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Highlighting the excellence in Civil Engineering research in Portugal with the help of the h-index

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Abstract

The Portuguese FCT-"Excellence Stimulus" prize is attributed to Investigators and Professors that published at least 100 papers in the Web of Science-WoS with 500 citations or else 50 papers published in the WoS with 250 citations and the supervision of 10 PhD Thesis. So far almost 70% of these prizes have been awarded to investigators and Professors working in the field of Chemistry. The present paper shows that the fact that this prize has never been award to an Investigator or to a Professor working in the field of Civil Engineering does not mean that excellence is lacking in this particular field. The highest h-index for Associate and Full Professors of Civil Engineering Departments of the six most productive Portuguese Universities are presented in this paper. Comparisons with world top Professors and researchers in the field of Civil Engineering are made.

Key Words: h-index; excellence prize; WoS, Scopus, Civil Engineering

Introduction

In 2005 the Physicist J. Hirsch from the University of California suggested a very simple method to evaluate the impact and the relevance of the scientific production of an investigator, the h-index. The paper of Hirsch has been cited 840 times, being that 347 citations has been made in 2010 and 2011. According to Hirsch the h-index of an investigator means that he has h papers with at least h citations (1). The h-index provides a combined effect of both the number of citations and the number of papers which is a more reliable output than the criteria based on the same indicators analyzed separately. Take for instance the case of investigators that has dozens of papers without any citation or the case of investigators with very few papers but with a small participation in a lucky paper that received several hundreds or even thousands of citations.

In order to compare investigators with a different career span Hirsch suggest the use of the m=h-index/n in which n is the number of years after the publication of the first paper. According to Hirsch (1) a physicist can be considered a successful one if after 20 years it has a h-index=20 (m=1). Achieving a h-index of 40 in the same period (m=2) characterizes outstanding physicists likely to be found in top Universities. As to the ones with a h-index=60 (m=3) they are truly unique scientists. Hirsch analyzed the h-index of investigators who received the Nobel Prize in Physics in the last 20 years noticing that 84% had a h-index above 30. This author still suggests that a h-index=12 should be a prerequisite to the advancement to the Associate Professor position in major research Universities, for Full Professor positions a h-index=18 should be required. One must bear in mind that the field of Physics has investigators with very high h-index. The highest belonging to the theoretical Physicist Edward Witten (h-index=110), known for this crucial investigations about the String Theory. But it is the field of Life Sciences that has the highest h-index values, between 120 and 197.

This paper intent to show that the h-index is a more reliable indicator to assess the relevance of the scientific production of Portuguese Investigators when compared to the indicators of the Portuguese FCT-"Excellence Stimulus" prize. In order to achieve that goal this paper

evaluates the h-index of almost 70 Associate and Full Professors of Civil Engineering Departments of the six most productive Portuguese Universities.

The state of the art of the h-index

The h-index has raised a lot of interest by the scientific community and the paper in which it was formulated published in the Proceedings of the National Academy of Science of the U.S. has received so far several hundred citations. Bornmann & Daniel (2) analyzed Post-Docs applications concluding that successful candidates have a higher h-index. Other authors refer that the h-index can used to evaluate the performance of researchers (3). According to Hirsch (4) this index can predict future performance. This author analyzed the production of 50 Physicist during a period of 12 years, referring that the h-index can predict their production in the next 12 years in a more reliable may than other indicators.

Mugnaini et al. (5) compared the average h-index of the members of the Brazilian Academy of Sciences with the ones from the Academy of Sciences of the U.S, referring that the later have higher h-indexes. Those authors state that the h-index is dependent on the scientific field and also that the average h-index of the members of the Brazilian Academy of Sciences have a higher dispersion. The h-index of the Academy of Sciences of the U.S had already been analyzed by Hirsch (1) who mentioned a value above 45.

