Research Performance of Tenured Professors in Portuguese Civil Engineering Departments

Fernando Pacheco-Torgal

C-TAC Research Centre, Civil Engineering Department, University of Minho, Guimarães, Portugal

Corresponding author: Fernando Pacheco-Torgal (torgal@civil.uminho.pt)

Abstract: This paper presents a bibliometric evaluation of the research performance of tenured Professors in Civil Engineering Departments of six Portuguese Universities using Scopus/Elsevier database. The research performance of Full Professors in Civil Engineering Departments at the Imperial College London (ICL) and MIT was used as benchmark. The bibliometric indexes used in this assessment were the number of papers in SCI journals, ratio SCI papers/year, number of citations (self-citations excluded); ratio citations/SCI paper, h-index, ratio h-index/year, self-citations percentage and uncitedness rate. Results show that only the Portuguese Civil Engineering Professor with the highest h-index exceeds the average h-index of Full Professors in ICL and almost reach the average h-index of Full Professors in MIT. Top 5% Portuguese Full Professors have more citations and also a higher ratio citations/SCI papers than their counterparts at ICL. The comparison between the average performance of the Top 5% Portuguese Full Professors in the five year period (2009-2013) and their counterparts at the ICL and MIT shows that the former produced slightly more papers, received almost the same citations of ICLs and 64% of the citations received by MITs Top 5% Full Professors in that period.

Key words: Civil engineering, research performance, bibliometrics, SCI papers, citations, h-index, uncitedness rate.

1. Introduction

The scientific competitiveness motto "Publish or perish" [1] led to an exponential increase in the number of publications. This makes it extremely difficult and sometimes even impossible to assess its quality. In many countries and long ago is the assessment of research performance a current practice. The use of bibliometric indexes like the number of papers, number of citations, the h-index and others makes this task easier and allows for direct comparisons between similar scientific areas in different universities and more important for benchmark purposes [2, 3]. In some cases they are even used for promotion and tenure [4, 5]. Citations deserve a special comment because some authors [6] state the number of highly cited researchers can be used as a country level indicator of citation excellence.

This index helps to understand why Switzerland was the most competitive European country concerning the project funding under the Seventh Framework Programme (FP7). This country got 5.3 euro for each euro won by Portugal research proposals, and after normalization to correct the different number of inhabitants of the two countries [7]. This difference is not surprising if we notice that the comparison of the number of "ISI Highly cited researchers" between Switzerland and Portugal favours the former by 75 to 1. Recently this difference decreased to 67 to 2 [8] which is still an amazing difference showing some weaknesses in the excellent citation record of Portuguese researchers. The need to increase Portugal scientific competitiveness implies that first a research performance assessment must be made for all scientific areas. In Portugal such an assessment never took place and only recently the Portuguese Scientific

Foundation (FCT) have hired Elsevier to assess the scientific production of Research Units (RU) in the period 2008-2012 using Scopus database. However, and apart from the fact that it will only evaluates a limited time frame this research assessment does not cover the scientific production of Professors that are not member of any RU and also do not cover the scientific production of Professors that choose not to participate in the research assessment. Furthermore, this assessment in no way will allow for the assessment of the scientific production according to the professional status of researchers. The author thinks this is important because tenured Professors (Associate and Full Professors) have a special obligation concerning scientific production. Even because according to the Portuguese University Professorship Law research activities constitutes the first obligation of University Professors. The assessment of the Portuguese Civil Engineering research performance and its comparison with the best international practices in this area it's crucial for an understanding of its international competitiveness. This paper presents a bibliometric evaluation of the research performance of Associate Professors and Full Professors in Civil Engineering Departments of six Portuguese Universities. The research performance of Full Professors in Civil Engineering Departments at the Imperial College and MIT is used as benchmark submitted to our journal are considered on the understanding that they have not been published, and are not under consideration for publication, elsewhere; and that all persons entitled to authorship have been named and have approved the final version of the submitted manuscript.

2. Data Retrieval Methodology

The research assessment was carried out using the database Scopus/Elsevier in 2014. The scientific production of 124 tenured Professors (78 Associate Professors and 46 Full Professors) in Civil Engineering Departments of six Portuguese Universities as follows:

University of Lisbon (UL)-44 Professors;
University of Porto (UP)-31 Professors;
University of Coimbra (UC)-17 Professors;
University of Minho (UM)-17 Professors;
New University of Lisbon (UNL)-8 Professors;
University of Aveiro (UA)-7 Professors.

