter whether that be an article, journal, individual author or an institution. First, bibliometric indicators are well defined and straightforwardly determined. Secondly, scientific works of higher quality by prescribed criteria, are to be considered within scientific community receive better funding. As a consequence, in many cases nowadays, quality of scientific work is related to quantitative indicators. The last sentence is generally treated as an oximoron, and a lot of efforts and researches have been conducted in order to either making smaller the gap between the quality and quantity in a context of scientific publications, or to clearly express the finite difference between them.

However, despite the fact that a lot of bibliometric indicators have been introduced after impact factor (as is stated, we are currently experiencing an explosion of research metrics [4]), yet we consider that the very journals and particular volumes are not covered appropriately.

We aim to contribute to broadening the characterisation of scientific impact of a given journal. Thus we concentrate on the set of citations to scientific articles published within a given volume of scientific journal. Our conjectures are that such a set of citations: (a) is proper basis for defining more comprehensive bibliometric indicators of the journal's scientific impact, (b) should be considered statistically as a representation of a proper distribution function.

In order to test these conjectures, we ask what could be additional bibliometric indicators which: (i) are straighforwardly determined from the set of collected citations for articles within one volume of a given scientific journal, (ii) are statistically consistent, which (iii) contribute to more detailed characterisation of scientific impact of a given journal, and which (iv) minutely depend on the large-scale changes in scientific publishing. Before proceeding let us emphasise that such indicators are to be used solely for characterisation of scientific journals, along with impact factor already determined for that purpose. The underlying reasoning is that by defining clear, unique, reliable set of bibliometric indicators of a given scientific journal one broadens understanding of what part of quality of a scientific work can be expressed using quantitative indicators.

In this article we describe initial set of such measure, put it into a proper context, and argue how they fulfil the listed points (i) and (ii). Along with the average, the measures are standard deviation, and corresponding sensitivities, of a distribution posed for a set of citations to scientific articles published in one volume of a given journal. For clarity, further in the text we assume without explicit mentioning that set of citations and citation distribution function refer to scientific articles published in one volume of a given scientific journal.

Section two focuses onto a citation distribution function and presents both the methodology for its construction and its general characteristics. Section three contains results of determining citation distribution function for several journals. Section four discusses obtained results and section five presents conclusions along with projections of further work.

STATISTICAL DISTRIBUTION FUNCTION

CONSTRUCTION

The starting point is a set of citations to the group of articles which were published within a given volume of a chosen scientific journal. Citations included in the set generally occur in diverse publications during generally unspecified time interval. The elements of that set should be precisely defined in order to obtain the uniquely constructed set of citations for further analyses. Before proceeding, let us emphasise that we ask in this article what could be additional bibliometric indicators. Regarding that, we implicitly assume that the very definition and overall usefulness of such indicators do not crucially or substantially depend on the very volume of the citations considered. In that sense, in this article the chosen journal would be any of journals included in the Web of Science. Given volume of that journal is any volume published at least two years ago. Set of citations includes all citations as listed in the Web of Science database, collected during time interval from the year of publishing of the given volume to present time. Such a determination invokes systematic difference between e.g. the impact factor and here introduced indicator. However, we assume that the difference is of the similar amount in the most of cases. Naturally, the more stringent the assumed use of the indicator the more prescribed the set of citations.

Let A be the number of articles in the group. We enumerate them using index i = 1, ..., K by some non-specified criteria, e.g. ascending date when manuscripts were received. Number of citations for i-th article is n_i and the total number of citations for the given volume is $N = n_1 + ... + n_K$. Relative frequency of citation to the i-th article is $f_i = n_i/N$. The set

$$\{f_1, f_2, ..., f_K\}, \qquad (1)$$

is a distribution of citations (DC) to the group of articles which were published within a given volume of a chosen scientific journal.

GENERAL CHARACTERISTICS

Modelled citation probability distribution function (CPDF) is the following

$$p(x;a,b) = b^{1-1/a} \cdot \frac{\sin(\pi/a)}{(\pi/a)} \cdot \frac{1}{b + x^a}\,, \tag{2}$$

where x is the continuous variable, a generalisation of the number of citations, while a and b are two parameters to be determined from fitting (2) to (1) using the nonlinear least square method [16]. Parameter a is responsible for large citation tail of (2). In that region of x axis the function acquires the power-law form

$$p(x{>>}b;\, a,\, b) \sim x^{-a}, \tag{3}$$

while in the opposite region, $x << b$ function (2) tends to a constant value. The form (3) is aligned with a number of results based on analyses of a significant quantity of citations. Since N as defined here is considered to be much smaller than the number of citations utilised in other contexts, we expect that here discrimination of different, yet qualitatively similar forms, is not possible. In that sense, form (3) approximates sufficiently well expected tails of DC. In the region of small number of citations, $x << b$, similarly, we expect that the shape of DC could not discriminate among many functionally different, yet qualitatively similar functions which is why we choose a form that in a simple way grasps non-divergent behaviour of low-number of citations limit. Before proceeding, in (2) we assume that x is continuous, real, non-negative variable which integer values have the meaning of possible number of citations. It is interesting to note that the form (2) resembles modified Pareto distribution, originating in the economic context thus represents another contribution of other disciplines to formulating of bibliometric indicators [14-16]. To summarise, form (2) has two parameters which are separately related to the two observed, mutually different parts of the DC. We assume that in case of rather large N the DC tends to a definite CPDF.

First characteristic of the CPDF is its first moment, the expected value. It is closely related to the impact factor, the differences being stringently prescribed number of years during which the citations to a set of articles are collected as well as the set of literature sources within which citations are collected. Nevertheless, we assume that listed differences are not of substantial but technical character. Thus we consider the expected value of the CPDF to resemble the impact factor. For CPDF (2), the expected value exists for $a > 2$ and equals

$$\overline{x}(a,b) = \frac{b^{1/a}}{2\cos(\pi/a)}\,. \tag{4}$$

However, expected value is assumed on the basis of average value determined for DC. But, in statistics, average value is reasonable representative of a distribution if that distribution is a normal distribution. Since prevalently the DCs obtained are skewed distributions, average values do not reliable represent them. Instead, medians and related statistical quantities (deciles, quantiles, ...) are reliable representations. In order to relate as much as possible to impact factor, we proceed with (4). Its sensitivity κ_x is two-component function defined as follows:

$$\kappa_\mathrm{x}(a,b) = \left(\left(\frac{\partial \overline{x}}{\partial b}\right)_{a,b}, \left(\frac{\partial \overline{x}}{\partial a}\right)_{a,b} \right). \tag{5}$$

Second characteristic of a distribution is its variance, calculated as a combination of distribution's second and first moments. Standard deviation of CPDF (2) exists for $a > 3$ and equals

$$s(a,b) = b^{2/a}\left[\frac{\sin(\pi/a)}{\sin(3\pi/a)} - \frac{1}{4\cos^2(\pi/a)}\right]. \tag{6}$$

while corresponding sensitivity κ_s equals

$$\kappa_s(a,b) = \left(\left(\frac{\partial s}{\partial b}\right)_{a,b}, \left(\frac{\partial s}{\partial a}\right)_{a,b}\right). \tag{7}$$

Sensitivities are quantities which measure to what amount will CPDF (2) change, for given values of a and b, in case of a minute, formally unit, change in the DC (1). Figure 1 shows CPDF introduced in (1), while Figure 2 shows expected value (4) and variance (6). Graphs of different components of the two sensitivities have the form similar to that of the expected value and variance, especially in the region close to the lower boundary of the range of a for which they are defined. In that sense, for $a > 3$, components of sensitivity (7) of standard deviation have more pronounced dependence on the small changes in a and are more suitable for discriminating seemingly similar, yet quantitatively different CPDFs.

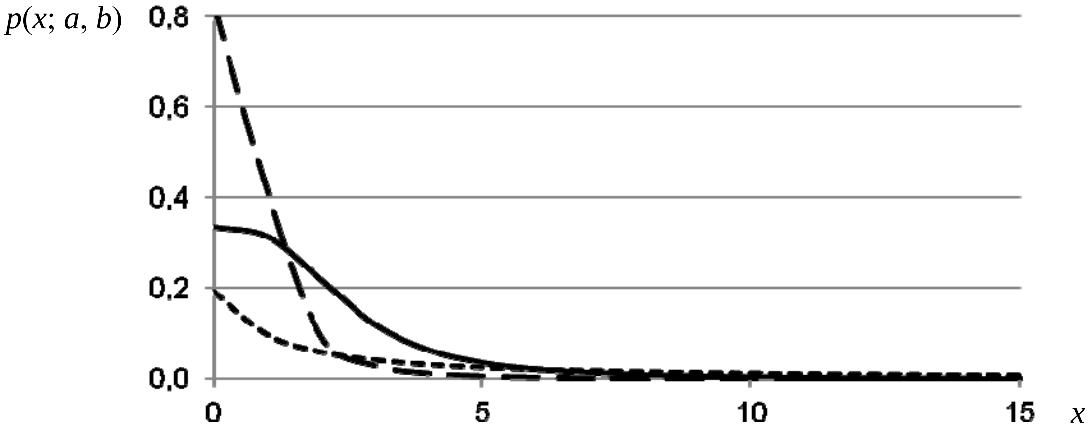

Figure 1. Graph of model CPDF (1) for a = 3 and b = 15 (solid line), a = 3 and b = 1 (dashed line), a = 1,2 and b = 1 (dotted line).

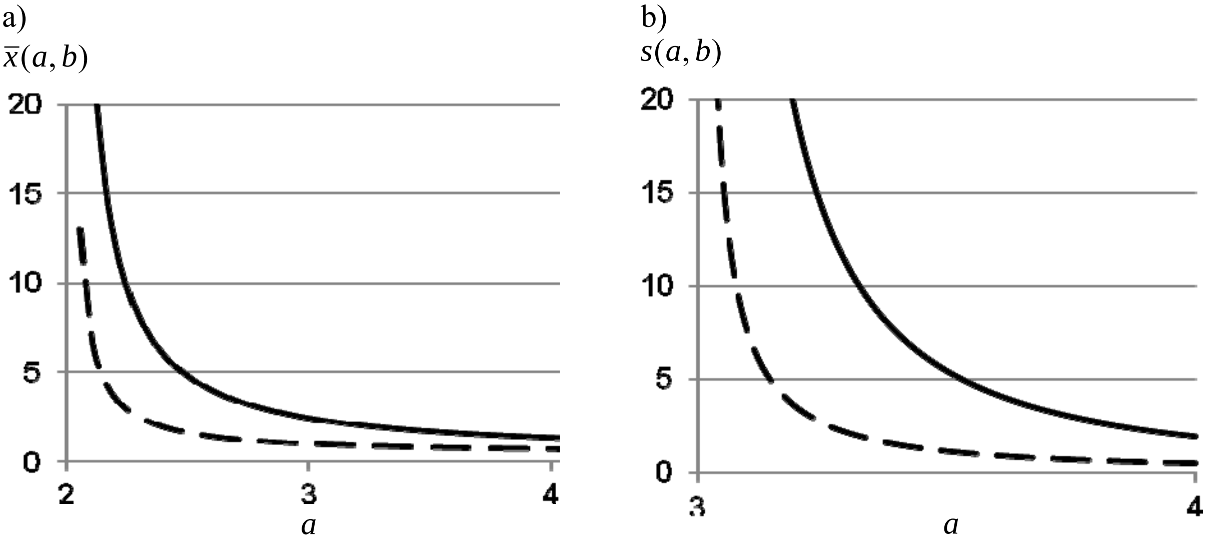

Figure 2. Graphs of model CPDF's a) average value, b) standard deviation as a function of a. Solid lines are for b = 15 and dashed for b = 1.

