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Proposed system for the scientific research capacity evaluation in university

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Abstract

The introduction of the indicator concept for the performance measurement in higher education has been associated with the new public management to improve research capacity and quality and to better manage the funds invested. Currently the university research evaluation has become indispensable in most countries. Great efforts are made by university managers to have an objective evaluation tool based on quantitative indicators but without really worrying about the exact determination of what we want to evaluate in terms of the scientific research or why it is being evaluated, which influences the indicators type used and then the overall coherence of the evaluation system adopted. This paper aims to conceive a quantitative evaluation system of the university scientific research capacity that can be used in order to improve the research capacity influencing the research quality.

Introduction

Evaluation has become indispensable in many countries, especially those where universities are faced with great responsibility demands and whose funding is reduced. The university scientific research evaluation process can be done on several dimensions; different organizations also use different criteria and indicators. Generally, they tend to focus on four typical output measures: the **capacity**, quality, impact, and utility. In this paper; we are interested in evaluating the university scientific research performance on the dimension "research capacity" and this through quantitative indicators we propose. Several concepts can be linked to the indicator notion, whose more important are: "... a numerical value used to measure something that is difficult to quantify "or" ... ratios, percentages or other quantitative values allowing an institution to compare its position in strategic areas, with peers, past performance or previously set goals» .In Europe, since the beginning of the 1980s, the performance concept in higher education has a significant impact, especially in the UK. The introduction of the key performance indicator concept (KPI) in higher education is associated with new management to better manage the funds invested. The concept of indicator in higher education is also defined as follows: "... a measurement - usually in quantitative form - of an aspect of an institution's activity higher education ... "[1(2)]. Without a general understanding of past events, we can not envisage a change or improvement. Therefore, without university performance evaluation based on indicators clear and objective, we cannot improve the universities quality. The performance quantitative evaluation is one of the essential needs of universities, and the KPIs definition is one of the main steps of this evaluation. Several university performance types exist, the university research performance among the most important. The scientific research performance evaluation can concern several dimensions; in this article we are interested in the "research capacity" dimension. The scientific research capacity evaluation in the university is very important and even indispensable especially when we are interested in comparing, for improvement purposes, the "quality" of the research production in universities, this comparison cannot be make correctly when the research capacity of the entities evaluated is neglected. We cannot speak of a correct and objective research quality evaluation without considering capacity indicators. The research capacity evaluation allow making adjustment decisions in order to improve this capacity and then to improve the production and the quality of research, given that the research capacity impacts directly its quality. In this article, we are interested in conceiving a research capacity evaluation system based on quantitative indicators, we introduce a model that identifies the components influencing research capacity in order to define the appropriate type of measurement indicators. Those indicators validity is assessed before adopting them in order to use them in the right context and for the appropriate measures [2,3].

Related Work

In Australia, Portugal, Great Britain, the United States and other countries, by the scientific and bibliometric indicators for the measurement and evaluation of university research, we mean indicators of research capacity, indicators of research production, and indicators of research quality and impact [1(37-45),4]. The university research evaluation concerns several dimensions of scientific research; in this article we are interested in performance indicators allowing the evaluation of the "capacity" dimension of research. In the Slovak Republic, an accreditation committee was created in 1992 to evaluate institutes and academic departments. For the institutes, the indicators used are related to the publications and citations. Basis of these data, the institutes are evaluated and classified. In the case of university departments, the same indicators are used and are supplemented by: The teaching staff qualifications; the number of PhD students; the professional integration rate of graduates, as well as the foreign student's number [5].

In 1993, the Australian Minister of Education announced that starting in 1995 funds would be distributed on the basis of a new "composite index". Since 1998, data has been collected to determine the composite. Measures of research inputs and outputs are integrated into the "composite index" as follows: First, the research inputs ; they concern the funding of each university through competitive grants, sources of research funding from industry, and other sources of research funding. Secondly, the results of the research integrating the publications, students and advanced diplomas (master's and PhD's) completed (Geuna and Martin, 2003, 293-294).

In the Netherlands, expert commissions are created to evaluate research performance over five-year periods, in the following categories: Academic staff, program missions and research plan, program content and results, publications, and other quality and reputation indicators (such as patents and conferences). An evaluation of each program is then made in four dimensions: 1. scientific quality. 2. Inputs (**capacity**) and outputs (productivity). 3. Scientific relevance And 4. Research continuity. The assessment is translated into five points (1 = "poor", 5 = "excellent"). [6 (284-285), 7(45-53)]