The invited Professors were not considered nor the Professors that do not belong to the Civil Engineering area like several Professors of Architecture and Georesources in the University of Lisbon. The option for Scopus/Elsevier database instead of the Web of Science database relates to the fact that the former is much more versatile and much less prone to author name ambiguity problems leading to more reliable results. Also because this database was the one chose by the FCT to assess the scientific production of Portuguese RU in the period 2008-2012. Besides some authors [9] have already shown that the differences between the two aforementioned databases are minimal and do not sustain the hypothesis that the latter covers journals scientifically more relevant. The research performance of Full Professors in Civil Engineering Departments at the Imperial College and MIT was used as benchmark and the bibliometric indexes used in this assessment were as follows:

(a) number of papers in SCI journals;

(b) ratio SCI papers/year, count starting in the first year of the first article;

(c) number of citations received by SCI papers (self-citations excluded);

(d) ratio citations/SCI paper;

(e) h-index;

(f) ratio h-index/year, count starting one year after paper publication;

(g) self-citations percentage;

(h) uncitedness rate, for papers published at least 4 years.

The citations of all co-authors were not considered as already suggested by Lillquist e Green [10] and also because previous investigations [11] showed that the number of self-citations is high enough to alter the

citation impact assessment. However, other authors [12] have decided to include self-citations.

3. Results and Interpretation

Fig. 1 shows the average number of SCI papers published by tenured Professors in Portuguese Civil Engineering Departments. The tenured Professors of UA show the best performance with an average value of 37 SCI papers. Secondly comes the tenured Professors of UC with 29 SCI papers, UL and UM follows with more than twenty SCI papers and last comes the tenured Professors of UP and UNL respectively with 16 and 10 SCI papers. When the production is analyzed according to the academic position the results show that Full Professors of UA still come in the first place with 46 SCI papers, the Full Professors of UC, UL and UM come in the second place with an average of almost 40 SCI papers.

Finally comes the Full Professors of UP and UNL with half the number of papers of UA Full Professors.

The scientific dominance of UA in the number of SCI papers also occurs for Associate Professors (33) twice the number of SCI papers authored by Associate Professors in UC, UL and UM, three times the production of UP Professors and four times the number of SCI papers authored by Associate Professors of UNL. The benchmarking for this bibliometric index is not favourable to Full Professors in Portuguese Civil Engineering Departments just because the average number of SCI papers of Full Professors in ICL (94)
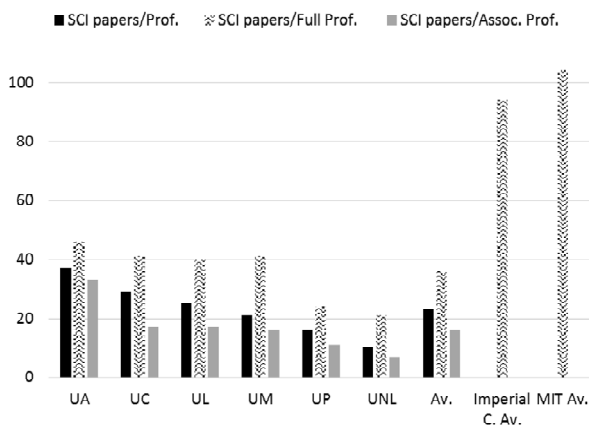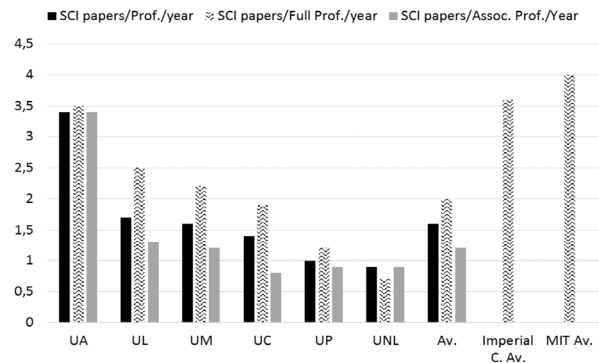

Fig. 2   Ratio SCI papers/year.

and in the MIT (104) is much higher. Even the Full Professors in UA which have the best average production concerning SCI papers are very far from ICL/MIT paper production. Concerning the ratio SCI paper/year (Fig. 2) again tenured Professors in UA lead Civil Engineering in Portugal.