Kelly & Jennions (6) showed that Editors of international journals in the field of Ecology and Evolution have h-indexes between 21 and 34. Bornmann et al. (7) compared the performance of the h-index with other indicators (number of papers, citations, impact factor and peer review) for investigators of Molecular Biology concluding that it is a valid indicator.

Bornmann & Daniel (8) mentioned that the simplicity of the h-index raises some limitations such as the fact that it disregards the total number of papers, the total number of the citations, and does not takes into account the number of authors per paper. Other authors (9) synthesized five advantages of the h-index:
1º - It can be obtained in a very fast manner;
2º - It can be obtained with minimum costs;
3º - Avoids subjective evaluations intrinsic in the peer review process;
4º - It allows for international comparisons;
5º - It allows for transparent evaluation procedures.

Van Raan (10) analyzed the h-index of more than one hundred international research teams in the field of Chemistry observing a correlation with the number of citations. A similar correlation was detected by Cronin & Meho (11) in the field of Communication Sciences. Those authors mentioned that the h-index can differentiate the authors with a high number of papers that have a high scientific impact. Egghe (12) refers that two authors can have the same h-index, although one may have two or three times the total number of citations of the other. Schreiber (13,14) suggests modifications of the h-index to exclude self-citations. However, the databases WoS and Scopus already have tools that allow a fast calculation of the h-index of an author excluding self-citations.

Costas & Bordons (15) mentioned that the dissemination of the h-index could influence the publication pattern increasing the productivity and lowering the quality. However this view is not without criticism because the h-index relies on citations and the papers published in high impact factor journals are the ones that received the highest number of citations. Besides in the scientific fields with a low productivity, as it happens in Civil Engineering anything that can increase the numbers of paper published in international journals is welcome.

Kelly & Jennions (6) also defend that the h-index favors the authors that published few papers with high impact by opposition to the authors that published hundreds of papers that become forgotten very soon. For Rosseau (16) an author may have relevant papers presented in a

conference or in a Open Access journal not covered by WoS not contributing to its h-index. Lovegrove & Johnson (9) found a correlation between the h-index and the peer review process in grants applications. Bar-Ilan (17) compared the h-index of several researchers using three databases (WoS, Scopus e o Google Scholar), mentioning that although the results are different they are more similar between WoS and Scopus.

Schreiber (18,19) refer that the normalization of the h-index to take multi co-authorship into account, dividing it by the mean number of authors as suggested by Batista et al. (20) is unfair for authors with some papers with a large number of co-authors suggesting instead that the h-index should be assess considering the inverse fraction of the number of authors. Bornmann & Daniel (21) mention that the h-index should only be used to compare investigators with the same career span and in the same scientific field. Gonzalez & Gonzalez (22) defend that the h-index is not appropriate to evaluate the performance of social science investigators, because the number of citations in this area is much lower when compared to others like Physics that have the double of citations.

According to Schreiber (23,14) the h-index cannot differentiate between two authors with the same number of highly cited papers although one has much more citations, thus suggesting modifications of the h-index to take into account the total number of citations of the highly cited papers. However this author recognizes that the changes probably are not enough to reduce the advantages intrinsic in h-index simplicity. Franceschini & Maisano (25) also refer that the popularity of the h-index relies in its simplicity and that other indexes may be more complete but have lower acceptance because they can hardly express the connection with what is being assessed. The h-index can be used in a fast manner by a Editor to invite a reviewer or it can be used to allocate resources in investigation projects from different reviewers or even to merit their performance.

This index can also be used to establish rankings between countries (26) or rankings between Universities. Table 1 shows how the h-index can be used to differentiate between highly productive Universities with low scientific impact and less productive ones with a higher impact. The University of S.Paulo produced in 2004 three times more papers than the University Autonoma of Madrid, but the later has a higher scientific impact.

From quite some time the database Scopus/Elsevier uses a tool that allows assessing the h-index of a given investigator. More recently Elsevier developed “The find reviewers tool” a software to help Editors finding adequate reviewers. This tool provides a list of potential reviewers; publish history, affiliation and h-index. Also the SCImago & Country Rank uses the h-index to make rankings of scientific journals. According to Hodge & Lacasse (27) the h-index correlates highly with ISI 5-year impact factors.