The research capacity evaluation through performance indicators, which are generally of the "Input" type, is made by several countries, given its importance for measuring production potential and scientific quality. This evaluation generally concerns the human and financial potential, and research infrastructures [8].Some indicators such as "the number of enrolled PhD students" are used by some countries as "capacity" indicators and by other countries as "quality" indicators such as In the Slovak Republic [5]. This means that the first step in conceiving a good evaluation system must be the determination of the evaluation objective and the exact dimension that is to be evaluated in order to correctly decide on the measurement indicators to be adopted. When an indicator is valid to measure two research dimensions, it's inevitably that it does not have the same weight to perform the two measurements, moreover for the aforementioned indicator, it is better to measure the capacity research that to measure its quality even if we consider the hypothesis linking the number of PhD students enrolled in the reputation and the quality of the establishment, which could be true but not in the absolute. The number of PhD students enrolled, for example, also depends on the university location, the research specialties it offers, and even the research trend during a given period, this means that this indicator will be better and more significant for measuring capacity than for measuring quality.

Researched Method

We consider the "capacity" as one of the scientific research dimensions and use systemic thinking to emphasize the components of this scientific research dimension that we are trying to evaluate in order to identify the key performance indicators types to measure this dimension and to develop a logical repartition of each indicators type proposed according to what they allow to evaluate. The model integrating the different components considered to evaluate the scientific research capacity is illustrated in **[Figure 1]:**

In designing the evaluation system proposed, each component of the "search capacity" dimension is represented by an indicators group (Gi) measuring said component. Four components, and then four groups of measurement indicators, are adopted:

Indicators for Human Resources (G1): Long-term research capacity largely depends on human resources: researchers, students, and competent research support staff. Population-based measures provide valuable data on the capacity and competitiveness of the research [9, 10, 11].

Funding indicators (G2): The measures relating to the financial resources invested in research and the human resources deployed to direct research activities are very important for assessing inputs, they give an idea of the competitiveness ability [9, 12].

Indicators for research infrastructures (G3): Equipment and facilities constitute critical determinants of research capacity; good infrastructure means an opportunity to improve the researcher's competences and to use advanced technologies [1,12]. The importance of the research infrastructure varies from one domain to another, but it can influence human resources and collaborative networks and thus long-term research capacity. A study has shown that in the high energy physics domain, for example, the quality of the scientific installations and instruments used influence the scientific efficiency [13]. Difficult to make comparison by research domain using these indicators, because the needs for research infrastructures vary by domain.

Collaborations indicators (G4): Collaborations allow the latest knowledge sharing, methods and research tools, which contributes to improving the researcher's capacity. Academic-industrial collaborations also contribute to the promotion of knowledge transfer activities and collaborations between public research and commercial enterprises, they allow the data collection, the sensitization or the exchange between various scientific knowledge or between scientific and local knowledge [14, 15].

Subsequently, we proceed to a deep analysis of the literature related to the quantitative evaluation of a rather complicated object such as the scientific research capacity at the university. Following this analysis, we first began by evaluating the most used indicators in research capacity assessment to adapt the ones we considered valid to the new conceptual model proposed by proceeding to adopted indicators distribution by group according to what they measure. During this assessment process of the indicators used in the research capacity evaluation, we introduced a new concept of "validity degree» of the indicators used which depends on the limits' number that these could represent to make correctly a given measure. Different weightings were then assigned to the indicator groups considered according to their validity degree compared to the other groups used for the research capacity evaluation. This weighting can be high "Wa (Gi)", average "Wb (Gi)" or low "Wc (Gi)" for which we propose a numerical value reflecting its importance. The indicators we consider within each group are judged valid, other indicators are used in other evaluation systems and in other contexts that are not considered in the proposed system given their validity degree judged weak or average.

Results and Discussions

For this conceived evaluation system, the value of the following parameters must be set: The year's evaluation **period** and the research **area** to evaluate are also defined seen that some of the proposed indicators don't allow comparison between research areas, especially those related to "research infrastructures". This proposed system should be used for an evaluation by **research**

area.The adopted indicators, constituting the conceived research capacity evaluation system according to the proposed model are detailed in **[Table 1].**

The first component influencing research capacity is considered through the first indicators group related to "human resources", a high validity is associated with this group and then a high weighting (35% is proposed). The first indicator (I1) measuring the researcher's number in the entity evaluated is a significant indicator of research capacity. By the second indicator (I2) that we propose, we seek to qualify this research capacity by measuring the average number of citations per researcher in order to conclude on the researcher's competence degree involved, which translates into high or low research capacity depending on the quality of researchers involved. The third indicator (I3) concerns the PhD students enrolled each year giving an idea of the human potential involved in research, this indicator is completed by the fourth (I4), determining the foreign PhD students proportion, since it allows to conclude on a skills and technologies exchange influencing the research capacity of a given entity. By the fifth indicator (I5), we seek to measure the PhD students supervision rate proportionally influencing the research capacity, the sixth indicator (I6) allows to conclude on the work environment quality of the researchers by measuring the proportion of staff dedicated to research by research professor, the higher the work environment quality is, the higher the productivity capacity of researchers will theoretically be high.