The results show that in UA Full Professors and Associate Professors have a similar ratio. The tenured Professors of the other five Civil Engineering Departments show a lower SCI paper/year ratio but in all (except for UNL) Full Professors clearly score above Associate Professors. The average Portuguese ratio of 2 SCI papers/year is well below the performance of ICL (3.6) and MIT (4) but the differences are not as high as for the previous bibliometric index. Besides the ratio of Full Professors in UA is almost the same as of ICL and near the one of MIT. Fig. 3 shows the number of citations received by SCI papers authored by tenured Professors in Portuguese Civil Engineering Departments.
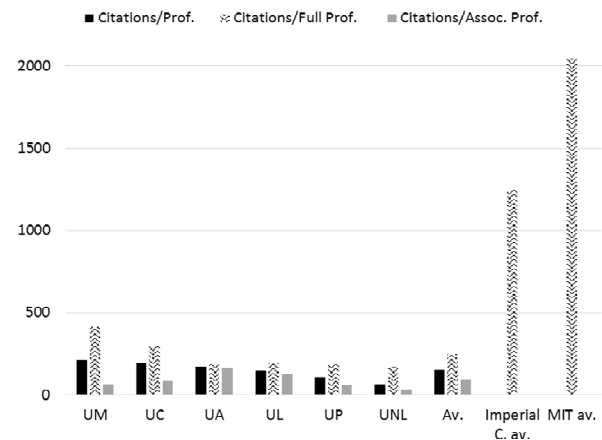

Fig. 1   Number of papers in SCI journals.

Fig. 3   Citations.

With 209 citations the tenured Professors of UM lead this index followed by the Professors of UC (194). UA and UL are close to UC and Professors at UP and UNL show a performance that is respectively 33% and 51% when compared to UM. In all six Civil Engineering Departments the number of citations received by papers authored by Full Professors is well above the citations of Associate Professors papers and the major difference takes place at UM (412 versus 67). The benchmark for this index is clearly unfavorable to Portuguese Civil Engineering because the average number of citations received by SCI papers authored by Portuguese Full Professors (243) is well below the number of citations received by the SCI papers of their counterparts in ICL (1241) and in MIT (2043). This can due to the fact that the latter has three times more SCI papers, to the fact that probably ICL and MIT´s Professors usually publish in higher impact factor journals and also to its high visibility as top universities. Antonakis et al. [13] mentioned that the papers with co-authorship from top universities are more prone to be cited. Concerning the ratio citations/SCI paper (Fig. 4) the tenured Civil Engineering Professors of UC and UNL have the lead position with 7 citations per SCI paper, Professors at UL have 6 citations per paper (the same result of the national average) and the tenured Professors of the remaining Portuguese Civil Engineering Departments have 5 citations per paper.

With 9 citation per paper the Full Professors from UC present the best performance among all Full Professors. Full Professors of UNL, UM and UP follow with 7 citations per paper, Full Professors from UL and UA have respectively 6 and 5 citations per paper. The national average for Full Professors (7 citations per SCI paper) is clearly below the average citations per paper for Full Professors in ICL (13) and for MIT's (19). Fig. 5 shows the results of the h-index.

This index was first suggested in 2005 by the Physicist J. Hirsch from de University of Californian order to evaluate the impact and the relevance of the
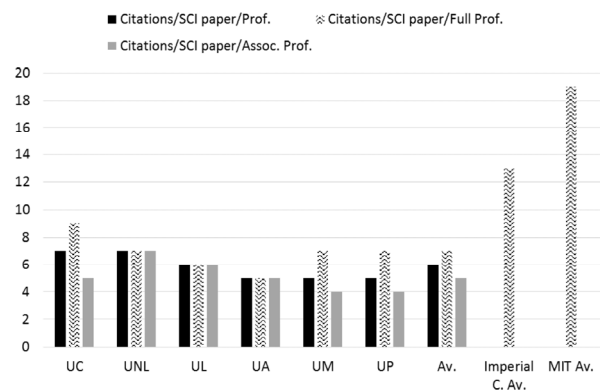

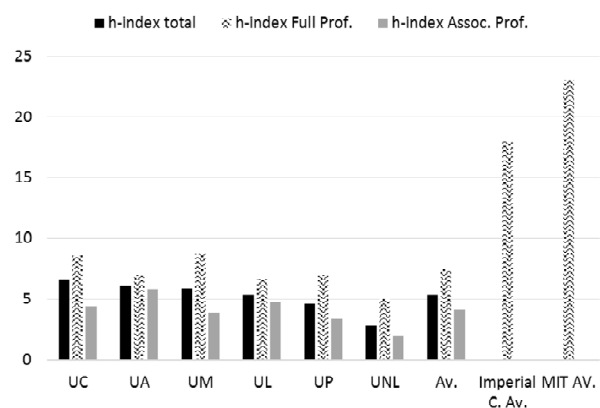**Fig. 4   Ratio citations/SCI paper.**

Fig. 5   H-index.