Table 2 presents the h-index of international Civil Engineering journals compared to the impact factor (IF). There’s a correlation between the h-index and the IF. The differences could be explained by different update periods. The IF is obtained dividing the average number of papers published by a journal in a two year period and the average number of citations of the same papers in the same period:

IF example:

Nº of papers published in 2007=116
Nº of papers published in 2008=71
Total=287

Nº of citations in 2009 of the papers published in 2007=258
Nº of citations in 2009 of the papers published in 2008 =199
Total of citations=457

IF (2009)= 457/287=2.444

Table 1- Number of papers published in journals of the WoS and the h-index of some Universities from Portugal, Spain and Brasil in 2004 for a 5 years citation window (28)

University	Nº of papers	h-index
University of Barcelona	2497	57
University Autónoma of Madrid	1558	55
University of S.Paulo	5301	52
University of Valencia	1705	49
University Complutense of Madrid	1978	46
University Autónoma of Barcelona	1543	41
Technical University of Lisbonn	1291	43
University of Porto	1235	39
University of Santiago de Compostela	1118	37
Polytechnic University of Valência	878	36
University of Sevilha	1027	36
University Federal of Rio de Janeiro	1792	36
University Estadual de Campinas	2035	36
University of Saragoça	900	34
University of Pais Basco	967	34
University of Granada	1058	34
Polytechnic University of Catalunha	1240	33
University of Coimbra	852	31
Federal University of Minas Gerais	894	31
University La Laguna	420	30
New University of Lisbonn	581	30
University of Oviedo	803	30
University of Alicante	451	29
University of Aveiro	697	29
University Estadual Paulista	1350	29
Federal Universidade of Rio Grande do Sul	1202	29
University of Córdoba	459	27
University of Salamanca	650	27
University of Vigo	624	26
University of Valadolid	491	25

Table 2 – h-index and IF for several international journals related to the civil engineering area

Journal	h-index	IF
Journal of Hazardous Materials	62	4.144
Cement and Concrete Research	49	2.376
Advances in Water Resources	49	2.354
Landscape and Urban Planning	43	2.170
Waste Management	43	2.433
Composite Structures	41	2.006
Engineering Structures	38	1.256
Applied Thermal Engineering	34	1.922
Resources, Conservation and Recycling	34	1.987
Energy and Buildings	33	1.593
Building and Environment	29	1.797
Cement and Concrete Composites	29	1.839
Journal of Hydraulic Research	26	0.801
Construction and Building Materials	25	1.456
Computers and Geotechnics	25	1.229
Materials and Structures	24	0.753
Soil Dynamics and Earthquake Engineering	24	1.340
Journal of Earthquake Engineering	22	0.587
Applied Acoustics	20	0.784
Journal of Management in Engineering	17	2.367
Journal of Urban Planning and Development	11	*
Road and Transport Research	5	*
Computers and Concrete	4	0.351
International Journal of Sustainable Development and Planning	3	*
International Journal for Housing Science and Its Applications	3	*
Road Materials and Pavement Design	3	*
WIT Transactions on the Built Environment	2	*
Journal of Building Appraisal	2	*

Assessment of the highest h-index for civil engineering Professors in top Portuguese Universities

The highest h-index of all the Associate and Full Professors of Civil Engineering Departments in six Portuguese Universities (University of Aveiro-UA, University of Coimbra-UC, University of Minho-UM, New University of Lisbon-UNL, University of Porto-UP, Technical University of Lisbon-UTL) was assessed using the Scopus/Elsevier and excluding self-citations. For Civil engineering five different five areas can be established as follows:

- Structures and Structural Mechanics (EME);
- Building Materials and Construction Technology (MTC);
- Hydraulics and water Resources (HRH);
- Geotechnics (G);
- Territory and Urban Planning; Transports and Highways (UTPV)

Figure 1 shows the highest h-index according to the different five scientific areas in Civil Engineering.