RESULTS

Citations were counted for three international scientific journals in the Web of Science database. We will refer to them as to the journals A, B and C, without listing explicitly their titles. All three journals belong to the same scientific discipline. Journal A is an international-level journal publishing scientific reviews, journal B is an international-level journal publishing prevalently regular scientific articles, while journal C is regional-level scientific journal publishing regular scientific articles. Impact factor of the journal A is the largest among these journals, and that of journal C the smallest. Impact factors of journals A and B are significantly larger than median for the underlying scientific discipline, while impact factor of the journal C is much smaller than that median.

All journals contain one volume per year, and the volume spans the complete calendar year. We considered volumes of the journal A published in the period from 2007 to 2011, volumes of the journal B published in 2010 and 2010, as well as the volume of the journal C published in 2010. Data were collected in November 2012 and included all citations that were recorded and available then in the Web of Science database. Number of articles and corresponding total number of citations are listed in Table 1. Medians, formally calculated average values and variances for the three journals are given in Table 2. Distributions of citations are shown as histograms in Figure 3.

Obtained histograms were fitted to (3), with the linear transformation in which a representative value of number of citations in a given bin (x) was linearly transformed to x' which coincides with the ordinal of that bin. There were no additional criteria for determining the width of the bins.

The software R-project Ver. 2.15.2 was utilised for fitting the expression $N_A \cdot p(x; a, b)$ to collected data within the nonlinear least square approach. Formally, in order to suppress all normalisations and include described linear transformation, data presented in Figure 3 were fitted to the form

$$\frac{k_1}{1+k_2 x^{k_3}}, \tag{8}$$

with the values obtained for coefficients $k_{1,2,3}$ as listed in Table 3. Graphs of functions (8) for a particular journal are in Figure 3 incorporated into histograms in order to make the comparison easier.

Table 1. Number of articles A published per considered journal and corresponding total number of citations N_A.

Journal	A	N_A
A	99	6067
B	159	2691
C	73	56

Table 2. Elementary statistical quantities for the DCs of three considered journals: medians, formally calculated average values and standard deviations.

Journal	Median	Average value	Standard deviation
A	31	61,3	76,9
B	12	16,9	1,3
C	0	0,8	15,5

Table 3. Values of coefficients in obtained for modelled CPDF (8).

Journal	k_1	k_2	k_3
A	277,4	3,870	1,895
B	45,89	0,002	4,792
C	64,80	0,079	6,107

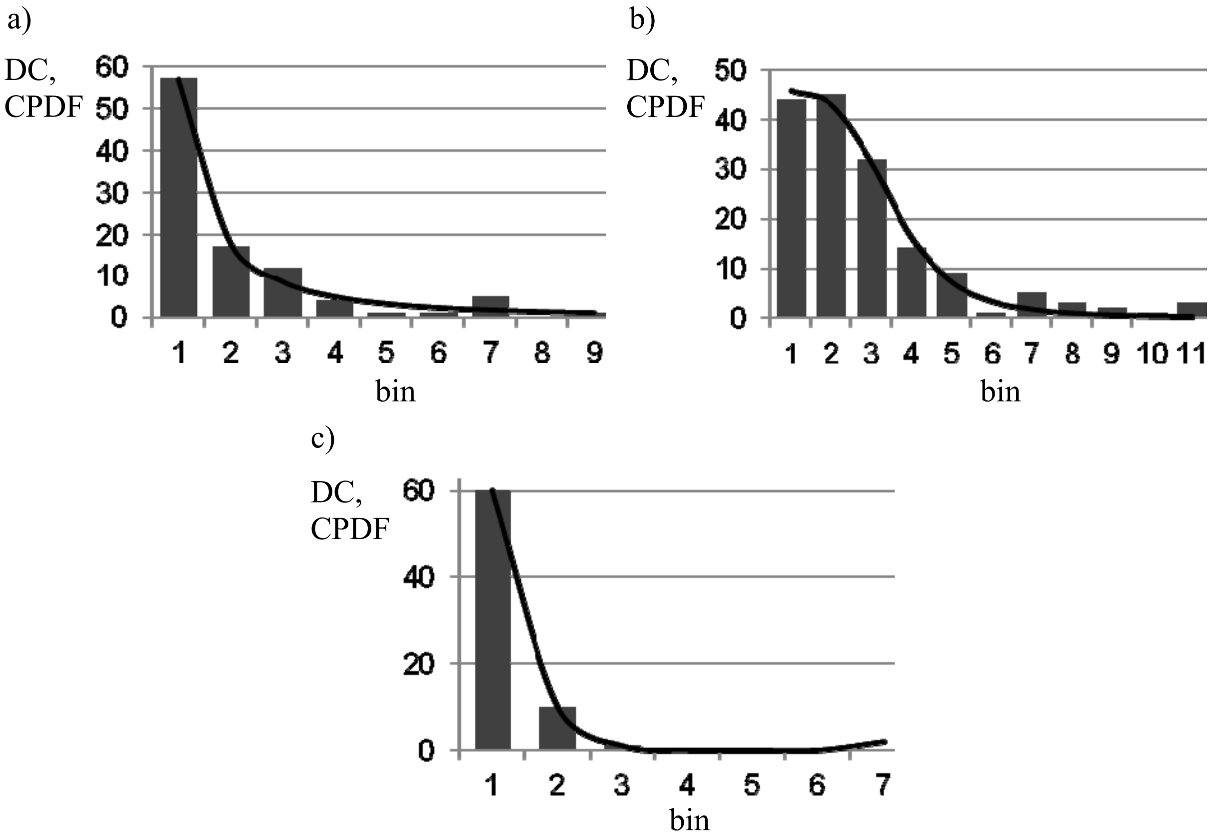

Figure 3. Graphs showing dependencies of DCs and CPDFs of citations for journal a) A, b) B and c) C. Grey bars refer to histogram of counted citations, while solid black lines refer to fitted values based on (2). Values on the axis abscissas are ordinals of the bins of histograms. These ordinals are linearly related to the corresponding average number of citations in a bin.

We utilised the nonparametric Kolmogorov–Smirnov test for testing the goodnes of fit. The stated hypothesis was that the data follows the specified distribution, and the alternative hypothesis was that the data does not follow a specified distribution. For each journal, the test statistic D is less than the critical value D_{critical}, therefore we do not have sufficient evidence to reject the stated hypothesis. It can be concluded that, with the level of significance being 0,05, the data follows the specified distribution.

Table 4. Data for the performed nonparametric Kolmogorov-Smirnov test for the significance level 0,05.

Journal	D	D_{critical}
A	0,030	0,388
B	0,064	0,452
C	0,027	0,381

DISCUSSION

Data collected represent rather small set, sufficient for presenting introduced idea, yet clearly too small to obtain precise amounts of bibliometric indicators for their utilisation in other areas. Yet, collected data are of rather large variability within a given discipline since they include review journal and scientific journal, international and regional journal, with rather large and with rather small average number of citations (collected within the given time span) etc. All stated brought about manifestly rather different histograms of DCs, shown in Fig. 3. The chosen model of CPDF as given by (3), previously encountered prevalently within the context of measuring income, with its free parameters adapts rather well to collected data.

While coefficient k_1 is combination of a and b (for normalised CPDF) as well as total number of citations N for non-normalised CPDF, coefficients k_2 and k_3 have simpler interpretation

$$b = 1/k_2,\ a = k_3. \tag{9}$$

In that sense, it is seen that among the analysed journal's citation sets, that of the journal A correspond to the set that has rather suppressed influence of the articles with low number of citations (i.e. has the smallest b). Correspondingly, that journal's citation set analysis resulted in the most pronounced influence of the articles with large number of citations (i.e. has the smallest a). For different choice of bins in obtaining histograms, it is expected that values in Table 3 would change, but without the need for changing the underlying functional forms, i.e. (8) or (2).

In deriving (4) and (6), the restrictions $a > 2$ and $a > 3$, respectively, were encountered. Set of journals B and C falls within the available region of a, while set of journal A violates both of imposed restrictions. That has consequences in further extracting and prescribing bibliometric indicators. Since such indicators will be calculated on a given DC, they will naturally be finite, yet one must additionally analyse what is the range within which calculated estimates can be reliably used if their theoretical limits diverge for some set of journals, i.e. DCs. Alternatively, instead of (2) one can use its finite version (c.f. equation (4) in [16]).

CONCLUSIONS AND PERSPECTIVE

This article emphasises importance to introduce reliable set of bibliometric indicators which are intrinsic to the journal in the sense that they take explicitly as few as possible indicators not belonging to a given journals, such as are quantities determined using data for other journals as well. In that way, the emphasis is in building the complete set of coherent intrinsic bibliometric indicators for a journal. Following that, the foundation for such an approach is formulated, illustrated and analysed, based formally on the Pareto-like functional form for modelled citation probability distribution function.

For the group of obtained distributions of citations it was shown that prescribed form (3) makes possible their reliable representation in the two-parameter set spanned by power-law exponent a that was previously encountered in analyses of large-citation tail of distribution functions, and by the parameter b representing influence of the small-citation end of the distribution function. Currently, there is a large number of parameters to be check and modified if needed, thus the first step in prospective research is to apply the function (3) (or its modification given by equation (4) in [16]) onto sets of distributions of citations for larger number of scientific journals.

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RASPODJELA CITATA U JEDNOM GODIŠTU ČASOPISA

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SAŽETAK

Citiranja objavljenih znanstvenih radova redovito se pohranjuju i obrađuju, čime se dolazi do faktora utjecaja i velikog broja drugih bibliometrijskih indikatora. Citate prikupljene tijekom određenog razdoblja razmatramo kao karakterističnu statističku raspodjelu citata te diskutiramo o njenim svojstvima i postavljamo tvrdnje o tome koje statističke mjere pouzdano predstavljaju takve raspodjele. Time nastojimo doprinijeti preciznom određivanju opsega i razine primjenjivosti faktora utjecaja u slučaju kad je nadopunjen manjim brojem dodatnih indikatora, koji su svi određeni isključivo na temelju raspodjele citata.