scientific production of an investigator. So far the paper in which the h-index was suggested received an astonishing number of 1950 citations on Scopus data base and 1651 citations on Web of Science. According to Hirsch the h-index of an investigator means that he has h papers with at least h citations. The h-index provides the 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 taken isolated. The higher average h-index for Portuguese tenured Professors in civil engineering departments occur at UC (7), UA and UM tenured Professors follows with an average h-index = 6, tenured Professors at UL and UP have an average h-index = 5 and the last position is for UNL Professors (h-index = 3). When the h-index is analyzed according to the academic position the results show that Full Professors at UC and UM have an identical performance (h-index = 9), Full Professors at UA, UL

and UP have an h-index = 7 and again the last Portuguese Civil Engineering position goes to UNL Full Professors (h-index = 5). The national average h-index for Portuguese Full Professors in Civil Engineering Departments is similar to their counterparts in Greek Civil Engineering Departments [12] however the Full Professors of the University of Patras having an average h-index = 10 (self-citations excluded) are slightly above the best Portuguese Full Professors performance. The Portuguese Full Professors h-index national average (7) is clearly below the h-index for Full Professors in ICL (18) and its just 30% of MIT´s Full Professors performance (h-index = 23). It's worth remembering that a study over a sample of 750 Full Professors in top Universities in the Academic ranking of World Universities (ARWU) found a median h-index = 10 (self-citations excluded) in the Web of Science for the field of civil engineering [10]. Recently UA open a position for Teaching Assistant in the field of Biology requiring a minimum h-index = 13 [14], which is much higher even than the typical Full Professors h-index for civil engineering, however the study of Lillquist et al. [10] found that Full Professors in Biology have a h-index around 30 (three time the h-index for civil engineering). A recent survey confirms that different scientific areas have very different h-indexes [15]. Hirsch [16] suggested that for major research universities a h-index around 10-12 would be a typical value for advancement to tenure (associate professor) suggesting an h-index around 18 for advancement to full professor (in the field of physics). One must bear in mind that the field of physics has investigators with a very high h-index. The highest belonging to the theoretical physicist Edward Witten (h-index = 110), known for this crucial works about the String Theory. Hirsch analyzed the h-index of the investigators who received the Nobel Prize in physics in the last 20 years noticing that 84% had an h-index above 30. The average percentage of self-citations (Fig. 6) stays below 25% for all Professors in all the six Civil Engineering Departments.
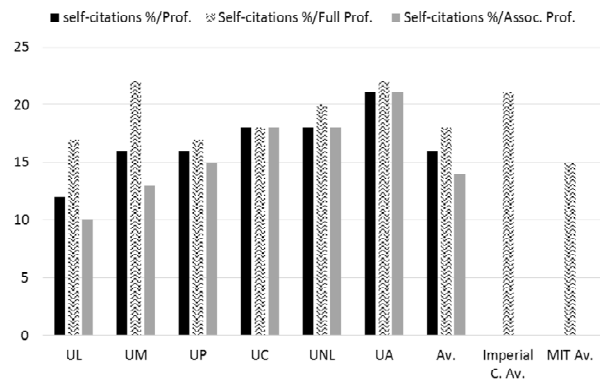

Fig. 6   Self-citations percentage.