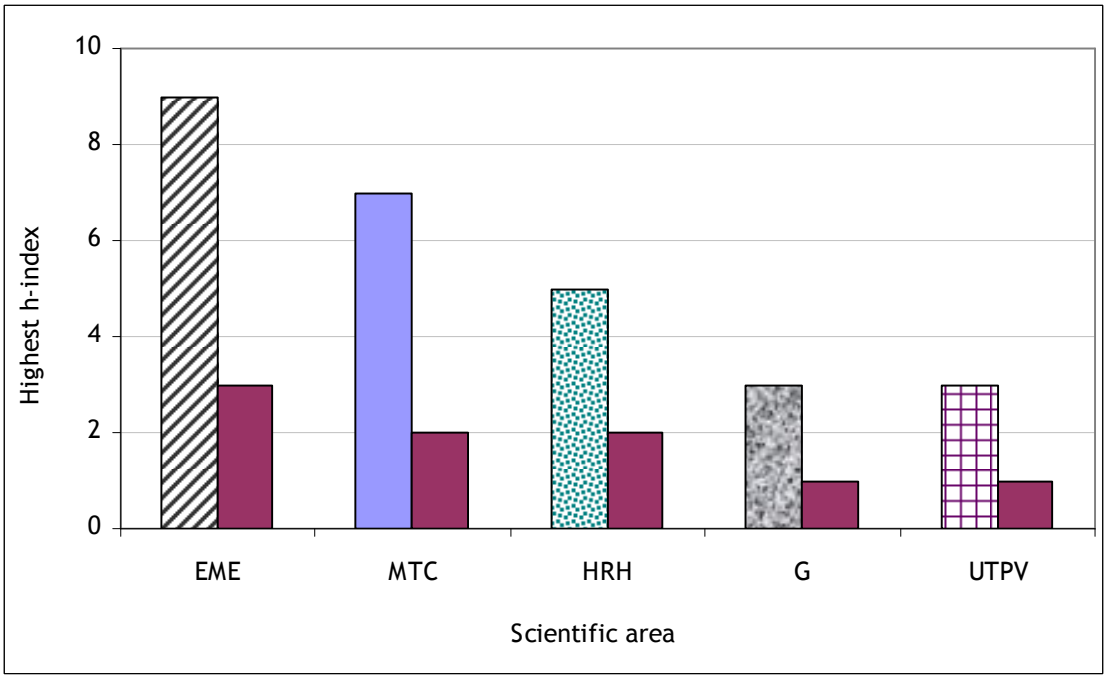

Figure 1 – Highest h-index and median by scientific area

The highest h-index in Civil Engineering is 9 and belongs to a Professor of EME. The h-index of the areas MTC and HRH is respectively 7 and 5, and the areas G and UTPV has the same h-index=3. Although the different areas have different highest h-index, the median h-index is not so different. The different highest h-index can be related to the different number of Professors in each area (Figure 2).

The only exception is the area UTPV that has the same performance of the area G, although it has twice the number of Professors. Figure 3 shows that the Professor with the highest h-index in Civil Engineering works in the University of Minho. This Professor has 70 Scopus journal based papers and 397 citations. He also has an m=0.53 that could be considered a benchmark for young researchers in this area. The University of Coimbra comes in second place although it ranks first in the median of the h-index.