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RELATIONS BETWEEN THE OBJECT UNDER CONSIDERATION, DIALECTICAL SYSTEM, SYSTEM AND MODEL OF IT AS A BASIS FOR THE REQUISITE HOLISM AND REALISM OF MODELING AND ITS RESULTS*

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ABSTRACT

Modelling is a crucial tool in research and development, but models simplify one's perception of systems as mental pictures of reality, maybe too much. Therefore one must be aware of the addressed relations, typology of models, and apply 'USOMID – 6 Thinking Hats' method of creative cooperation to attain requisite holism of approach and requisite wholeness of outcomes.

KEY WORDS

object, system, dialectical system, model, USOMID, 6 thinking hats

CLASSIFICATION

JEL: B52

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THE SELECTED PROBLEM AND VIEWPOINT OF WORKING ON IT HERE

Humans live in the given reality and deal with it by behavior (i.e. observation, perception, thinking, reflecting, conclusions making, decisions making, communication, and action). The given reality is too complex and complicated for the human behaviour to have a full, i.e. really **holistic** basis, i.e. ability to consider **totally all** attributes of reality without limitation to one's single selected viewpoint reflecting one's specialization/interest. Thus, actions have a poorly reliable basis, because there are (many) **oversights**. One strives at a better insight by making and using models, all way from pre-conceptions, e.g. stereotypes that a nation or profession has typical attributes covering everybody, to scientific **models**. Though: models are created by **simplification** of reality that is supposed to be represented and presented; one might **over-simplify**, thus creating a **poorly reliable** basis for practical behavior. This is the selected problem of this contribution. The selected viewpoint is the response offered by Mulej's Dialectical Systems Theory.

HOLISTIC THINKING VERSUS NARROW SPECIALIZATION (MODELING INCLUDED)

A good half a century ago, right after the end of the 'World War I & World Economic Crisis & World War II (1914-1945)' period, scientists such as L. von Bertalanffy, N. Wiener and their colleagues (from several disciplines and in interdisciplinary creative co-operation!) found a new response to the terrible consequences of one-sidedness visible in events of that period, again: holistic rather than fragmented thinking, decision-making and action. They established two sciences, growing into one over time, gradually and more or less, to support humankind in the effort of meeting this end – holism – as a promising alternative to the world-wide and local crises. These were (General) Systems Theory and Cybernetics. Rightfully they are called the **science of synthesis** [1]. System is the word entitled to represent the whole. One fights one-sidedness in order to survive. Bertalanffy wrote very clearly [2; Ch.VII] (exposure of crucial words by bolding is ours, authors):

> "Systems science ... is predominantly a development in engineering sciences in the broad sense, necessitated by the complexity of 'systems' in modern technology ... Systems theory, in this sense, is pre-eminently a mathematical field, offering partly novel and highly sophisticated techniques ... and essentially determined by the requirement to cope with a new sort of problem that has been appearing.
>
> What may be obscured in these developments – important as they are – is the fact that systems theory is a broad view which far transcends technological problems and demands, a **reorientation** that has become necessary in science in general and in the gamut of disciplines ... It ... heralds a new world view of considerable impact. The student in "systems science" receives a technical training which makes systems theory – **originally intended to overcome current over-specialization** into another of the hundreds of academic specialties. ..." [2; Ch.VII].
>
> "It presents a **novel »paradigm«** in scientific thinking ... the concept of system can be defined and developed in different ways as required by the objective of research, and as reflecting different aspects of the central notion." [2; Ch.XVII].
>
> ... "General systems theory, then, is scientific explorations of '**wholes' and 'wholeness'** which, not so long ago, were considered to be metaphysical notions transcending the boundaries of science." [2; Ch.XX] "... 'Systems' problems are problems of interrelations of a great number of 'variables' " [2; Ch.XX].

> "... models, conceptualizations and principles – as, for example, the concept of information, feedback, control, stability, circuit theory, etc. – by far transcend specialist boundaries, were of an **interdisciplinary** nature.." [2; Ch.XX].

This fact about the Systems Theory itself speaks of the "uncommon sense" Bertalanffy has been speaking for [3]: he was fighting the common current practices of **one-sidedness**, because they were dangerous and still are so increasingly. The great author on creativity, Eduard De Bono might say that Bertalanffy has been using the lateral thinking rather the vertical one [4]. Systems thinking was and is fighting the vertical thinking that only follows rules like e.g. in solving crosswords; instead, it requires creative thinking along an unknown path, i.e. **lateral thinking** to become a normal human habit along and combined with vertical thinking. Let us return to Bertalanffy:

> "What is to be defined and described as a **system** is **not** a question with an obvious or **trivial** answer. It will be readily agreed that a galaxy, a dog, a cell and an atom are real systems; that is, entities perceived in or inferred from observation, and existing independently of an observer. On the other hand, there are conceptual systems such as logic, mathematics (but e.g. also including music) which essentially are symbolic constructs; with abstracted systems (science) as a subclass of the latter, i.e. conceptual systems corresponding with reality. However, the distinction is by no means as sharp and clear as it would appear. ... The **distinction** between **'real' objects and systems** as given in **observation** and 'conceptual' constructs and systems cannot be drawn in any commonsense way." [2; Chs.XXI-XXII].

This supports our understanding of the term system [5]: **Systems are mental pictures of real or abstract entities as 'objects' of human thinking; they are concepts that 'represent' something existing from a selected perspective/viewpoint/aspect**. Thus:

> In **mathematical** formal terms, a system is a round-off entity consisting of elements and relations, which makes it **holistic**. In terms of **contents**, a system depends on its **authors' selected viewpoint**; hence, it does not comprise all attributes of the object under consideration, but only the **selected** part of them. This fact makes a system both **holistic** (formally, with no contents, or inside the selected viewpoint only) and **one-sided** (due to the unavoidable selection of a viewpoint). Therefore **models are also one-sided**.

See Table 1 for brief presentation of these relations:

- **objects** exist, and humans watch and manipulate them with different levels of holism. Total holism makes the object and the system as someone's mental picture of the object totally equal, but it reaches beyond human natural capacity,
- this is why humans are specialized and limited to single viewpoints causing humans' limitation of consideration of any object to a **one-viewpoint system**,
- by co-operation, normally by an inter-disciplinary one that includes several essential professions in a (creative) synergetic effort, a team can attain more holism – by a **dialectical system**,
- both a system and a dialectical system exist inside the human mental world, in human thinking and feeling; they can be expressed in **models** for other humans and other living beings to receive information about humans' thinking and feeling.

Why is **requisite holism** important? There are scientists attempting to say that their discipline offers the **only** unique and unifying basis for dealing with systems. They do not speak of worldview, like Bertalanffy does, but of professional/scientific disciplines. Can they be right? Yes, in their own **perspective/viewpoint** they can. Can they be sufficient for holism? They can be so rarely, exceptionally. **Nobody can be really, i.e. totally, holistic**: teams can perhaps

Table 1. Relation between reality and holism/realism of human consideration of it.

Level of humans' realism of consideration of the selected topic	Level of humans' simplification of consideration of existing objects	Viewpoints of consideration taken in account by humans	Components taken in account in consideration by humans	Relations taken in account in consideration by humans
Existing object to be dealt with	None	All existing	All existing	All existing
Dialectical system	Small – requisite	All essential	All essential	All essential
One-viewpoint system	Big due to specialization	Single – selected by specialization	Selected inside the boundaries set by the selected viewpoint	
Model of/about the one-viewpoint system	Big due to specialization and modeling aimed at clear presentation	Single – selected by specialization and simplified to be clear	Selected inside the boundaries set by the selected viewpoint and shown in a simplified – modeled way	

be requisitely holistic with interdisciplinary creative co-operation.

Bertalanffy – as you see – stresses the **whole, wholeness, and interdependencies**, rather than parts and independencies or dependencies. This necessary worldview **fights reductionism**, which has been very **helpful** over the recent centuries, but causing **oversights** as well, with consequences causing World Wars, climate change, and economic and social crises. Table 1 states that **models are permanently in danger of reductionism** leading to **over-simplification** with dangerous consequences:

- **viewpoints** from which an object is looked at, **select** the attributes to be found crucial among many. They do not erase other attributes, but **forget** about them, find them (fictitiously and wrongly, sometimes) unimportant or even non-existent, at least "belonging to another discipline" rather than to the same nature, biosphere, organization (in Bertalanffy's terms). Holism becomes rather **fictitious**, if a **single viewpoint** is selected, in terms of the requirement that e.g. the entire biosphere should be considered,
- **interdependence of viewpoints** is in this way forgotten about, so are synergies that result/emerge (also) from the **overseen** impacts over each other resulting from interactions based on interdependencies of the fictitiously separated attributes of reality,
- **complexity** of the real life tends to be forgotten about, too. **Generality** is emphasized; this seems to be a version of understanding of the so-called trans-disciplinary approach by several later authors. But generality is unavoidably **limited** to the general part / subsystem of the entire system of attributes, thus leaving aside the group-specific and individual subsystems of attributes (Table 2). This is a serious **simplification**, based on admitting (realistically!) the definition that science simplifies and is based on reductionism.

Table 2. Interdependence of the general, group specific and individual part of attributes

<table>
<tr><td colspan="6">(1)
The general part or subsystem of interdependent attributes, common to all considered objects</td></tr>
<tr><td colspan="2">(2) Group specific subsystem (1)</td><td colspan="2">(2) Group specific subsystem (n –1)</td><td colspan="2">(2) Group specific subsystem (n)</td></tr>
<tr><td>(3) Individual subsystem (1)</td><td>(3) Individual subsystem (2)</td><td>(3) Individual subsystem (3)</td><td>(3) Individual subsystem (m –1)</td><td>(3) Individual subsystem (m –1)</td><td>(3) Individual subsystem (m)</td></tr>
</table>

Bertalanffy's concept of organization involves interdependence and interaction of **components** of the same entity and different from each other. It **should** imply the same **interdependence** concerning the **viewpoints** (which have evolved, among other effects, to many specialized scientific disciplines and professions). Consideration of the real complexity can hardly be done without a lot of (the **requisite**) **interdisciplinary** work, which enables specialists to be what they are **and** to attain the requisite level of holism, too. Which level is the requisite one, depends on the **decisive persons**; they unavoidably take the risk of success versus failure.

Our concept of 'the law of requisite holism' may lead the way out from the blind alley [6].

REQUISITE HOLISM IN BRIEF

Systems thinking as the practice of **holistic** (Table 3) rather than **one-sided** behavior had been many millennia old practice of the **successful** humans, before systems theory as its theoretical generalization was created. Like most other human capabilities, the practice of systemic behavior was **informal**, first, and then received the form of theory for transfer of good practice through teaching to be easier to make.

Inside an authors' (usually tacitly!) selected viewpoint, one tends to consider the object dealt with (**via models**) on the basis of **limitation to one part of the really existing attributes** only. When specialists of any profession use the word system to call something a system inside their own **selected viewpoint – it makes a system fictitiously holistic**. It does not include all existing attributes that could be seen from all viewpoints and all their synergies. See Table 3.

Thus, summary of the law of requisite holism (Tables 4a and 4b) reads: one needs always to try and do, what many, but not all, have the habit to do in their behaviour – **avoid the exaggeration** of both types:

1. the **fictitious** holism, which observers cause by limiting themselves to **one single viewpoint** in consideration of complex features and processes,
2. the **total** holism, which observers cause by trying to include **totally all attributes** with no limitation to any selection of a system of viewpoints in consideration of complex features and processes.