Full Professors at the ICL show a 21% self-citations and MIT's Professors has a self-citations percentage of 15%. Since the self-citations national average percentage for all Portuguese tenured Professors is 16% this means that the performance of Civil Engineering Portuguese Professors are within the range of the best practices in this field. It is important to notice that the average self-citations percentage of Full Professors at ICL is not negligible as suggested by Kazakis [14]. Fig. 7 shows the ratio h-index/year. This index designated as "m" by Hirsch allows for a dynamic view of the h-index evolution through time. Only by the use of "m" is it possible to compare the citation patters of two authors in the same field whose career span is very different. According to Hirsch (2005) a physicist can be considered a successful one if after 20 years it has an h-index = 20 (m = 1). To achieve an 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 an h-index = 60 (m = 3) they are truly unique scientists.
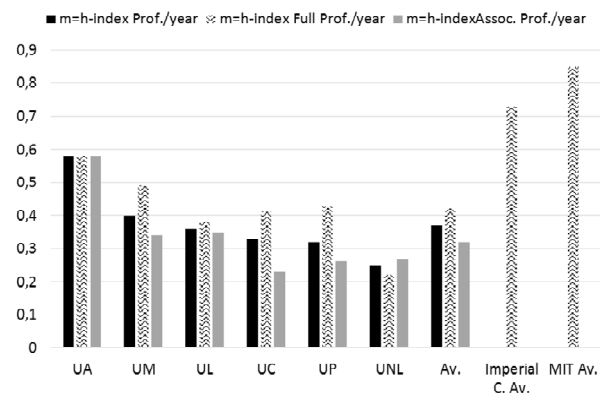

Fig. 7   Ratio h-index/year (m).

Concerning Portuguese Civil Engineering Professors the results show that UA tenured Professors are on the lead with an m = 0.58 while UCs that were on the top position of the h-index are downgraded to the fourth "m" position. This means that the former higher h-index benefited from a longer career span. UM tenured Professors have the second best national (m = 0.4). However Ums performance is much more related to UM Full Professors which compensate a lower performance of the Associated Professors in this University. With an m = 0.36 UL tenured Professors come in third place. In this University the m performance for Associate and Full Professors is similar. UC and UP tenured Professors are both at the fourth position. In this Universities Full Professors contribute much more to the ratio h-index/year than Associate Professors. Finally with m = 0.25 UNL tenured Professors occupy the last position. The national average m = 0.42 for Portuguese Full Professors is clearly below than ICLs m = 0.73 is only half the average m for Full Professors at MIT. The results show that the higher h-index (21) in Portuguese tenured Professors (Fig. 8) belongs to a Full Professor of UM.

A previous study [11] showed that in 2010 this Professor had an h-index = 9, which means that since then it grew an amazing 3 points per year. The use of the algorithm developed in Northwestern University by Acuna et al. [17] shows his the h-index will reach 31 by 2017 which represents an increase of 3.3 points per year. For the remaining Universities the higher h-index for Full Professors can be order as follows UP (15),
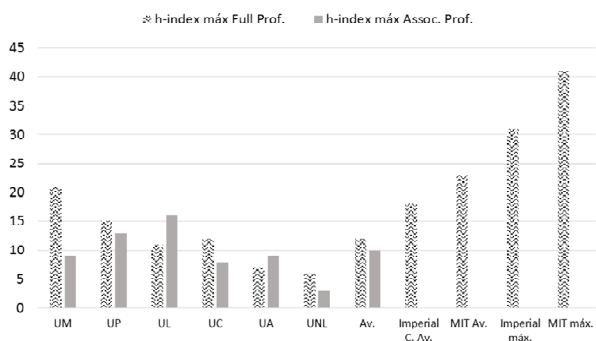
UC (12), UL (11), UA (7) and UNL (6). The higher h-index for Associate Professors belongs to a Professor of UL. The average of the higher h-index for Full Professors (12) is about 67% of its counterpart's average h-index in ICL and 57% of MITs Full Professors average h-index. Although the highest Portuguese Full Professors h-index (21) exceeds the average ICL h-index and almost reaches the MITs h-index average it represents only 67% of the highest ICL h-index (31) and only 51% of the highest MIT h-index (41). Fig. 9 shows the self-citations percentage for Professors with the highest h-index.

When this are compare to the average percentage of self-citations in Fig. 6 it's possible to see that one Associate Professor and a Full Professor at UL and a Full Professor at UC exceed the 25% self-citation threshold. The lowest self-citations percentage belongs to Professors at UNL, where the Associate Professor with the highest h-index has zero self-citations. The ratio h-index/year for Professors with the highest h-index (Fig. 10) shows that UL Professors are on the lead, followed by Professors at UM and UP. UC, UA and UNL perform below the national average. The highest ratio h-index/year = 1.6 belongs to an Associate Professor at UL, this represents twice the national average ratio.