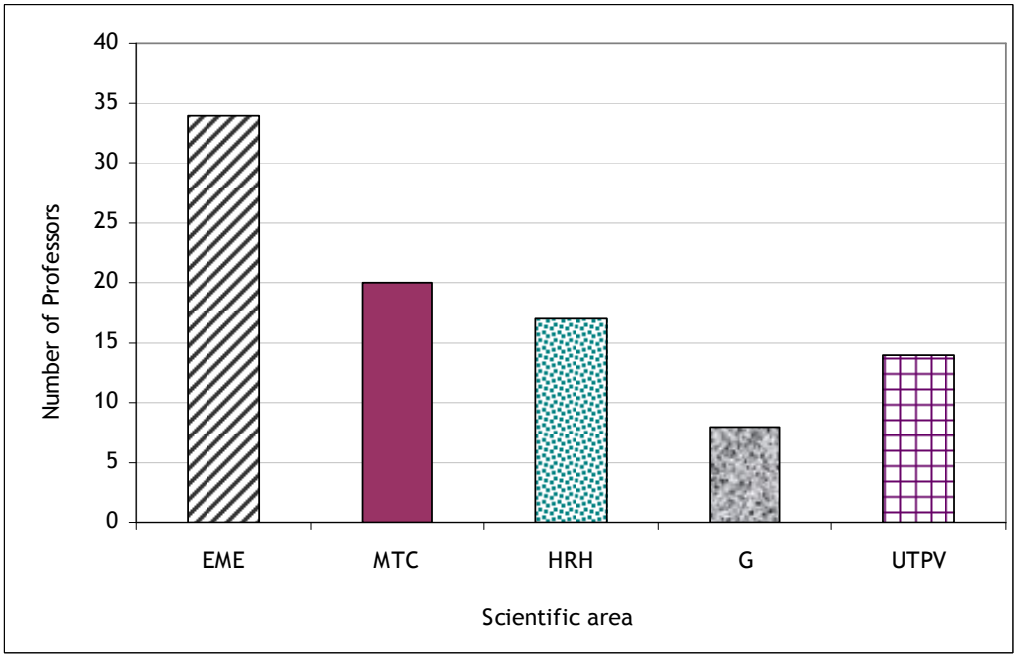

Figure 2 – Number of Professors by scientific area

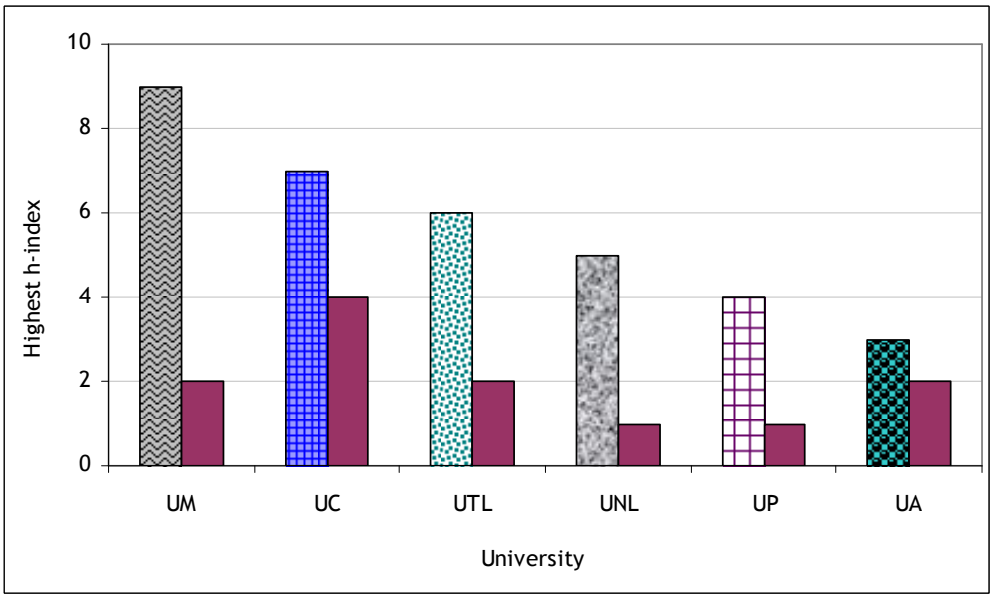

Figure 3 – Highest h-index and median by University

Comparing the h-index with the best world practices in the field of Civil Engineering

Comparisons with top authors in Civil Engineering were made in order to analyze the position of Portuguese Professors in a world level. The Table 3 presents the highest h-index of the reviewers invited by the Portuguese Science and Technology Foundation to evaluate the research projects submitted to the Portuguese Science and Technology Foundation-FCT in the field of Civil Engineering and Mines – 2009.