Instead, the **middle ground** between both exaggerations should be covered, which can be achieved via "**dialectical system**", made by the author/s as a system (i.e. network) as an entity or **network of all essential and only essential viewpoints**.

For the requisite holism to be achieved three preconditions, at least, matter:

1. both **specialists and generalists** are needed, working in **teams** that feel **ethics of interdependence** and co-operate,
2. they include professionals from all and only essential professions/disciplines,
3. their **values** are expressed in their ethics of interdependence and practiced in a creative teamwork, task force, session(s) based on an **equal-footed cooperation** rather than top-down one-way commanding.

Requisitely holistic **behavior, e.g. concerning modeling,** cannot include the **global/general** attributes only, because they make **a part** of the really existing attributes only, although they matter very much and tend to be subject to oversight by specialists. Neither can requisitely holistic thinking include the **parts' attributes** only, although they matter very much and tend to be focused by specialists of single disciplines and professions. **Oversight** of relations,

Table 3. Dialectical system of basic attributes of requisite holism/realism of human behaviour.

Interdependent actual general groups of real features' attributes	**Interdependent attributes of the requisitely holistic consideration of real features**	**Considered attributes of thinking about real features**	**Attributes of participants of consideration at stake**	**Surfacing of all these attributes in a given case**
Complexity	Systemic	Consideration of the **whole's attributes** that no part of it has alone	Interdisciplinary team	The final shared model resulting from research as a dialectical system of partial models
Complicated-ness	Systematic	Consideration of the **single parts' attributes** that the whole does not have	One-discipline team/group or individual	Partial models resulting from one-viewpoint based investigation
Relations – basis for complexity	Dialectical	Consideration of **interdependences of parts** and **viewpoints** that make parts unite into the new whole – emerging (in process) into synergy (in its outcome)	Ethics and practice of interdependence – path from one-discipline approach to the interdisciplinary teamwork	Shared attributes and complementary different attributes, which interact to make new synergetic attributes, i.e. **from systematic to systemic** ones
Essence - basis for requisite realism and holism of consideration	**All** essential	**Consideration** that selection of the **systems of viewpoints** must consider reality in line with the law of requisite holism for results of consideration to be applicable – by reduced reductionism	Capability of researchers to **deviate from reality as little as possible** in order to understand reality, including systemic, systematic and dialectical attributes of it	Findings applicable in practice, due to/ although resulting from theoretical considerations

especially **interdependences** causing influences of parts over each other, may not be forgotten about in (requisitely) holistic thinking/behavior; especially specialists, who have not developed the habit to **consider specialists different from themselves**, tend to make crucial oversights in this respect. This experience makes them **not realistic enough**. See Tables 1-4.

Take a look at experience around you and discover (again): **Success** has always resulted from absence of oversights with crucial impact. And **failure** has always resulted from crucial oversights, be it in business, scientific experiments, education, medical care, environmental care, invention-to-innovation-to-diffusion processes, etc., or wars, all way to World Wars of the 20th century, or the world-wide economic crises.

Any level of holism depends on information and provides information.

Table 4a. The selected level of holism and realism of consideration of the selected topic between the fictitious, requisite, and total holism and realism.

⟵		⟶
Fictitious holism/realism (inside a single viewpoint)	Requisite holism/realism (a dialectical system of all essential viewpoints)	Total = real holism/realism (a system of all viewpoints)

Table 4b. Law of requisite holism (Table 4a) in some details.

Approach to dealing with an object as a topic of behaviour	One-sidedness by a single viewpoint	Requisite holism by co-operation of all essential professionals and only them	Total holism by consideration of totally all viewpoints, insights from all of them and synergies of all of them
Type of approach	(Too) Simple	Requisitely simple	Very entangled
Type of system as a mental picture of the object dealt with	Single-viewpoint based system	Dialectical system	Total system
Attributes of object included in system	(Very) Few	All essential	All
Result of approach	Fictitious holism (in most cases)	Requisite holism (good in most cases)	Total holism (ideal)
Focus made possible	(Too) Narrow focus (in most cases)	Requisitely holistic focus	Lack of focus
Number of professions	One single	Requisitely many	Literally all
Type of work	Individual	Mixed team of requisite and different experts	All humankind in co-operation/synergy
Consequences	Complex due to crucial oversights, dangerous	No problem due to no crucial oversights	Simple due to no oversights
Availability	(Too) Frequent in real life	Possible in real life	Not possible in real life

THE ROLE OF INFORMATION IN SYSTEMIC BEHAVIOUR (INCLUDING MODELING)

In the daily life, the word information tends to be used in many different **contexts and contents** without a clear definition. We see the same reality concerning the words system and model. This is far from being the only attribute they may have in common.

Information must, first of all, be **delimited** from the notions of data and message:

- **data** exists when signs are **ordered** into a **syntactic** entity, such as a word, an organ of a body, a leaf of a tree, a picture, piece of music, etc,
- **message** shows up when data is ascribed a **meaning**, thus receiving its **semantic** dimension,
- **information** shows up when a message makes an **impact** by coming to be understood, accepted and causing an action. This is called the **pragmatic** dimension of information.

From such a definition, one can see that it is problematic, if the making and application of computer is called informatics, even less so to let it monopolies the notion. The same would apply to ordering data in book keeping, in libraries etc. One can find something, which all of them have in **common**:

- information is an influential relation,
- there is no system, hence, without information,
- there is no entity, hence, without information,
- there is no order, hence, without information,
- information is a natural phenomenon, which is not limited to humans and their relations and organizations,
- information is, potentially, but not unavoidably, supportive of holism,
- information is an expression of interdependence in general,
- information can be a physical (e.g. in a stone, in a machine), biological (in a living cell, organ, organism), and/or human (in a group, organization, society, humankind) relation,
- information can be linked with evolution (e.g. of a cell of an embryo, developing into lever, of another cell of the same embryo becoming the eye, etc.) and with development (of e.g. a society from a nomadic one to a postindustrial one over many steps in the process),
- information can be a tool against entropy, a tool of negentropy, because (and if) it induces order, evolution, development, holism, interdependence, relations etc., keeping or transforming an identity of an entity under impact of/by information,
- information can (also, but not only!) be a product of consciousness in terms of knowledge, data interpretation, learning and other experiencing, indeterminism and determinism,
- information can be insufficient and/or exceed the information requirement/needs,
- information can be subject to individual subjective understanding of given data and messages. It depends on the **selected viewpoints**,
- **information is also the essence of modeling**.

The viewpoints in which the **traditional** sciences were specializing did not focus on information – but rather on **energy** and **matter** and their flows. The issue, e.g., was how much energy, food, etc. an embryo may need to become able to be born and survive. The issue from the viewpoint of cybernetics and systems theory results from a different viewpoint: **why** will an embryo become a dog or an elephant rather than a tiger? The answer is: **information**.

In dealing with e.g. **modeling**, humankind of today may still have to come across a similar change of questions put from different viewpoints. As long as only the traditional question was asked, only (!) the basic process (the one of production of products and/or services, its supplies and their sales) was found worth consideration. Cybernetics found (1) **information** and (2) **management** processes to be (interdependent and interactive) preconditions of the (3) **basic** process (and impacted by it, too, of course). Hence, consequence in the form of e.g. a model, do not come from the basic processes only, even less from them alone or in isolation from anything else, but they also/rather come from the information and management processes, involving both the humans and the other nature.

These two processes govern the basic process – in a way of the **choice made by the owners of the management process**, e.g. the **model authors**. Its owners, of course, must consider the basic process very carefully in order to place the right instructions into it, but this is their choice anyway. This set of findings lets us see the growing complexity of managing an organization (of any size) and of its consequences. Let us, hence, take a look at possibilities to **simplify** management processes, which may let us have more time to deal with the crucial open issues of the dialectical system of all three processes.

INFORMATION NEEDS – FRAMEWORK TO REQUISITE HOLISM, INCLUDING MODELING

The very practical issue is open to decision and opinion: what is **really requisite**? Which **information** provides the **requisite holism**?

The common denominator of all the (very many) possible cases and examples as well as of all different contents of systems, all of which in one way or another meet criteria of the law of requisite holism, are the **information needs/requirements**. The latter are addressed by the **content** of the system(s) as mental/emotional pictures of reality (both mental and/or physical), which are tackled from the (dialectical systems of) viewpoints that are selected by those, who introduce systems to (re)present the selected attributes of the selected parts of reality. Once authors match information needs with **all crucial information and no overburdening with unnecessary data**, the law of requisite holism is met. **Simplification** is around, but may **not** become **over-simplification** all the time anyway for human abilities to be either good enough rather than overburdened or sufficiently informed rather than be misinformed or lack crucial information.

SOME TOOLS USABLE FOR SIMPLIFICATION IN COMPLEX PROCESSES AND SITUATIONS, INCLUDING MODELING

First of all, we should never forget the sentence by Albert Einstein: Let us simplify as much as we can, but no more.

What can be simplified? Reality is as it is, it cannot be simplified; this would reach beyond the human scope. The **human image of reality** can be simplified; this generates dialectical systems, systems, and models. They are used as the **bases of the human action, not insight only**. If the basis is over-simplified, the **action** will tend to have a too **unrealistic** background. Hence, this simplification may be helpful and dangerous, both at the same time, even. **Object** exists and has all attributes it has by its nature (Table 1). **Dialectical system** allows for a requisitely holistic presentation of the object. **System** allows for a one-sided presentation of the object from a single selected viewpoint. **Model** allows for a rather understandable **presentation of the system, not of the object**. In human interaction models are used; hence the basis of human interaction is **very simplified**, compared to the reality that humans try to comprehend and master; if there is not enough of the **creative interdisciplinary co-operation**, success is rarely possible.

If simplification is **unavoidable**, **reduction** from the object level to the model level is so, too. The reductionism, which Bertalanffy was fighting rightly under the label of over-simplification (and we are as well), is back, for natural reasons. The issue, which shows up, reads:

> in which ways can one simplify / reduce the total amount of attributes to the requisite one, in order **not to exaggerate**, but to rather comply with the law of the **requisite holism**?

