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QUANTITATIVE INDICATORS OF SCIENTIFIC AND RESEARCH WORK IN KNOWLEDGE MANAGEMENT AT HIGH EDUCATIONAL INSTITUTIONS - CASE STUDY: UNIVERSITY OF BELGRADE, TECHNICAL FACULTY IN BOR (SERBIA)

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ABSTRACT
Quantitative indicators of scientific and research work in knowledge management at high educational institutions examined in the example of Technical faculty in Bor, University of Belgrade (Serbia), for the post accreditation period, are presented in this paper.
Keywords: knowledge management, high educational institutions, science and research

1. INTRODUCTION

The universities are knowledge organizations. Their core objectives are to generate, acquire and transfer knowledge, but also to develop and transfer technology innovation, support and challenge current political establishments, as well as support the economy by becoming the providers of appropriate knowledge and skills demanded by the workforce in the global market [1].
Nowadays, the universities are exhaustively compared from the educational and research perspective, such as student to staff ratio, number of citations, or number of scientific publications. In contrast, the implication of environmental issues has received little or no attention, although many universities are monitoring their environmental footprints [2]. The intention of any application of performance indicators is to either identify 'high quality' or to find out which research is 'better'. The most common measures used to evaluate science are based on bibliometric data, or rather publication records which include citation numbers, journal impact classifications, etc.[3]
Research activities at high educational institutions present important element in actual evaluation accreditation standards. Therefore, significant attention is paid to the measurement of quantitative indicators of knowledge management at universities and colleges, in order to strengthen the ability of scientific work, individual skills and competencies of the employees and combine them into a corporate knowledge. Increased number of publications and patents should be the final forms of such knowledge realization at high educational institutions.
The results of analysis of quantitative indicators of scientific and research work in knowledge management in the example of Technical faculty in Bor, University of Belgrade (Serbia), for the post accreditation period – 2009-2011, are presented in this paper.

2. QUANTITATIVE INDICATORS OF SCIENTIFIC AND RESEARCH WORK IN KNOWLEDGE MANAGEMENT AT HIGH EDUCATIONAL INSTITUTIONS

Most academic research institutions evaluate researchers by one of two measures (in addition to the number of publications): the citation score and/or h-index [4].
The pure citation score - the number of times a publication has been cited by others, allows one to evaluate the value of a publication given comparing to the field. That measure can also be used as a

performance measure for a scientist or institution providing insight into how the scientist or institution's publications are valued within the field. In addition to the citation scores for evaluating scientists or a publication, citation data is also used to analyze the impact factor of a journal. The impact factor (IF) measures the average number of citations per article published in a specific journal: the higher number of citations to the journal - the higher impact/importance of the journal in the field. The IF can be found in common databases and is frequently used by academic institutions to specify journals that will be considered in evaluations of researchers [4].
Another common measure is the h-index, developed by Jorge E. Hirsch, which attempts to provide a single metric describing the quantity (number of publications) and quality/impact (number of citations) of a scientist's work. In practice, publications are arranged in descending order according to how many times they have been cited (citation score) [5]. These scores can be interpreted and implemented in a number of ways, depending significantly on comparison to correctly interpret, as every field has different dynamics and communication practices [6-9]. These indexes are highly influenced by the reliability of the publication data used to compute them. Furthermore, most institutions are, unfortunately, uninformed about the application of these measures and use them as universal evaluating tools comparing disciplines with each other [6].
The literature focuses on the relationship of bibliometric indicators to these concepts, as it is this connection that has attracted most investigation. The development of these indicators has been advanced by the bibliometrics community, while other quantitative indicators have not been systematically scrutinised and are applied in an ad hoc and in a much less sophisticated way [3-5].