Table 3 – h-index of the reviewers invited to evaluate the research projects submitted to the Portuguese Science and Technology Foundation-FCT in the field of Civil Engineering and Mines - 2009

Reviewer	University	h-index
David Nethercot – Coordinator	Imperial College London - Department of Civil & Environmental Engineering	10
Chris Cheeseman	Imperial College London - Department of Civil & Environmental Engineering	9
Aronne Armanini	Universita di Trento - Department of Civil & Environmental Engineering	5
Raffaele Landolfo	Università degli Studi di Napoli Federico II - Department of Constructions and Mathematical Methods in Architecture	5
André Plumier	Universite de Liege - Architecture, Géologie, Environnement et Constructions	3
Caspar Groot	TU Delft - Faculty of Civil Engineering and Geosciences	3
Michael J. Kavvadas	National Technical University of Athens - Department of Civil Engineering	2

Only the Coordinator of the review team, the Professor David Nethercot from the Department of Civil & Environmental Engineering of the Imperial College London has a h-index slightly higher than the highest h-index in Portugal. However, one must bear in mind that this h-index have been obtained after a career of 40 years. When analyzing the performance of other senior members of the same Department (Table 4) we conclude that the highest h-index of Portugal in Civil Engineering is in line with the best practices of the ICL.

Table 4 – h-index of some Professors in the Department of Civil Engineering and Environment of the Imperial College

Professor	Position	h-index
J. Bommer	Professor	16
Richard Jardine	Professor	11
Neil Mcintyre	Sénior lecturer	9
Susan Grimes	Full Professor	8
J. Burland	Professor Emeritus	7

A similar behavior happens with some Professors of the Department of Civil Engineering and Environment of MIT (Table 5), in which only Professor Franz-Josef Ulm has an uncommon high h-index.

Table 5 – h-index of some Professors in the Department of Civil Engineering and Environment of MIT

Professor	Position	h-index
Franz-Josef Ulm	Professor	18
Andrew J. Whittle	Head of the Departament	9
Chiang C. Mei	Professor Emeritus	9
Nigel Wilson	Professor	5

As to the comparisons with the highest h-index of Editors of ISI journals related to Civil Engineering (Table 6) it can be concluded that although several of them have a h-index above 10, no one has a h-index above 20, so this can be assumed to be a very rare h-index in Civil Engineering.

Table 6 – h-index of Editors of ISI journals related to the Civil Engineering area

Name	Institution	Journal	h-index
David Barry	Swiss Federal Institute of Technology, Lausanne	Advances in Water Resources	19
Mike Batty	University College London	Environment and Planning B: Planning and Design	16
A. S. Elnashai	University of Illinois	Journal of Earthquake Engineering	15
Karen Scrivener	Swiss Federal Institute of Technology, Lausanne	Cement and Concrete Research	13
Andrew Collop	University of Nottingham	Road Materials and Pavement Design	8
Mike Forde	University of Edimburg	Construction and Building Materials	7

Nevertheless, some considerations must be made about it. First a Editor position is a very visible one so it may have contributed to the increase of their citations and the increase of

the h-index. Secondly, Civil Engineering courses in Portugal are very recent, the majority of the Civil Engineering Departments has less than 40 years old, and University of Minho that has the Professor with the highest h-index has just been found in 1973 so they do not have the dimension of their world counterparts measured in staff, PhD students, Post-Docs or even equipment.

One must bear in mind that the Department of Civil Engineering and Environment of MIT is operating since 1985, so the realities are completely different helping to explain the differences in the h-index. The highest h-index in Civil Engineering in the world is below 20 showing that this area can never be compared with areas like Life Sciences, Physics or even Chemistry, areas in which it is unusual to found a h-index below 20.