Modeling can be based on several different **principles** and apply several related methods/tools:

- **hierarchy**, if it is not limited to a commanding hierarchy of subordination with no creative co-operation between bosses and their co/workers, is a useful tool of simplification of management. It allows for parts **different** from each other in the same process to be considered as **relatively independent** entities on which specialists can work. The interdependencies and interactions among members of such a sub-entity (e.g. finance department in an organization, etc.) are more frequent and important than the ones among different sub-entities. Acknowledging the differences among parts of the process is the basis for **division/distribution** of labor and even more for **co-ordination** of work processes into one entity. Specialization does not make e.g. departments special only, but also **interdependent**: they are **complementary** rather than self-sufficient. The same applies to organs of a body, parts of nature, products, etc. **Models** may reflect this hierarchy,

- **recursion** is a different way of simplification, although quite closely linked with hierarchy in a number of cases. The point of this simplification of management is not in the differences, but rather in the **similarities**, which show up again and again. Specialization to a specific profession is such a case: it is easier to become a good boss inside the same specialized department and industry than in a different one. Repetition of the same features (i.e., recursion) allows for routine and requires creativity to be employed to the remaining, non-repetitive, non-reoccurring, non-recursive features. **Standardization** is enabled e.g., if attributes of products, processes etc. are built into automatic machines, in decision making (at least on a framework basis), etc. Today, recursion is often called **fractal** structure/attribute,
- **'black-box'** can also help simplify the management. Car drivers need not to know the **functioning**; it is enough, if they know only the **behaviour** of their cars, so do TV-viewers, users of kitchen appliances, persons cooking their own tea, coffee etc., who are no profound professionals. Frequently it is not necessary to know the inside, the "hidden processes", to manage, these cases say. Sometimes these processes are impossible to know but on the level of behaviour, i.e. on a (**more superficial**) black-box level, such as processes in a brain. In business, democratic bosses may have much less work to do, because they are capable of trusting, hence of considering their subordinates as black-boxes and concentrate on the remaining variety,
- **feed-back** may help such bosses to control the process well enough. But feed-back is not only a type of input-output relation between human beings and/or other part of nature. It is a basic attribute of artefacts based on first order cybernetics. All automata are self-regulating due to feed-back, but the level of temperature of a water-heater etc. is predetermined by feed-forward information installed. This is called regulation rather than self-regulation, for this reason. Nature applies self-regulation as well,
- in nature, there is a lot of **self-regulation**, if humans do not intervene too much. Harmony arises from **interdependence and interaction** of different parts making the same eco-system; it is a process of a dynamic stability. A trusting boss with trustworthy co-workers may use a black-box approach and self-regulation much more than other bosses. This can be called autonomy,
- **autonomy** can be found in nature and in organization. It can be called a way of **using the black-box approach, hierarchy and recursion/fractals combined**, as well as **regulation and self-regulation combined**, or even **all of them combined,**
- **standardization** is another way of simplification of management. Standardized parts of machines are **easier** to replace. Standardized rules of conduct are easier to follow. Programoteque is such a case on a framework level. Standardization of decision making is also possible, but it is easier to attain in terms of methods than in terms of contents [7].

Models can be classified from other viewpoints, too.

TYPOLOGY OF MODELS

There are no models about objects, but models **about system's** state, behaviour or functioning/working and models **for** it. The first ones are **descriptive**, the latter ones are **prescriptive**. Both types are influential as the **basis** for analysis and for synthesis, decision, and action. Therefore they **may not be oversimplified** pictures of systems, which in their turn may not be oversimplified pictures of objects dealt with.

- Models must therefore be **usable and useful**; this attribute depends on the **analogy and similarity to the system**, which can be made understandable with a legend (like in the practice of geographic maps, etc.). The level of simplification must be clear and match the purpose. Otherwise **disinformation** results and requisite holism of approach and wholeness of outcomes cannot be attained. Consequences may be fatal.
- As a type of **similarity**, *isomorphism* is more precise than *homomorphism*. The latter is not requisitely reliable in e.g. engineering blueprints as models for building a house or making a car, bridge or another technical artifact. But isomorphism is hard, if not impossible, to attain in social sciences.
- Models bring **mathematics and verbal expression** closer. In mathematics, a model means coming closer to reality by introduction of concrete data in formulas. In other sciences a model means reduction of concrete data under consideration.
- **Simulation** is another word meaning **model building** aimed at discovering of attributes of the system, which in its turn is aimed at **mastering** the object. This means that models provide feed-forward information as the basis for action. Hence, models are also tools of influence.
- Thus, *information* is a model that serves *management*, *regulation* as well as *self-regulation*. It can be a **hypothesis, a decision, or supportive feed-forward information**.
- Due to the influential role of models as *partial* sources of information, which may meet requisite holism or miss it, one must pay attention to **dangers of exaggeration** in making and using models. **Too much or too little mathematics** might cause a lack of requisite holism (market situations and trends are less well expressed with mathematics than attributes of technical artefacts, such as engines, hydro-power stations, airplanes, houses, etc.). Too many or too few **details** are another case of danger. Too much or too little attention to the **limitations** of the model may make it unrealistic. So, conclusions from models can be over-drawn.
- From the viewpoint of the **way of expression** models can be verbal (such as books), physical (such as prototypes of engines), graphic (such as pictures, diagrams, maps), or formal (such as quantitative models, e.g. formulas).
- From the viewpoint of **analogy** of the model **with the system** to be expressed, models can demonstrate *functioning/working* (such as electric network), *structure* (such as models of molecules, hierarchies in organizations), or *behaviour* (such as models of inputs and output in black boxes, mathematical equations).
- From the viewpoint of **purpose** model can serve *demonstration* (such as teaching or marketing materials), *experiments* (such as in laboratory research, field experiments in agriculture, practicing in sports and teathar), or *decision making* (such a constitutions and other legislation, decision trees). All three purposes can also be *combined*, of course, e.g. per phases of the same process.
- From the viewpoint of **research** models run through several **phases**: (1) modelling of **requirement** the systems under research should meet as attributes of objects in real life; (2) modelling of **hypotheses** about attributes of such systems to be met; (3) development and integration of such **systems** in tangible and intangible forms; and (4) evaluation of the system in terms of **suitability** or need to return to phases (1)-(3). Inside every phase one needs (a) **development** of models in several steps, (b) **collection** of research information, and (c) **synthesis** of information inside models.

For a **dialectical system of models** most or even all types may be used in **synergy**. This can be supported by some statistical methods, which apply to R&D process modeling better than some others.

QUANTIFIED APPROACHES TO MODELING

Social events and processes are difficult to study scientifically, because they are complex, multidimensional, and linked as causes and consequences. Whatever is the event or process under investigation (e.g. quality of research or education), investigation depends on a set or even a (dialectical) system of **influences**, some of which are **unknown**. Choice of simple research models that do not **respect** the **complexity** of the events or processes under investigation is hence not justified; a **complex methodological approach** is necessary for which the following four basic attributes are typical:

1. a precise, doubtless **definition of content** of the selected events or processes under investigation (e.g. quality of research or education),
2. a multi-dimensional **definition of factors with influence** on events or processes under investigation, both the external (the closer and/or broader social environment) and the internal (subjects under investigation); one must control the working of the tackled factors (under the experimental conditions) and discover differences depending on these factors as the independent variables and showing up in the dependent variables (in the non-experimental investigations),
3. a multi-dimensional definition of **indicators** of the events or processes under investigation (e.g. quality of research or education); indicators help us to investigate the events or processes under investigation in line with their complexity rather broadly (e.g. along with efficiency we investigate the personality changes in the investigated subjects),
4. a **methodological broadening** of investigation of the events or processes under investigation; we apply the requisite holism to add the **quantitative** (see e.g. [8-12]) and **qualitative** methodologies (see e.g. [13-16]) from the viewpoint of the procedures of data collection, data processing and results interpretation, see Table 5.

Table 5 enables us to see that one uses in investigation of the social events and processes the traditional, i.e. **structured** instruments (e.g. knowledge tests, assessment scales, survey questionnaires), and the free, i.e. non-coding scheme forms (e.g. non-coding protocols of observation or interviewing). The data collected with various instruments are processed **quantitatively** (by statistics and mathematics) with uni- and multi-variat statistical methods, and **qualitatively** (structuring of the text material, uncovering of the meaning of the given symbols, explanation of the given text). In **interpretation** of results one avoids the paradigmatic exclusivism by using the requisite holism in **linking** the causal and interpretative paradigms.

If one uses methodological complexity in investigation of the social events and processes,

one can come close to their complexity as much as to minimize the errors that are linked to research results and attain a high reliability of their application.

The next issue reads: how do we cooperate best?

‘USOMID’ AND ‘SIX THINKING HATS’ IN SYNERGY – A FRAMEWORK PROCESS OF MODELING

The point of this new combination emerged from the insight that the Six Thinking Hats (6TH) method mostly covers the **emotional** part of the human personality, while the USOMID-SREDIM procedure covers the **rational** one. About the essence of the ‘hats’ see Table 6. The combination means that in every step in Table 7 the appropriate hats are applied.

The USOMID model of creative co-operation enables smooth work covering **several professional views** and **organized procedures**, thus leading toward the law of requisite

Table 5. The basic procedures of data collection and processing and results interpretation in the quantitative and qualitative investigation.

Investigation phase	Quantitative methodology	Qualitative methodology
Procedures and instruments of data collection	• **Testing** of knowledge – knowledge test • **Assessment** – assessment scale • **Survey** – survey questionnaire (mostly closed questions) • Structured **interview** – coding protocol of interview • Structured **observation** – coding protocol of observation	• Unstructured **observation** – non-coding protocol of observation • Unstructured **interview** – non-coding protocol of interview • **Analysis of documents**
Procedures of data processing	1. Statistical methods for the analysis of nominal and ordinal variables: • frequency distributions, • chi-square test hypothesis about independence and hypothesis of equal probability, • measures of contingency 2. Statistical methods for the analysis of numerical variables: • basic descriptive statistics (measures of central location, variation measures, distribution measures), • statistical methods for the analysis of differences with parametric tests (t-test, analysis of variance) and non-parametric tests (Mann--Whitney, Wilcoxon, Friedman, Kruskal-Wallis, test), • statistical methods for the analysis of relationships (bivariate, multiple correlation, regression, factor analysis).	• **Content analysis** • **Semiotic analysis** • **Hermeneutics**
Interpretation of results	**Causal paradigm** – paradigm of the causal explanation	**Interpretative paradigm** – paradigm of interpretation in the form of comprehension of intentions and behavior

holism. This enables a lot of creativity and a lot of innovation, not invention only. A problem that has remained unsolved over all 30 years is (1) relative **waste of time**, (2) **fight/arguing** and bad feelings. The organizational jobs are supposed to solve this problem, but it does not always work without trouble. This is where the 6TH applies.

The 6TH enters the scene as **the third dimension** along with SREDIM and the four USOMID steps in every one of them. The 6TH namely enables all circle members to not argue, but to **think from the same viewpoint**, and to do so in terms of the exposed part of values rather than of knowledge. Thus, our tendency toward the requisite holism is not blocked. The six

Table 6. Essence of each of the six thinking hats.

Thinking hat	Essence
white	neutral, objective, facts without interpretation, like a computer
red	feelings, emotions, intuition, irrationality, unproved feelings, no justification
black	watching out, caution, pessimism, search for danger, doubt, critique; it all works well against mistakes and weak points of proposals
yellow	optimism, search for advantages of proposals, search for implementation ways, sensitivity for benefit of the idea, constructive approach
green	energy, novelty, creation, innovation, in order to be able to overcome all obstacles
blue	organization, mastering, control over procedure, thinking about thinking

Table 7. Synergy of USOMID/SREDIM and 6TH methodologies in procedure of USOMID.

