Impact and Productivity of PhD Graduates of Computer Science/Engineering Departments of Hellenic Universities

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Abstract—This article presents an anatomy of PhD programmes in Hellenic universities’ departments of computer science/engineering from the perspective of research productivity and impact. The study aims at showing the dynamics of research conducted in computer science/engineering departments, and after recognizing weaknesses, to motivate the stakeholders to take actions that will improve competition and excellence. Beneficiaries of this investigation are the following entities: a) the departments themselves can assess their performance relative to that of other departments and then set strategic goals and design procedures to achieve them, b) supervisors can assess the part of their research conducted with PhDs and set their own goals, c) former PhDs who can identify their relative success, and finally d) prospective PhD students who can consider the efficacy of departments and supervisors in conducting high-impact research as one more significant factor in designing the doctoral studies they will follow.

1 INTRODUCTION

Nowadays the availability of rich bibliometric data in online databases such as Google Scholar, Elsevier Scopus, Thomson Reuters WoS allows for the data-centric study of the performance of various entities participating and shaping the research landscape. In an increasing fashion, decision makers related to promotions, funding, strategic orientation are asking for the exploitation of these data concerning ‘individuals’ (ranging from scientific articles to PhD students, post doctorals, faculty members), as well as ‘collections of individuals’ (ranging from journals, to universities, institutions, companies) to backup their decisions. There is really huge literature on this topic of data-centric (bibliometric) evaluations, and it is not within the scope of the present article to survey them (even in a brief manner); instead it directs the interested reader to begin his/her investigation from a couple of recent books [22], [28]. The use of such quantitative measures in research evaluation is under constant debate; for a discussion on the benefits and dangers of research evaluation using bibliometric methods, the reader is directed to [8] and [18].

Departing from all previous national and international studies we investigate in this article the performance of both individuals and organizations from the perspective of PhD studies. In particular, we compare in terms of productivity, impact and a proxy of both productivity and impact (with the $h$-index [10]), the lifetime performance of PhDs of Hellenic universities’ departments of computer science/engineering, and based on that analysis, we evaluate the success of their supervisors and of the respective departments. The salient hypothesis in our study is that the future success of a PhD has its origins (at a significant degree) in his/her PhD studies. This hypothesis does not precludes the positive assessment of PhDs who never followed a research career after their graduation, because their impact still continues to ‘grow’ and their work can still attract interest, in case it was influential and innovative. On the other hand, this hypothesis does not preoccupies the positive assessment of PhDs who followed/follow research careers, because their current quantifiable performance might show strong evidence of moderate or even low performance.

The motivation of this study stems from authors’ personal interest and their belief that several stakeholders can benefit from this investigation. In particular, the departments can assess their relative performance and then set strategic goals and design procedures to improve themselves and promote competition and excellence. Supervisors can assess the part of their research conducted jointly with PhDs and set their own goals for self-improvement and excellence. Former PhDs can identify their relative success and draw conclusions to use in their current jobs, and finally prospective PhD students can consider the efficacy of departments and supervisors in conducting high-impact research as one more significant factor in designing the path in their doctoral studies.

The rest of this article is organized as follows: Section 2 describes which departments are evaluated here; Section 3 presents some gross statistics and establishes the soundness of the present investigation; Section 4 shows the results which concern the performance of the supervisors, and Section 5 gives the details of PhDs’ performance; Section 6 which is the heart of the present article, presents the ranking of the departments; Section 7 describes our data collection methodology and its challenges; Section 8 surveys some related work on evaluations of Hellenic universities’ departments, and finally Section 9 concludes this article.

2 THE EVALUATED DEPARTMENTS

The task of data collection that would feed our study turned out to be quite tough; the challenges are described in Section 7. We ended up having available data for 15 university departments, which are shown in Table 1 sorted according
to their key. In the rest of the article, this key will be used as the name of the respective department.