The excellence in research according to the Portuguese Science and Technology Foundation-FCT

It was the Sixth Framework Programme- FP6 (2002-2006) that for the first time "*posited excellence as a fundamental principle underpinning European funded research*" (29). According to these authors this new approach came in order to "solve" the European Paradox, i.e, the fact that Europe was strong in scientific performance but unable to transform it into new products and processes. In 2004 the FCT create the Portuguese "Excellence Stimulus" prize to distinguish investigators and Professors in the field of Engineering, Chemistry, Physics, Biologic sciences, biotechnology and life sciences. The criteria for the prize are as follows:
a) to have published 100 papers in the WoS with 500 citations;
b) to have published 50 papers in the WoS, with 250 citations and to have supervised 10 PhD Thesis
The first criterion could theoretically reward an investigator with 100 papers published in low impact journals with only five citations each, or worse an investigator with 99 papers with zero citations and a paper with 500 citations. As to the second criterion it basically cuts by half the demands of the first one and tries to compensate that with the supervision of the 10 PhD Thesis. Unfortunately the supervision of PhDs Thesis can hardly be considered an indicator of excellence, since their quality is dependent on the quality of the University, the quality of the Supervisor, the quality of the Jury etc etc etc.

The distance between the two criteria is so large that it means this prize generates first class and second class excellence. Besides it makes no sense to establish similar criteria for such different scientific areas. This assumption is demonstrated in Table 7 that shows that almost 70% of these prizes have been awarded to investigators and Professors working in the field of Chemistry.

Table 7 – Number of researchers that received the Portuguese FCT-"Excellence Stimulus" Prize by scientific area

Scientific area	Nº
State solid chemistry, materials	10
Molecular synthesis chemistry	7
Bioinorganic chemistry	5
Physics chemestry, photochemestry, spectroscopy and crystallography	10
Theoretical and computational chemestry	2
Analytic chemestry	3
Chemical engineering	4
Health sciences	11
Biologic sciences and biotechnology	5
Biologic engineering and biomaterials	6
Environmental sciences	1
Physics	8
Mechanical engineering	1
Systems and computer engineering	1
Total	74

The common sense contradicts that such a high number of world quality Chemistry investigators could exist in Portugal. Csajbok et al. (2007) analyzed the scientific production of almost 40 countries and 21 scientific areas confirming that the Portuguese Chemistry investigations are lower than the average production. So, the aforementioned criteria cannot real distinguish excellence. Some of the investigators working in the field of Chemistry that have been award with this prize have a h-index below 25. This is a h-index much lower than the h-index of world top Chemistry investigators. For instance the Professor Bjorn Lindman hired in 2008 as a Full Professor for the Department of Chemistry in the University of Coimbra has a h-index=71.

The same low level of h-index pattern occurs with the investigators in the field of Physics awarded with this prize. Eight of them had a maximum h-index=24 and a median h-index=13. One award winner even had a h-index=8 raising serious doubts about his excellence record. These facts clearly demonstrate that the Portuguese FCT-"Excelence Stimulus" prize is based on biased criteria and a better output could be obtained by using a minimum h-index for every scientific field related to the highest h-index of world top investigators in the same field. For Civil Engineering one could considered that a h-index=9 could be considered a excellent performance level.

Conclusions

Created by Hirsch in 2005 the h-index has bee used since then to make rankings of investigators, journals and Universities. This index has some limitations related to the fact that it forget the importance of multiple co-authorship and do not count relevant papers published in conference proceedings or in journals not covered by traditional databases like Scopus and WoS. Besides it cannot be used to assess the complexity of an academic career, because as Einstein put it "*not everything that counts is countable, and not everything that's countable counts*". Still its simplicity justifies its dissemination and acceptance. The assessment of the Portuguese "Excellence Stimulus" prize reveals that it's based on criteria that favor investigators from the field of Chemistry. Replacement of the aforementioned criteria by the h-index could generate a more reliable output to other fields specially Civil Engineering.

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