SREDIM Phases USOMID Steps Inside SREDIM Phases	1. Select problem / opportunity to work on in an USOMID circle	2. Record data about the selected topic (no 'Why')	3. Evaluate recorded data on the topic ('Why is central')	4. Determine and develop the chosen solution/s to the topic	5. Implement chosen solution to the topic in reality	6. Maintain implemented solution for a requisitely long term
1. Individual brain-writing by all in the organizational unit / circle	All 6 hats	White hat	All 6 hats, red, black, yellow, green first of all	All 6 hats, red, black, yellow, green first of all	All 6 hats in preparation of implementation	All 6 hats in preparation of maintenance
2. Circulation of notes for additional brain-writing by all	All 6 hats	White hat	All 6 hats, red, black, yellow, green first of all	All 6 hats, red, black, yellow, green first of all	All 6 hats in preparation of implementation	All 6 hats in preparation of maintenance
3. Brain-storming for synergy of ideas / suggestions	All 6 hats	White hat	All 6 hats, red, black, yellow, green first of all	All 6 hats, red, black, yellow, green first of all	All 6 hats in preparation of implementation	All 6 hats in preparation of maintenance
4. Shared conclusions of the circle	All 6 hats	White hat	All 6 hats, red, black, yellow, green first of all	All 6 hats, red, black, yellow, green first of all	All 6 hats in preparation of implementation	All 6 hats in preparation of maintenance

thinking hats are namely neither used by one person each nor all at the same time, but **all** circle members use **the same hat**, and later on another one, **at the same time**. According to De Bono, this replaces the old western habit that the discussion participants close themselves in their respective viewpoints (like e.g. solicitors or politicians or armies or angry children) and fight for the upper hand rather than for **mutual completion** and **shared and beneficial new solution** [17]. In other words, the 6TH supports well the creative cooperation, but from different viewpoints than the above-summarized attributes of USOMID do: 6TH points more to the **values-and-emotion** part of the human personality than to the **professional** part. Both of them are **interdependent** anyway.

In 6TH **all** circle members think in the frame of the **same hat at the same time**. De Bono calls this manner "parallel thinking" that provides for the same orientation, i.e. looking for **ideas and proofs**. It lets **nobody fight** each other. Hats enter the scene as **phases**, ruled by emotional accents of thinking, thus providing the power of focusing, time saving, neutrality and objectivity, removal of "ego": **one viewpoint in one moment** (by phases – hats). For the essence of hats see Table 6.

SOME CONCLUSIONS

Modeling provides crucial bases for action**,** but often an over-simplified one, which is dangerous. Creative interdisciplinary cooperation with application of the 'USOMID-cum-6TH' method of cooperation and combination of quantitative and qualitative models in a requisitely holistic way can help model authors/users to overcome over-simplification. Understanding and use of (Dialectical) Systems Theory has helped in thousands of cases over close to forty years of its application and evolution.

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RELACIJE IZMEĐU RAZMATRANOG OBJEKTA; DIJALEKTIČKOG SUSTAVA, SUSTAVA I NJEGOVOG MODELA, KAO OSNOVA NUŽNOG HOLIZMA I REALIZMA MODELIRANJA I NJEGOVIH REZULTATA

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SAŽETAK

Modeliranje je krucijalno sredstvo istraživanja i razvoja. Međutim, modeli možda i previše pojednostavljuju percepciju sustava kao mentalnih slika stvarnosti. Zbog toga treba biti svjestan relacija i tipologije modela te primijeniti metodu ‘USOMID – šest misaonih šešira’ za kreativnu kooperaciju kako bi se postigao nužni holizam pristupa i nužna cjelovitost ishoda.

KLJUČNE RIJEČI

objekt, sustav, dijalektički sustav, model, USOMID, šest misaonih šešira

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SOME CHARACTERISTICS THAT INFLUENCE MOTIVATION FOR LEARNING IN ORGANISATIONS

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ABSTRACT

The aim of the research was to discover the motives for lifelong learning, for studying part time, possibilities for personal and career development and the level of learning support within organisations, where randomly selected students are already employed. We were interested in motivation for learning on behalf of the individual and its potential links with the organisation.

In this research we tried to establish which factors have the most influence on individual's personal development and career planning; whether organisation promotes career development; whether organisations promote learning and which support mechanisms are available. Employees' motive for learning, education and training – even after they become employed – is linked with the possibility to receive a promotion. The research was conducted among large group of part time students, already holding a job. Over 150 respondents filled out questionnaire and results were statistically treated. The results of this research show, similar to other recent findings, that knowledge and work experience have the most influence on the possibility for development and for a career. Clear personal and organisational objectives are also crucial. And the importance of knowledge sharing with the help of peers, coaches or mentors is significant.

KEY WORDS

individual characteristics, environmental characteristics, career development, learning

CLASSIFICATION

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INTRODUCTION

The problem and the fundamental question studied in this paper is, what is the reason that individuals invest energy, time and resources in continuous learning, even after they have been employed? After they completed their professional qualification, managed to get through the selection process when seeking employment and after acquiring a stable contract? What is their motivation, what are their expectations from training, education and their inclusion in the lifelong learning process?

Numerous researches show that at the level of society, as well as the level of the enterprises and the level of individuals that increasing attention is devoted to the promotion of learning and personal development. "Knowledge-workers are the greatest managerial challenge of the 21st century. They must be considered as a valuable resource and not as a cost – they represent a competitive advantage of expert organisations" [1].

What makes people studa and learn, even after their graduation, and after receiving theri job, after getting employed? Which things today ensure employability for the individual and growth, development and profit for the enterprise? In the knowledge society a formal education, which allows people to make a career, to get a specific job, complete certain tasks and comply with specific occupational standards, is no longer enough.

Not only in Europe, we can find similar situation for students looking for a job and a career also in other developed countries all over the world. McKeon and Lindorff performed a study on "job search process and stated that a key change in the graduate labour market is a development of mass higher education system which provides an increasingly larger supply of graduates, while the same time the traditional routes into employment decrease, as organisation downsize and delayer" [2; p.311]. How to find the first right job? There are several possibilities. It could be an easy, but time consuming way, suggested also by one of very experienced managers: "It is about enduring the same gummy, time-consuming, up and down, iterative process that all working people go through. You take one job, discover what you like and don't like about it and what you are good and bad at, and then, in time, change jobs to get something closer to the right fit. And you do that until one day you realize… I'm finally in the right job. I like what I am doing, and I'm making the trade offs I'm willing to make".[3; p.256]. While considering new job, a person must consider people, opportunitiy, options, ownership and work content. There are some interesting recent research about situations that are important for employees after getting a job. There are some interesting findings in the research, completed and published by scientists, who conducted a study, about the span of career guidance and career development support to support labour force development in the 25 EU member states, and identifying best practices in these states [4]. The results indicate that there is a great need for the support of career development for people, who are already employed or have just completed their education. The study establishes that there are no clear processes for career development in several enterprises and where there are, such processes are generally focused on key target groups; i.e. workers with completed higher education or managers.

Shoffner Creager [5] published a review of the 2010 career counselling and development research, that presents "the breadth and depth of topics published in the field ranging from children's conceptions of career to employee burnout. Her review covers topics in the career literature on professional issues, career theory and concepts, career development, the world of work, career assessment and technology, and career interventions. The author summarizes the 2010 research to provide information and direction to career practitioners, theorists, and researchers".

Even wider review was made by important authors in the field of personal development [6]. It was about anniversary of *The Career Development Quarterly.* They recount its history of publishing foundational articles in vocational guidance practice and career development theory, commitment to improving counselling practice, leadership in public policy and social justice issues, and expansion to international audiences” [6].

The purpose of the paper was to establish which factors have the most influence on individual’s personal development and career promotion in organisation. Do organisations promote learning and which support mechanisms are available.

In this paper I discuss promotion of learning in todays society, especially regarding to connection between environmental characteristics (organisational variables) and individual characteristics of person, already having a job and being inetested in perosnal development. A research between part time students was conducted and some inetsting results are revealed. At the end of the paper, there is an interpretation of the results especialy regarding some recent international studies.Recomendation for further reserach and especially soem managerial implications are added.

PROMOTION OF LEARNING

Similar to Drucker’s observations on increasing attention to th epromotion of learning, mentioned above, conclusions have been also reached by Peter Senge: “Today, a competitive advantage of an enterprise is its ability to learn and hold on to that path. People who want to learn must master five disciplines: they must know how to abandon their old thought patterns; understand how their organisation really functions – systematic thinking; discuss common vision and then cooperate with others in order to achieve common goals – team learning.” [7; p.146]. “According to the Drucker’s vision of the new organisation the business of the future will be based on knowledge-based and personal initiative. Each individual will participate in the recognition and solving of problems, which shall allow for constant experimenting and improvements of the organisation’s operation, while managers of the learning organisation will have to ensure that learning is carried out throughout the entire organisation.” [8; p.52].

ENVIRONMENTAL CHARACTERISTICS

I shall briefly address the organisational level only (and disregard the systematic efforts at the level of a company as a whole) and establish that companies do this both, systematically and organised (and introduce e.g. career development systems, possibilities of different models of vertical and horizontal promotion, introduce decentralisation and empowerment, transfer of knowledge and competences in centres of excellence and knowledge or declare themselves as learning organisation) as well as in a more informal manner. Knowledge is being constantly upgraded; benchmarking is expressive; management with objectives and management with vision and listening, as well as democratic communication are prevailing; innovative and encouraging organisational climate is typical; team-learning is prevailing; the company carries out bench-learning with related enterprises. Knowledge is highly appreciated and is not only one of the fundamental rights and duties of all employees, but it is one of the most important values of the organisation [9; pp.354-359].

Why do employees require constant care, training, education and be provided with opportunities for promotion and a career? The latter is due to the fact that a modern organisation can not develop without continuous versatile learning and the application of explicit and implicit knowledge. In the modern organisation training, promotion and evaluation of employees prevail in the light of development of labour force and/or employees.

All of the above listed elements are components of an individual's career. It is very important that employees [10] possess required sills and knowledge; that they are kind, respectful and polite, trustworthy and do their jobs reliably, and respond quickly; they must be communicative and try to understand the client, since clients are very important for the company. The client shapes its key opinion on the organisation through personal contacts with employees. The fact, that acquiring a new customer is approximately ten times more expensive than keeping an old customer, is well known. This especially applies to the services sector, i.e. catering and tourism.

As already mentioned, when addressing training, organisations can choose between a formal and informal approach, training can be provided to selected workers only, it can be provided in the workplace or before/after work; it can be accredited or non-accredited; it can occur in different periods and it can be provided by internal or external providers. The ability and willingness of the company to provide for training depends on the available resources – time, money and human resources. An unstable base of employees, who work upon need or demand, also represents a serious barrier for systematic training. There is a higher possibility that training is provided for jobs, where there is a clearly defined base of required skills and knowledge, i.e. catering and cooking. While the extent of quality-related training in »soft » areas such as team-working process and interpersonal skills are positively related to stronger role of human resource management system in company. Small companies in hospitality field with informal HRM, relying on casual, part-time and seasonal labour are more likely to make a poor investment in training [11].