| Key     | Department's name                                      | Location |
|---------|--------------------------------------------------------|----------|
| AEGEAN_JCSD | Department of Information & Communication Systems Engineering | Samos    |
| AUEB_DI  | Department of Informatics                               | Athens   |
| AUTH_DI  | Department of Informatics                               | Patras   |
| AUTH_ECE | Department of Electrical & Computer Engineering          | Thessaloniki |
| CRETE_CSD | Computer Science Department                             | Chania   |
| IOAN_CSE | Department of Computer Science & Engineering             | Ioannina |
| IONIO_DI | Department of Informatics                               | Corfu    |
| NTUA_ECE | Department of Electrical & Computer Engineering          | Athens   |
| PATRAS_ECE | Department of Electrical & Computer Engineering          | Athens   |
| PELOP_DI | Department of Informatics & Telecommunications           | Patras   |
| CA_DI    | Department of Informatics & Telecommunications           | Corfu    |
| UNIPI_DI | Department of Informatics                               | Piraeus  |
| UTH_DUB | Department of Computer Science and Biomedical Informatics | Lamia    |
| UTH_ECE | Department of Electrical & Computer Engineering          | Volos    |

**TABLE 1**

Departments studied and their respective key used to represent the department in the plots.

Eight of them are departments which belong to the faculty of sciences in their university (we will call them collectively the ‘science departments’), and the rest belong to the faculty of engineering of their university (we will call them the ‘engineering departments’). Six out of fourteen departments reside in the three major Greek cities, namely Athens, Thessaloniki and Piraeus, and we will call them ‘the central departments’, whereas the rest – called ‘the peripherals’ – reside in various Greek cities, both in the mainland and in islands. Figure 1 shows the geographical location of the evaluated departments.

![Geographical distribution of evaluated departments.](image)

**Fig. 1.** Geographical distribution of evaluated departments.

Table 2 shows the time span covered by our data for each department. This interval does not necessarily coincides with the interval that the respective department has been awarding PhDs. The table also shows the total number of PhDs awarded during that interval.

In other words, we used the productivity and impact data of 2328 PhDs awarded from 15 departments to carry out evaluation involved persons (PhDs and PhDs supervisors) and departments. Our two measures of efficiency are productivity and impact. When the term ‘productivity’ is used to describe the output of a department or a supervisor, then it refers to the number of awarded PhDs, but when it is used to describe the output of a PhD, then it means the number of articles authored by this PhD. We measured the impact of both persons and departments in terms of the number of citations. Should we had more rich data, we could quantify the impact in terms of the prestige of jobs acquired after graduation, in terms of the number of patents granted, in terms of average salaries, and so on. However, in this study, we follow the standard bibliometric model by means of citation counting.

We will start presenting our results in the next section by showing how the productivity of each department collectively varies with time, and we will argue about the validity of our methodology to compare PhD programmes that have started in different time instances.

3 **A MACROSCOPIC VIEW OF PRODUCTIVITY**

Figures 2 and 3 depict the distribution of awarded PhDs per year and per department for the science and engineering departments, respectively. For comparison purposes, we include in each plot the average number of PhDs over all departments, i.e., both science and engineering. The numbers in the plots are absolute numbers without any normalization, e.g., per department’s faculty size, because the size and composition of faculty members set varies considerably with time, even during the course of a PhD thesis development. In other words, these plots depict the ‘productivity’ of the departments in terms of PhD awardees.

Obviously, the engineering departments award more PhDs, because they are older and thus they have a) more faculty members, and b) more ‘scientifically mature’ faculty members. The first PhD graduates from science departments appear in 1991, compared to 1984 from engineering departments. The generic trend is that the number of PhDs increases with time. We speculate that this is partly due to social reasons (e.g., increased social recognition), and also due to the availability of more funding by the Greek state. This trend was quit steep during the
years 1995 – 2009 (see Figure 4), and in general during the decade of 2000, but it declines during the years of recession. We can see that the number of PhDs drops during the years 2014 – 2015, compared to the respective number during the period 2009 – 2010. Assuming that a PhD takes 4 years to complete, this means that: a) less people are pursuing PhD studies during the economic recession, and/or b) departments have less faculty members, and/or c) faculty members are not willing to supervise many PhD students, and/or d) faculty members have received less funding, in particular from Greek state agencies.

A couple of science departments, namely AUTH_Di and UA_Di are constantly very close or above the average, and the three major engineering departments, namely NTUA_ECE, PATRAS_ECE and AUTH_ECE are clearly above the average. Looking at the growth pattern, we can observe that almost all (except from the very small UTH_DIB) science departments follow the same growth pattern, but only the two major engineering departments (NTUA_ECE and PATRAS_ECE) follow their own pattern.