The second indicators group representing the second component of the "capacity" dimension to consider is in relation to the "financing" of the research measuring the funding and grants. To this group we associate a high validity and therefore a weighting of the same importance order of the «human resources "(35% is proposed) given the great influence of funding in terms of funds invested and grants on research capacity. Concerning the third indicators group considered "research infrastructures" we associate an average weighting (20% proposed). We think that this component is important and must be considered but less important than the first two components, which are "the Human Resources" and "the funding". Moreover, the "Research Infrastructures" importance varies according to the research area evaluated, the importance of the research infrastructure in chemistry area, for example, is generally greater than its importance in information systems' domain. Reason why we assign to this indicators group an average weighting.

The last indicators group adopted is "collaborations" influencing research capacity given the transfer and exchange of knowledge they allow but less than the other indicators groups considered, we so associate a low weighting (10% is proposed) compared to other indicators. However collaborations' indicators should be considered given their added value in estimating the overall search capacity of a given entity.

Some indicators could be important, but their acquisition cost is high, which constitutes a criterion for the indicators adoption, moreover the obtaining of the adopted indicators values could present certain limits in relation to the absence of the indicators data in local databases of universities or the need to query multiple databases at once for calculating the value of a single indicator. It is obvious that the quality of evaluation system proposed is dependent on the data quality used for the measurements, which must be ensured.

Conclusion

The approach we followed in conceiving the research capacity evaluation system to adopt offers some flexibility. Other possibilities can be considered depending on the application method of the overall system designed, according to the indicators groups to be considered, and then according the weights assigned to them. The extreme approach might be, for example, to consider only high-validity and high-weight indicators groups, in which case the system proposed in this article will be reduced to two indicators groups, those related to "Human Resources" and those related to "financing". We preferred to remain broad by considering even the indicators whose the validity is judged less important by affecting them less important weightings to integrate the maximum of components that can influence the research capacity evaluation. The indicators to be considered depend on the objective and the approach chosen by the institution conducting the evaluation. Moreover, a perfect evaluation system could not exist, any evaluation system could be improved, and our system proposed in this article does not escape. We have tried to integrate all the components constituting variants influencing our evaluated object which is "the research capacity " considering the influence weight of each variant that we translated by weights whose values are proposed in our approach. These values can also be changed and improved, but keeping approximately the overall importance order of the proposed weights so as not to influence the overall proposed system coherence.

Conflict of interest: The authors declare that they have no conflict of interest.

References

[1] Cave Martin, hanney Stephen, Henkel Mary and Kogan Maurice. 1998. « The use of performance indicators in higher education: the challenge of the quality movement ». Third Edition. Jessica. Kingsley Publishers. London and Bristol, Pennsylvania:2-45. Available from:”https://books.google.co.ma/books?id=fNlVwMJLK4wC&printsec=frontcover&hl=fr#v=onepage&q&f=false”.

[2] Gingras, Yves 2008, « La fièvre de l’évaluation de la recherche – Du mauvais usage de faux indicateurs », Bulletin of sociological methodology : 42-44. Available from: « http://bms.revues.org/3313 »

[3] Gingras, Yves. 2014. « Les dérives de l’évaluation de la recherche : Du bon usage de la bibliométrie », [The drifts of the research evaluation: The good use of bibliometrics], Bulletin des bibliothèques de France, n°2, 2014, p. 186-188. Available from: « https://halshs.archives-ouvertes.fr/halshs-01009987/document ».

[4] Meek V.Lynn and Van der Lee J, 2005. « Performance indicators for assessing and benchmarking research capacities in universities », APEID, UNESCO Bangkok Occasional Paper Series Paper No. 2: 10-11p .Available from: « http://unesdoc.unesco.org/images/0015/001529/152960e.pdf »

[5] Tino,J. « Institutionalizing Evaluation of Research and Education in the Slovak Republic », in Frankel and Cave (eds.), op. cit. note 57, 166–169.

[6] Geuna, Aldo and Martin, Ben R. 2003. « University Research Evaluation and Funding: An International Comparison », Minerva 41(4): 277-304p. DOI: « 10.1023/B:MINE.0000005155.70870.bd ».

[7] Rip A and Meulen B.J.R, van der.1995. « The Patchwork of the Dutch Evaluation System », Research Evaluation, 5 (1), (1995), 45–53.DOI:” 10.1093/rev/5.1.45”.

[8] Chalmers Denise.2008. « Indicators of university teaching and learning quality », Australian learning and teaching council, promoting excellence in higher education: 1-18p. Available from: « https://www.oecd.org/site/eduimhe08/41216416.pdf ».