On the other hand this national average ratio is very near the average ratio at ICL and MIT. Fig. 11 shows the uncitedness rate of SCI papers authored by the Professors with the highest h-index. The Professors at UM have the lowest uncitedness rate where the
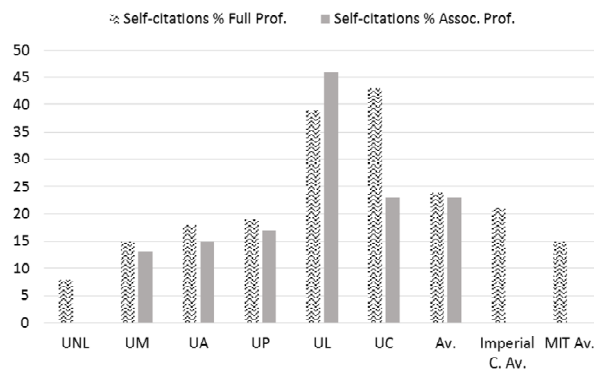

Fig. 8   Highest h-index.

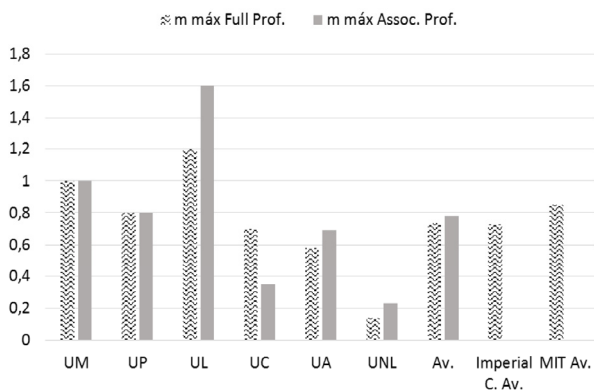**Fig. 9   Self-citations percentage of the Professors with the highest h-index.**

Fig. 10   Ratio h-index/year (m) of the Professors with the highest h-index.
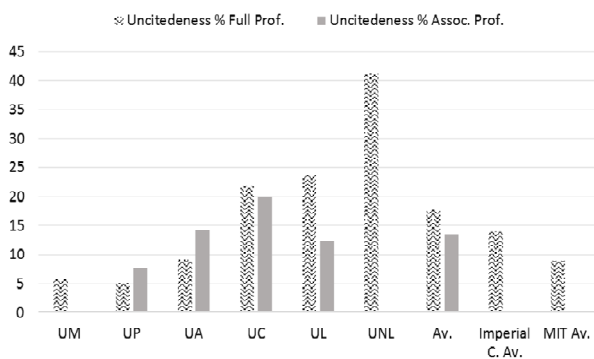

Fig. 11   Uncitedness rate of the Professors with the highest h-index.

Associate Professor with the highest h-index has an uncitedeness rate of zero. Professors at UP and Full Professors at UA has an uncitedeness rate below 10% which is the also the performance of MITs Full Professors and can be considered a benchmark. Associate Professors at UA and Professors at UC, UL and UNL exceed the 10% uncitedness rate.

The same occurs for ICLs Full Professors. The highest uncitness rate belongs to a Full Professor at UNL however the Professor with the highest number of uncited papers (19) belongs to UC. A close look to this 19 papers shows that 39% where published in ISI journals with an impact factor below 1.8, 11% concern papers published in SCI-Q2 journals, 13% were published in SCI-Q3 journals and the remaining 37% were published in SCI-Q4 journals. This seems to confirm the previous results of Van Leeuwen and Moed [18] who found that the uncitedness rate is impact factor related just because that low impact

factor journals show the highest percentage of uncited papers. Recent studies [19-21] developed mathematical models to validate this. This means that for civil engineering field the importance of publication in high impact journals already mentioned by Canas-Guerrero et al. [22] will be an increasing future trend not only to increase the number of citations but also as a way to minimize the uncitedness rate. Table 1 shows the average value of six bibliometric indexes for the tenured Professors in Civil Engineering Departments of the aforementioned six Portuguese Universities.

They show that the average scientific production of Full Professors in all the six indexes is clearly above the production of Associate Professors especially concerning the number of SCI papers (225%) and the number of citations received by SCI papers (261%). Table 2 shows the value of the same bibliometric indexes but for the top 5% most productive tenured Professors.

The results show that the top 5% Full Professors perform better than the top 5% Associate Professors

Table 1   Average performance of the Portuguese tenured Professors.

	Tenured Professors	Associate Professors	Full Professors
SCI papers	23	16	36
SCI papers/year	1.6	1.2	2.0
Citations	150	93	243
Citations/SCI papers	6	5	7
h-index	5	4	7
h-index/year	0.37	0.32	0.42

Table 2   Average performance of the top 5% tenured Portuguese Professors.