Therefore employees must be educated and raised, which requires a huge amount of time, knowledge and energy. Within a company this usually occurs systematically on the basis of a human resource development system, which is a systematic and planned process of preparation, implementation and supervision of all human resource/educational processes and measures, intended for professional and personal development [12; pp.147-148]. Usually, the latter occurs in the environment which develops the culture and concept of the learning enterprise.

During development of labour force – employees – within a learning organisation, training, promotion and evaluation of employees prevail. All these are personal development components of each individual. The research of the Institute for Corporate Productivity (I4CP) showed [13] that 60 % of the 382 enterprises, included in the research, have developed career development programmes. 41 % of enterprises use a system comprised by their own trainers and mentors. The latter is by far the most developed type of programmes to support the development of employees. One of the most prominent car manufacturers, Toyota, opened a European Global Production Centre in Great Britain already in 2006. The latter is a centre for training of trainers from all Toyota's European subsidiaries. Such an approach has proven to be extremely effective, since the parent company, located in Japan, introduced the same model in 2003. The above illustrates an example of transfer of knowledge about production on the basis of "best practice" for each specific skill. Methodology used comprises lectures, visual guides and other techniques that facilitate understanding and practical training on special workstations, which simulate the production environment. In Slovenia also, the encouragement of individuals to learn and develop abilities and skills, is becoming increasingly common as one of the complete methods of company management. The Chamber of Commerce of the Republic of Slovenia publishes the results of researches on the presence of elements of the learning organisation concept among Slovenian enterprises [14]. The results show that awareness, about the fact that in the knowledge economy employees are becoming an increasingly important element of the competitive advantage, among Slovenian enterprises is increasing. Thus investments in employees are rising, information systems are improving and the role of employees within a company is becoming clearer.

INDIVIDUAL CHARACTERISTICS

When planning individuals' personal development and career we must [9; pp.384-392] emphasize the completeness of personal development, which is the result of professional knowledge, development of personality and work development. All three components are joined together in personal development of individual. The latter are characterised by mutual interlacing and are often difficult to separate. Professional development usually represents the completed level of formal or informal education. This also includes the shaping of a person through education, the choice of profession, training and advanced training, which provides for a person's promotion at work. Personal development is defined as the development of personal characteristics of an individual in a broader sense. With this we refer to a combination of personal attributes, values, inclinations, motives, positions and interests which, together with the individual's abilities and knowledge, as well as work achievements comprise the complete personality.

Work development represents the accomplishments or success of an individual in a specific field of work. Often, this is marked with the term "career". This component is characterised by its connection with the work environment in which the individual works. The individual demonstrates his/her skills to a narrow group to which he/she belongs. Quite often this is linked with the achievement of a work position or a function, or is confirmed by work results. This component is always linked to success within a specific organisation or concerning personal wok. The comprehension of the term career has different meaning through different periods: no longer only for persons in high positions - it is a sequence of jobs in the work history of people regardless of the profession or organisational level; it is about vertical and horizontal mobility; it is a synonym for different professions and organisations; the importance of career planning and career management rises, and organisations are more inclined to listen to the needs of their employees.

Every individual stems toward growth and personal development. In order to achieve the set growth objective, he/she must draft a plan through which he/she shall achieve the set objective. Each individual plans personal development for himself/herself. Since personal development takes place within an organisation, where the individual works, the organisation will – if it wants to be successful – support the individual, guide him/her and assist him/her with the achievement of the set objectives [9; pp.387-388]. He states that planning of personal development comprises a critical judgement of one's own abilities, knowledge of possible careers and opportunities for such careers, setting of objectives and the preparation of a plan for achieving these objectives.

RESEARCH METHODS AND RESULTS

Within the scope of the research a survey was conducted on the population of students from the 2nd year of part-time study programme, whereas 184 surveys were distributed. 150 filled surveys or 82 % of all surveys were returned. The aim of the research was to discover the motives for studying part time, possibilities for personal and career development and the level of learning support within enterprises, where these randomly selected students are already employed. We were interested in motivation for learning on behalf of the individual and its potential links with the organisation.

In this research we tried to establish which factors have the most influence on individual's career planning; whether organisation promote career development; whether organisations promote learning and which support mechanisms are available for management of individual's career and links between possibilities for career development depending on whether an organisation has formal channels to facilitate, or even requires learning and knowledge transfer from its employees.

Respondents come from different sectors; 14 % work for the public administration, 37 % in production and manufacturing industry and 49 % from the service sector (out of which almost a half works in tourism and catering). Questions mostly referred to the possibilities for individual development and career. On the basis of demographic data 10 % of respondents were younger than 25; 14 % were aged between 25 and 30; 24 % were aged between 31 and 35; 26 % were aged between 36 and 40; 21 % were aged between 41 and 45; 4 % were aged between 46 and 50 and 1 % of all respondents were over 51. The distribution of students in age groups was expected. The fact that a quarter of students are older than 41 years is in line with the established principles of lifelong learning and the expected number of years of service. 77 % of respondents completed secondary education, while the remaining 23 % have a higher education degree. Career status of respondents shows that 39 % of respondents hold leading positions, while others hold professional and technical or administrative positions while 2 % of respondents are currently unemployed.

Positions of respondents, concerning the way in which their career is reflected (what do they believe career is), are very interesting. Most respondents (42 %) estimate that there is an emphasis on a higher level of knowledge, abilities and skills, while a third of respondents (32 %) linked the term with a more demanding position. However, only a quarter decided to link the term with a higher salary (14 %) and more responsibilities (12 %).

Employers often wonder what employees expect from their employer in connection with facilitating of a career? The position of respondents on the issue, who they believe is responsible for the realisation of employees' developmental needs, is encouraging. 84% of respondents believe that both, the organisation and the individual are responsible for realisation of career needs, while merely 16 % believe that it is the organisation, which is responsible for the realisation of employees' career needs. When we were checking, whether education and training were organised within the organisation, 86 % of respondents answered that they come from "learning organisations", while only 54 % of respondents who come from "non-learning organisations", that education and training are organised regularly.

Table 1 shows specific information in connection with variables, which have a decisive impact on a career within an organisation or on behalf of individual. Respondents were offered several options and had to decide on their influence. The question was as follows: Career is important during the work period of an individual. Enterprises facilitate promotion, development and career for their employees through different approaches. In your opinion what is the influence of the following characteristic of the individual or the environment on a career (1 – the least; 5 – the most)?

Respondents attributed (Table 1) two individual characteristics as for the most influence on their decision for education and training to increased knowledge and expertise, professionalism, work experience and individual counselling, which is expressed through the assistance of mentor or personal coach – as environmental characteristic. As stated at the beginning of this paper, research and trends in the field of development of employees indicate an increased emphasis on individual cooperation, counselling and support, which is mostly reflected as formal or informal mentorship and coaching. Intersting is, that very important reason was also communication about organisational objectives and in the light thereof also clear personal objectives of an individual who tries to adapt to organisational objectives – this was of course determined as combined individual and environmental characteristic.

Table 1. Elements of the invidual or the environmental characteristics important for career development (1-the least, 5-the most important). Source: conducted survey.

Characteristic	Average	Standard deviation	Standard error	Lower interval (0,95)	Upper interval (0,95)
Invidual characteristics					
Knowledge and expertise	4,68	0,59	0,048	4,586	4,774
Work experience	4,39	0,96	0,078	4,236	4,544
Formal education	3,11	1,59	0,130	2,856	3,364
Character and personal attributes	1,95	1,26	0,103	1,748	2,152
Individual training	1,75	1,12	0,091	1,571	1,929
Environmental characteristics					
Assitance from mentor or coach	4,28	0,98	0,080	4,123	4,437
Participation in work groups	3,66	1,13	0,092	3,479	3,841
Competition among peer colleagues	3,20	1,26	0,103	2,998	3,402
Comeptence centres and knowledge centres, professional help	2,90	0,89	0,073	2,758	3,042
Invidual & environmental characteristics					
Clear organisational and personal objectives	3,98	1,06	0,087	3,810	4,150

Project and team work are prevailing in a majority of modern organisations and therefore, the fact that participation in work groups lead by experienced professionals or project groups ranks high in the scale of factors that influence career, is not at all surprising. The latter allows for employees to learn from their colleagues, offer each other mutual assistance at problem-solving, and consequently shape new knowledge. Coaching is an excellent way to attain a certain work behaviour that will improve leadership, employee accountability, teamwork, sales, communication, goal setting, strategic planning and more. Mentoring, on the other hand, involves a developmental relationship between a more experienced "mentor" and a less experienced partner, and typically involves sharing of advice.

As the distribution of factors to which respondents attributed the most influence is evident (Figure 1), it is important and worth to consider why specific factors were placed lower on the influence scale as it would be reasonable to expect. Among other, the latter refers to competitiveness of other candidates. This fact surely serves as an encouragement for the individual to gain initiative, to work more for less direct rewards and thus gain long-term advantage from competitors when acquiring interesting positions, promotion or greater responsibilities. The placement of this factor among career influential factors of medium importance can be explained with the fact that today each employee is expected to continuously develop, learn and progress therefore respondents considered this fact as and objective fact in the environment.

The influence of the "formal education" education factor and, therefore, the influence of the higher level of formal education have also been placed in the second half of the above scale. Such a result is not surprising if we remind ourselves that among our respondents only a couple were employed in the public sector, where such formalities are decisive. In the real sector respondents attributed the highest importance to knowledge and experience. On the last three places of our scale you may find competence centres or knowledge centres, which have long been known, developed and nurtured in successful learning organisations; followed