3. CASE STUDY: UNIVERSITY OF BELGRADE, TECHNICAL FACULTY IN BOR (SERBIA)

Technical faculty in Bor, established in 1961 as the Mining-metallurgical faculty with two departments – Mining and Metallurgy, belongs to the University of Belgrade, the oldest, the biggest and the most prestigious state university in Serbia. Throughout the years, several departments were opened; some of them were closed, along with the changes requested by the industry and labor market. In 2005, Serbian high academic education was reformed according to the principles of Bolonia declaration. So, in 2007 and 2011 the Faculty was accredited as a scientific-research organisation in the field of technical-technological science, while in 2009 the Faculty accredited four academic study programmes: mining engineering, metallurgical engineering, technological engineering and engineering management, at all three levels (except doctoral studies for mining engineering), adjusted to the Bolonia declaration [10,11].
In the frame of continuous quality assurance procedure, quantitative indicators of scientific and research work at Technical Faculty in Bor are defined based on the Annual reports on scientific and research work [12]. It consists of different data - list of references and citations, list of projects, list of activities in the international cooperation, list of conferences organized by the Faculty, and list of publishing activities.
As it can be seen in Fig.1 and Fig. 2, references and citations of professors and other teaching staff, are progressively increasing from the Faculty foundation to nowadays, especially publications in international journals with impact factor – listed in Tompson-Reuters inventory. Number of citations in 2010 increased for 50 % than in 2009. [12,13]

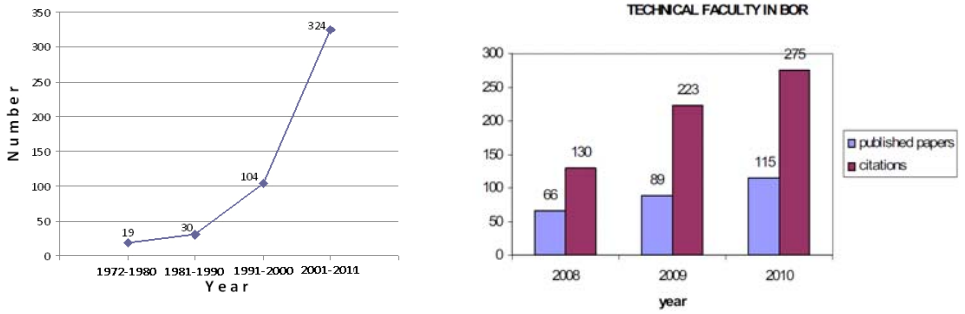

Figure 1. Number of published papers by Technical Faculty Bor staff in international journals with IF -1972-2011 [10] (a) and relation between published papers and citations 2008-2010 [13] (b)

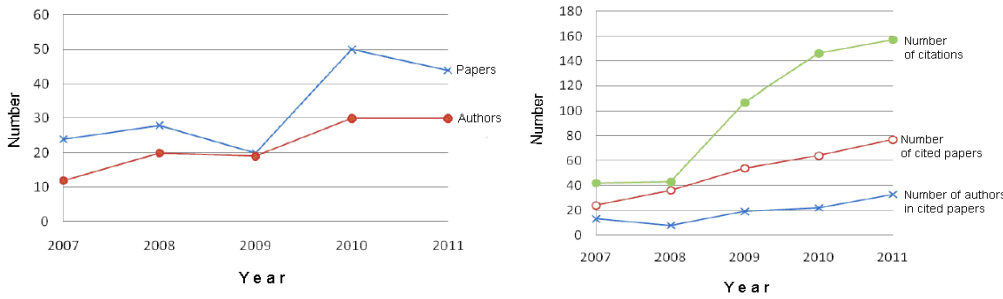

Figure 2. Number of papers published in journals with IF vs. number of authors (a) and number of citations according to SCOPUS (b) for the period 2007-2011

Recently, our group studied the quality index of scientific work at technical-technological faculties of Belgrade University expressed as a number of citations in terms of the number of published papers per researcher was done for post-accreditation period 2008-2010 [13]. Schematic presentation is given in Fig.3, showing that obtained index of quality of scientific work at studied faculties in the post-accreditation period is declining in the following way: Faculty of Technology and Metallurgy (TMF) – Faculty of Electrical Engineering (ETF) – Technical Faculty in Bor (TFB) – Faculty of Geology and Mining (RGF) – Faculty of Mechanical Engineering (MF) – Faculty of Organizational Sciences (FON) – Faculty of Transport and Traffic Engineering (SF) – Faculty of Civil Engineering (GF) [13].