[9] Benoît, Godin.2000. « Outline for history of Science Measurement », Project on the History and sociology of S&T Statistics, Paper N 1: 1-36p. Available from:” http://www.csiic.ca/PDF/Godin_1.pdf”

[10] Huong Nguyen T. L, February 2016. « Building human resources management capacity for university research: The case at four leading Vietnamese universities », Higher Education, Volume 71, Issue 2, pp 231–251, Available from: « https://link.springer.com/article/10.1007/s10734-015-9898-2 ».

[11] Bland, C J and Ruffin, M T.1992. « Characteristics of a productive research environment: literature review », Academic Medicine: Journal of the Association of American Medical Colleges, 01 Jun 1992, 67(6):385-397, Available from: « http://europepmc.org/abstract/med/1596337 ».

[12] Kirwan R.M, 1989. « Finance for Urban Public Infrastructure », Urban Studies, Vol 26, Issue 3, 1989. DOI: « http://journals.sagepub.com/doi/abs/10.1080/00420988920080301 ».

[13] Irvine John and Ben R Martin.1985.« Basic Research in the East and West: A Comparison of the Scientific Performance of High-Energy Physics Accelerators », Social Studies of Science. Volume: 15 issue: 2, page(s): 293-341 DOI : « https://doi.org/10.1177/030631285015002004 ».

[14] Gläser Jochen and Laudel Grit.2016. « Governing Science: How Science Policy Shapes Research Content », European Journal of Sociology, Volume 57, pp. 117-168. Available from: « https://www.cambridge.org/core/services/aop-cambridge-core/content/view/EE0FD491D34A8EEE51D69CEF3D33F4A3/S0003975616000047a.pdf/governing_science.pdf ».

[15] Groboljsek Blank, Ferligoj Anuška, Mali Franc, Kronegger Luka, and Iglic Hajdeja .2014. « The role and significance of scientific collaboration for the new emerging sciences: The case of SLOVENIA », Teorija In Praksa let. 51, 5/2014: 1-20 p. Available from: « http://dk.fdv.uni-lj.si/db/pdfs/TiP2014_5_Groboljseketal.pdf ».

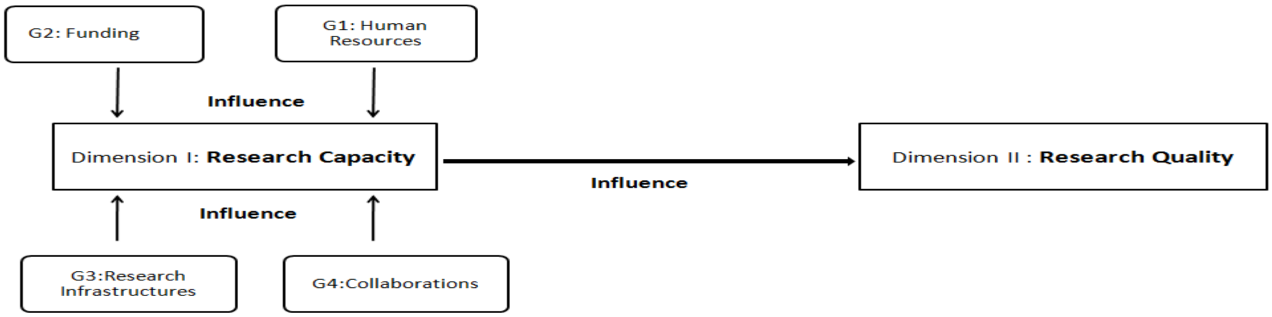

Figure 1: Components influencing the scientific research capacity

Table 1. Proposed indicators for research capacity evaluation

Groups (Gi)	Indicators (Ii)
Human Resources (G1): (Researchers, students and research support staff) **Wa, [Vp=35%]**	**I1**-Number of researchers
	I2-Average number of researcher citations
	I3-Number of students enrolled in PhD programs
	I4-Proportion of foreign PhD students enrolled
	I5-“PhD student / professor “ Ratio
	I6-Ratio "Number of staff dedicated to research / number of research professors"
Funding(G2): (Funding and grants) **Wa,[Vp=35%]**	**I1**-funding total amount for research (with repartition by type of funding)
	I2-Number of research projects funded internationally
	I3-Grants total amount dedicated to research (with a repartition by type of grants)
	I4- Percentage of researchers receiving grants
Research Infrastructures (G3): Wb, [Vp=20%]	**I1**-Average age of installations
	I2- Equipments cost (in MDH)
	I3-Operating costs (MDH)
	I4- Average surface area dedicated to research by research area (m2)
	I5- maintenance provisions of equipments (in MDH)
	I6-Number of research laboratories
Collaborations (G4): Wc, [Vp= 10%]	**I1**-Number of interdisciplinary research networks
	I2-Number of international research networks/ Number of national research networks
	I3-Number of partnerships with industry
	I4- fees of collaboration