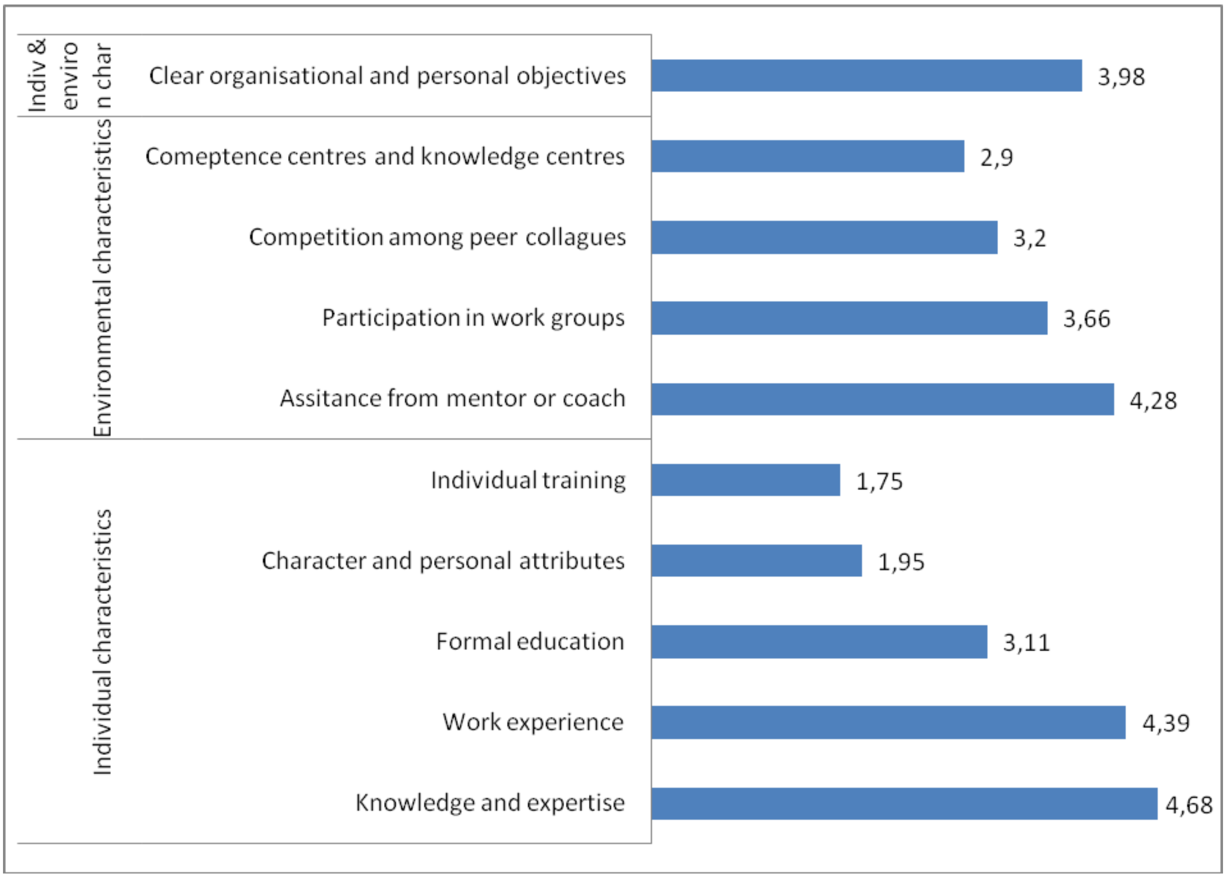

Figure 1. Average values for invidual or the environmental characteristics important for career development (1-the least, 5-the most important). Source: conducted survey.

by character and personal attributes, and individual training. Obviously, we can assess experience of our respondents from organised forms of learning within their organisations (work groups, mentors, coaches) as positive and thus they consider their own effort for improving specific competences of lesser importance or less effective.

Motivation for personal development and continuous learning is not only a matter of systematic effort of the company and organisation and it is not only a matter of the individual. In the area of dealing with people within an organisation in the field of personal development and provision of successful development of organisation in the knowledge-based society a couple of leading directions and practices are currently being developed [15; pp.35-57]. Several organisations implement the latter – fully or in part – while some can also be recognised in the results, presented in this paper. An emphasized role of individually focused development, consultative development work with the individual, which usually takes the form of mentorship or coaching. In our research this is also referred to as the "assistance of mentor or coach". Knowledge management, application of knowledge, good practices, knowledge centres within organisation. In this research also "work meetings of expert and project groups". Excellent communication and feedback. In this research: "communication on the objectives and results". Possibilities for development for everyone, continuous professional development. In this research: "knowledge and expertise, experience, competition from other candidates".

CONCLUSONS AND PROJECTIONS

Research shows and management worldwide concludes that individual's knowledge, abilities and skills are of key importance for both, the organisation and the individual. Also our research prooved that fact. The motive for the promotion of lifelong learning and personal development lies with ensured growth and increased competitive advantage, brought to the company by the qualified employees. Employees' motive for learning, education and training – even after they become employed – is linked with the possibility to receive a promotion.

Results of the research show that knowledge and work experience have the most influence on the possibility for development and a career. In the light of the latter other co-workers, who play the role of mentors and coaches, proved to be an important factor of influence as well. This conclusion complies with the results of different studies that list among the development trends also the provision of possibilities for training of all employees and individualised forms of transfer of knowledge and competences. The majority of respondents are aware of the huge influence of organisational possibilities and opportunities on the development of an individual's career.

The limitations of conducted research is in specific population of part time students, who all have jobs and careers – but we can not generalise to the whole workforce and their motivations for peronal development and learning.

People have to continuously acquire new knowledge and – mostly – improve their skills and abilities for their implementation in practice. The changed economic circumstances and new technologies affect the way people are seeking job opportunities within and outside the organisation. Scientists completed research and published the results of a study, studying the span of career guidance and career development support to support labour force development in the 25 EU member states, and identifying best practices in these states [4]. The results indicates that there is a great need for the support of career development for people, who are already employed or have just completed their education. The study establishes that there are no clear processes for career development in several enterprises and where there are, such processes are generally focused on key target groups; i.e. workers with completed higher education or managers.

It is assumed that other employees shall acquire help and support from their superior managers and through informal channels. It is also assumed that normal training and employee seeking processes offer a suitable access and information about job opportunities. Effective career support on behalf of employers for employees on their work post satisfies both, the needs of business, as well as the needs of an individual. Such a support shall remain permanent only under the condition that a mutual interest exists, which is clear to both sides - the employees and the organisations. Factors influencing knowledge sharing are "ability and willingness", motivation and ability" and "suitable chanels" [16].

There are several managerial and practical implications as a result of this research. Attention, focused on career development is especially important today, when the labour force is becoming increasingly diversified: the effectiveness of all employees is important for both, the organisation and individuals. The above-mentioned research highlighted three main guiding principles for the future which can be compared to the three guiding ideas for the focusing of activities in the field of personal and organisational development as follows: a) There is a great deficiency of effective support of career development for the majority of the employed labour force; b) The role of different organisations, providing such support is becoming increasingly important (consultants, professional, non-government and private organisations, etc) and c) The importance of individuals' opportunities to acquire and develop skills for successful career management is also increasing. The main message of the research within EU member states for employers is as follows: the support for organisation's own employees and managers must be implemented and such a support shall assist them to develop their own talents and skills; this shall attract and preserve a more educated and a highly motivated work force and result in an improved specialisation and productivity of employees.

The awareness of the importance of learning and systematic organised promotion of and support for lifelong learning, which contributes to individual's knowledge, abilities and skills continuous improvement, is increasing in the modern society. Life long learning is also the subject of the Resolution of the Council of Europe on Strengthening Policies, Systems and Practices in the field of Guidance throughout life in Europe [17]. The latter is based on the fact that the transition onto an economy and knowledge based society creates new challenges for policy makers in the field of development of human resources. Creation and effective management of knowledge-based society and the need for life long learning influence the conditions in the labour market and foresee that individuals will be encouraged through their entire life to continuous development of their skills and competences. However, the motivation for such activities depends on the individual and not only his/her wider (society) or closer (enterprise) environment. The assembly of conditions and circumstances decides whether the individual shall consider such a continuous personal development as a tool or as an opportunity to gain personal benefits.

Social environment, the increased need for continuous growth and modernisation of knowledge, skills and abilities are supposed to increase the interest of the wider society, organisations and individuals – each at their own level – for motivated approach to development. Some studies unfortunately indicate the lack of management span and career support to assist the development of employees in EU member states. Thus, there is a great need for career development support for people, who are already employed or have just completed their education. Within many organisations there are no clear processes for career development or such processes are focused on key groups, i.e. workers with completed higher education or management. It is assumed that other employees will acquire support from their supervising managers or through informal channels. On the other hand many organisations are implementing the concept of a learning organisation, support life long learning and include knowledge and experience among conditions for promotion.

The willingness for development and learning is explicitly linked with the possibility for promotion. However, from the motivational aspect, the key finding are that employees attribute most responsibility for their personal development to themselves and their knowledge, while the most desirable organisational factors are the support of a mentor or coach. Such a form of work with employees is becoming more and more developed, both formally and informally. Experts recommend systematically managed internal systems in organisations, guides and instructions which will promote and unify approaches to mentorship and work with individuals at "one to one" level. There are still many unexploited opportunities within organisations in the field of development of mentorship, coaching and systematic personal support for individuals in order to facilitate their personal development. This is surely one of the areas which all types of organisations (higher education institutions, public and private organisations) shall exploit as one of essential areas in order to gain their competitive advantage.

Transfer of knowledge is very important, since such co-workers are the most sensitive for acquiring new knowledge due to the fact that they have no, or very little work experience [15; pp.255-279]. Induction and training is very important. The first day at work is critical in shaping an employee's attitude to the company, influencing performance, satisfaction, commitment or intention to leave. (Lucas, 2004) As shown also in this research, trends in the field of personal development are therefore linked with self-discipline, proactive approach and all-in-one work in the form of support, mentorship, coaching, supported by the existence of a system for development of human resources or efforts for the implementation of a learning organisation. Support provided by mentor or assistance provided by a coach is placed highly on the scale of influence. As already stated in the introduction, such a form of work with employees is increasingly developing, both formally and informally. Experts recommend systematically designed internal systems in organisations, guides and instructions, which shall encourage and unify approaches to mentorship and work with individuals at "one to one" level [18]. They also list alternatives for mentorship; i.e. the role of specialised external coaches, mentorship by colleagues or co-workers at the same level and action learning as a method of individual and organisational development [19]. There are still many unexploited opportunities within organisations in the field of development of mentorship, coaching and systematic personal support for individuals in order to facilitate their personal development. This is surely one of the areas which all types of organisations (higher education institutions, public and private organisations) shall exploit as one of essential areas in order to gain their competitive advantage.

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NEKE KARAKTERISTIKE KOJE UTJEČU NA MOTIVACIJU ZA UČENJEM U ORGANIZACIJAMA

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SAŽETAK

Cilj istraživanja bio je izdvojiti motive za cjeloživotno učenje, za studij uz rad, mogućnosti za osobni i profesionalni razvoj te razinu podrške učenju unutar organizacija u kojima su zaposleni nasumično odabrani studenti. Razmatrana je motivacija za učenje sa stajališta pojedinca i potencijalnih veza s organizacijom.

U istraživanju se nastojalo ustanoviti koji faktori najviše utječu na osobni razvoj i planiranje karijere pojedinca; promoviraju li organizacije razvoj karijere, promoviraju li organizacije učenje i koji su mehanizmi potpore dostupni. Motiv zaposlenika za učenje, obrazovanje i usavršavanje – i nakon što je zaposlen – povezan je s mogućnosti napredovanja. Istraživanje je provedeno na većoj grupi studenata koji studiraju uz rad, dakle koji su već zaposleni. Više od 150 ispitanika ispunilo je upitnike koji su statistički obrađeni. Rezultati istraživanja pokazuju, slično rezultatima drugih istraživanja, kako znanje i radno iskustvo najviše utječu na mogućnost razvoja i na karijeru. Jasni osobni ciljevi i ciljevi organizacije također su značajni. Značajna je i izmjena znanja pomoću suradnika, trenera i mentora.

KLJUČNE RIJEČI

individualne karakteristike, karakteristike okoline, razvoj karijere, učenje

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