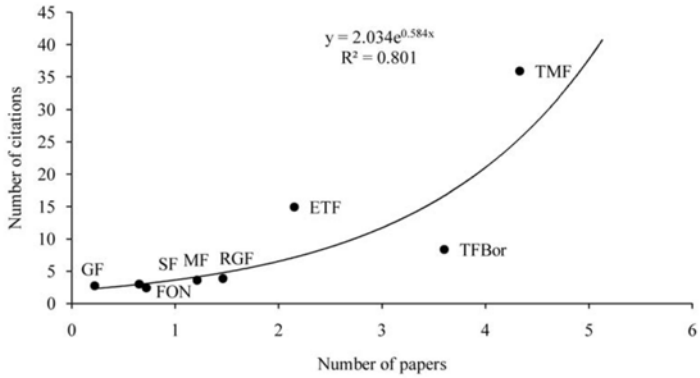

Figure 3. The quality index of scientific work at technical-technological faculties of Belgrade University expressed as a number of citations in terms of the number of published papers per researcher [13]

More, the number of technical solutions, patents and projects that involve teachers and staff of Technical faculty is increasing [10-13] - in example, seven international projects, 26 projects financed by the Ministry of Education and Science, Republic of Serbia; 12 other projects financed by other subjects realized during 2011; 26 actual projects to be realized in period 2011-2014 with 66 staff of the Faculty. These data are also significant indicators of knowledge management process in the field of research, being in accordance with previously mentioned data on published papers and citations and having importance to accent constant tendency in approaching science to engineering practice.
Additional notable factors, which could be described more as qualitative indicators in knowledge management are bilateral agreements, contracts, business&technical cooperation with relevant organizations, universities, scientific institutes and other institutions in related fields. These activities were increased in last ten years at Technical Faculty in Bor, presenting other important item with strong positive impact. Also, as active partner in academic networks – Resita Network, MetNet, EURAXESS, and through numerous international projects, Faculty achieved important contacts with respected European academic and scientific institutions, creating a favorable climate for the development of further joint research activities and mobility of students and staff [10-12].

Further, activities in the publishing field are promising [12]. Faculty publishes four journals - Journal of Mining and Metallurgy Section A: Mining, and Section B: Metallurgy, Serbian Journal of Management, Recycling and Sustainable Development). The oldest one, Journal of Mining and Metallurgy, Section B: Metallurgy, published from 1965, is the best ranked among them. According to the Tompson-Reuters Journal Citation Reports list, Journal of Mining and Metallurgy, Section B: Metallurgy was ranked as 12th among 74 journals in the field Metallurgy and Metallurgical Engineering with Impact Factor 1.294 in 2010, which can be considered as the greatest publishing success of the Faculty in its 50 years long existence[11].

Last, but not least qualitative factors in knowledge management activities at Technical Faculty in Bor are its four conferences, organized annually – International October Conference on Mining and Metallurgy, International Meeting - Ecological Truth, May Conference on Strategic Management, and Symposium on Recycling Technologies and Sustainable Development [11], which also contribute to total scientific and research work at faculty as one of additional, but significant factors.

If we consider steady upward trend in publications, citations and other factors of importance, it can be said that knowledge management exists at Technical Faculty in Bor, that educational reform process gave good results, which consequently leads to constant improvement of teaching staff competencies, upgrading their knowledge and qualifications, and expecting to provide a higher level actual classes to the students.

4. CONCLUSION

According to presented quantitative indicators of scientific and research work in post-accreditation period, Technical Faculty in Bor is situated very well [13]. The positive trend of increasing researchers' participation in various forms of scientific and research activities is noted, especially in publishing papers in top and leading international journals and what can be considered as a result of the quality standards implementation through the accreditation process, as well as more stringent criteria in the teaching profession.

Increasing the number of publications in journals in Science Citation Index list, with the aim of publishing in journals with higher impact factor, should in future increase the citation. Increased citations should increase the overall competence of teachers from the Faculty, the rating of the Faculty and give the contribution to the University of Belgrade entering the Shanghai list.

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