	Tenured Professors	Associate Professors	Full Professors
SCI papers	65	50	80
SCI papers/year	4.0	4.0	4.0
Citations	758	459	1057
Citations/SCI papers	11	9	13
h-index	15	12	18
h-index/year	0.9	1.0	0.9

concerning the number of SCI/papers (160%), the number of citations (230%), the ratio citations/paper (144%) and the h-index (150%).Table 3 shows the performance of the top 5% most productive Full Professors at ICL and MIT.

Top 5% Portuguese Full Professors have number of SCI papers similar to ICLs but lower than MITs. Top 5% Portuguese Full Professors have more citations and also a higher ratio citations/SCI papers than their counterparts at ICL. The average performance of the top 5% Portuguese tenured professors in the five year period (2009-2013) is shown in Table 4.

The results show that the Top 5% tenured Professors show a 175% increase of the ratio SCI papers/year when compared to their overall career ratio. This increase is due much more to the Top 5% Full Professors that to the Associate Professors whose ratio increased 135%. The increase in the impact can be seen by the fact that the h-index obtained in just five years represents 50% of the h-index obtained during the overall career. This can also be seen through the h-index/year which increased from 0.9 to 1.4. The comparison between the average performance of the Top 5% Portuguese Full Professors in the five year period (2009-2013) and their counterparts at the ICL and MIT (Table 5) shows that the former produced slightly more papers, received almost the same citations of ICLs and 64% of the citations received by MITs Top 5% Full Professors in that period.

Still this is an amazing performance since Portuguese Professors has much lower financial resources and much less visibility. Table 6 suggests minimum bibliometric indexes for a five year period

Table 3   Average performance of the top 5% Full Professors at ICL and MIT.

	ICL	MIT
SCI papers	84	128
SCI papers/year	8,4	6.1
Citations	974	2776
Citations/SCI papers	12	22
h-index	19	30
h-index/year	2.1	1.6

Table 4   Average performance of the top 5% tenured Portuguese Professors in the five year period (2009-2013).

	Tenured Professors	Associate Professors	Full Professors
SCI papers	34	27	44
SCI papers/year	7.0	5.4	8.8
Citations	180	155	229
Citations/SCI papers	5	6	7
h-index	7	7	8
h-index/year	1.4	1.3	1.6

Table 5   Average performance of the top 5% Full Professors at ICL and MIT in the five year period (2009-2013).

	ICL	MIT
SCI papers	42	40
SCI papers/year	8.4	8.0
Citations	235	354
Citations/SCI papers	6	9
h-index	10	9
h-index/year	2.0	1.8

Table 6   Suggested minimum bibliometric indexes for a five year period in the area of civil engineering according to the research performance.

	SCI papers/year	Citations/paper	h-index
Exceptional	5	6	7
Excellent	4	-	
Very Good	3	-	
Good	2	-	
Fair	1	-	
Poor	<1	-	

in this area according to the research performance to be used by the reviewers of the Portuguese national funding agency for science, research and technology-FCT.

4. Conclusions

This paper presents a bibliometric evaluation of the research performance of Associate Professors and Full Professors in Civil Engineering Departments of six Portuguese Universities. The research performance of Full Professors in Civil Engineering Departments at the Imperial College and MIT is used as benchmark. The results show that UA Professors lead the number of SCI papers and that UM Professors lead the number

of citations. The bibliometric index with the worst performance concerns the average number of citations of papers authored by Portuguese Full Professors which is between 500 to 800% lower than the average number of citations of papers authored by Full Professors in ICL and MIT. Professors at UC and at UNL lead the ratio citations/SCI paper. Concerning the h-index the results show that Civil Engineering Portuguese Professors have a performance similar to that of Greek Civil Engineering Professors. Results also show that only the Portuguese Civil Engineering Professor with the highest h-index exceed the average h-index of Full Professors in ICL and almost reach the average h-index of Full Professors in MIT. UA Professors lead the ratio h-index/year and the highest h-index belongs to a UM Full Professor. The average of the higher h-index for Full Professors is about 67% of its counterpart's average h-index in ICL and 57% of MITs Full Professors average h-index. Although the highest Portuguese Full Professors h-index exceeds the average ICL h-index and almost reaches the MITs h-index average it represents only 67% of the highest ICL h-index and only 51% of the highest MIT h-index. The Professors at UM have the lowest uncitedness rate. This Professors along with Professors at UP and Full Professors at UA has an uncitedness rate below 10% which is the also the performance of MITs Full Professors and can be considered a benchmark. Top 5% Portuguese Full Professors have more citations and also a higher ratio citations/SCI papers than their counterparts at ICL. The comparison between the average performance of the Top 5% Portuguese Full Professors in the five year period (2009-2013) and their counterparts at the ICL and MIT shows that the former produced slightly more papers, received almost the same citations of ICLs and 64% of the citations received by MITs Top 5% Full Professors in that period. Still this is an amazing performance since Portuguese Professors has much less much lower financial resources and visibility. It is suggested that the minimum bibliometric indexes for a five year period in

this area for an exceptional performance are 5 SCI papers/year, 6 citations/SCI paper and an h-index = 7.

References

[1]   W.O. Hagstrom, Competition in science, American Sociological Review 39 (1974) 1-18.

[2]   R. Tussen, M. Visser, T. Van Leeuwen, Benchmarking international scientific excellence: Are highly cited research papers an appropriate frame of reference?, Scientometrics 54 (2002) 381-397.

[3]   T. Ryan, W. Woodall, The most cited statistical papers, Journal of Applied Statistics 32 (2005) 461-474.

[4]   A. Austin, The reliability of citation counts in judgment and promotion, tenure, and status, Arizona Law Review (1993) 829-830.

[5]   J. Faria, P. Loureiro, F. Mixon, A. Sachsida, Faculty promotion in academe: Theory and evidence from U.S. economics departments, Journal of Economics and Econometrics 56 (2013) 1-17.

[6]   A. Basu, Using ISI's "Highly cited researchers" to obtain a country level indicator of citation excellence, Scientometrics 68 (2006) 361-375.

[7]   L. Parreira, Presentation by the Portuguese Secretary of State for Science, in: Science 2012-Meeting Paths for Excellence in Science and Technology, 2012. (in Portuguese)

[8]   HCR, Highly cited researchers, [Online], http://highlycited.com/.

[9]   E. Archambault, D. Campbell, Y. Gingras, V. Larivière, Comparing bibliometric statistics obtained from the Web of Science and Scopus, Journal of American Society Information Science 60 (2009) 1320-1326.

[10]   E. Lillquist, S. Green, The discipline dependence of citation statistics, Scientometrics 84 (2010) 749-768.

[11]   F. Pacheco-Torgal, Using the h-index to assess the quantity and the quality of the scientific production: The case of civil engineering research in Portuguese Universities, Civil Engineering Journal, University of Minho 39 (2014) 23-36. (in Portuguese)

[12]   N. Kazakis, Bibliometric evaluation of the research performance of the Greek civil engineering departments in National and European context, Scientometrics 101 (2015) 505-525.

[13]   J. Antonakis, N. Bastardoz, Y. Liu, C. Schriesheim, What makes articles highly cited? The Leadership Quaterly 25 (2014) 152-179.

[14]   Republic Diary, 2nd serie-N.º 74-15 de Abril of 2014. (in Portuguese)

[15]   L. Czarnecki, M. Kaźmierkowski, A. Rogalski, Doing Hirsch proud; shaping H-index in engineering sciences,

Bulletin of the Polish Academy of Sciences Technical Sciences 61 (2013) 5-21.

[16] J. Hirsch, An index to quantify an individual's scientific research output, Proceedings of the National Academy of Sciences of the United States of America 102 (2005) 16569-16572.

[17] D. Acuna, S. Allesina, K. Kording, Future impact: predicting scientific success, Nature 489 (2012) 201-202.

[18] T.N. Van Leeuwen, H.F. Moed, Characteristics of journal impact factors: The effects of uncitedness and citation distribution on the understanding of journal impact factors, Scientometrics 63 (2005) 357-371.

[19] J.W. Hsu, D.W. Huang, A scaling between impact factor and uncitedness, Physica. A 391 (2012) 2129-2130.

[20] L. Egghe, The functional relation between the impact factor and the uncitedness factor revisited, Journal of Informetrics 7 (2013) 183-189.

[21] Q. Burrell, A stochastic approach to the relation between the impact factor and the uncitedness factor, Journal of Informetrics 7 (2013) 676-682.

[22] C. Guerrero, F. Mazarrón, A. Pou-Merina, C. Calleja-Peru, F. Suarez-Tejero, Analysis of research activity in the field "Engineering, Civil" through bibliometric methods, Engineering Structures 56 (2013) 2273-2286.