The average values (depicted in Figure 2-3) show more clearly than Figure 4 the gradual decline (mainly after 2012) of awarded PhDs, as consequence of the economic recession.

Next, we investigate an issue that comprises the stepping stone for the ranking results presented in Sections 4 and 5. We will investigate the correlation between ranking by impact and ranking by graduation year for the PhDs per department. If there is a strong positive correlation, then any ranking scheme is practically worthless, and we cannot recognize any excellence and difference in quality among competitors, because the evolution is governed by the principle of the first-mover's advantage. On the other hand, if the correlation is close to 0 or at most 0.5, then this article’s results on rankings are sound. In general, this question is fundamental in network science research, and represents the battle among the rich gets richer and the fittest survives principles of evolution.

We use the Kendall’s τ rank correlation coefficient to demonstrate how a specific ranking is correlated to another ranking. Here, the Kendall’s tau coefficient considers the list produced by sorting the PhDs according to their graduation year (the least recent PhDs first), and the list produced by sorting the PhDs according to the total number of citations their articles have accumulated. Note that both lists are of the same size i.e., n. Then, the τ value can be computed as:

$$\tau = \frac{n_c - n_d}{n(n - 1)/2}$$

where $n_c$ is the number of concordant pairs, and $n_d$ is the number of discordant pairs. The denominator is the total number of pairs of n items in the lists. For each pair of items in the list, we determine if the relative rankings between the two lists match. For pair of nodes $(i,j)$, if node $i$ is ranked above (or below) node $j$ in both lists, then the pair is called concordant. Otherwise, it is called discordant. Clearly, $-1 \leq \tau \leq 1$. If $\tau = 1$, then the two rankings are in perfect agreement; if $\tau = -1$, then one ranking is the complete reverse of the other. In the ranking list based on the graduation year, there are a lot of ties. Therefore, we used as tie breaking criterion the lexicographic ordering of the PhDs' surnames which is a neutral criterion. Should we have used the non-decreasing
number of citations, then the correlation coefficient would be slightly lower.

Table 3 presents the correlation of rankings based on graduation year and impact for the PhDs in each department. We observe that in most of the cases (eleven out of fifteen, the correlation coefficient is less than or equal to 0.5; this implies that the correlation among the rankings in not strong (in a positive way). There are a several cases where the coefficient is very close to 0 (approaching it either from left or right) meaning that the two rankings are completely uncorrelated. We have even encountered two cases (NTUA_ECE and UTH_ECE) where the coefficient is negative, which affirms that recent PhDs are (slightly) more impactful, on the average. The only cases, where the correlation can be considered strongly positive are for IONIO_DI and PEL_DI which however have not awarded many PhDs and thus the statistical sample is not significant. The correlation is very low, i.e., 0.08 if we consider it across all departments. Therefore, we establish that graduation year and impact are not strongly correlated to each other in a positive or negative way, which is an intuitive result whatsoever.

| Department       | Kendal τ |
|------------------|----------|
| AEGEAN_CSD       | 0.27     |
| AUEB_DI          | 0.17     |
| AUTH_DI          | 0.27     |
| AUTH_ECE         | 0.34     |
| CRETE_CSD        | 0.40     |
| CRETE_ECE        | 0.50     |
| IOAN_CSE         | 0.58     |
| IONIO_DI         | 0.63     |
| NTUA_ECE         | -0.04    |
| PATRAS_ECE       | 0.03     |
| PELOP_DI         | 0.71     |
| UA_DI            | 0.39     |
| UMBR_DI          | 0.11     |
| UTH_DIB          | 0.54     |
| UTH_ECE          | -0.03    |
| TOTAL            | 0.08     |

**TABLE 3**

Correlation between graduation year and impact of PhDs per department. The results do not show a strong correlation among them.

Having established that the graduation year is not really significant to impact, we will refrain from performing any time-based normalization in the results shown in the next sections. The next section presents results about the productivity- and impact-based evaluation of supervisors.

4 Performance of Supervisors

We start our discussion by presenting some plain statistics regarding the number of distinct supervisors, and the average number of PhDs supervised by each one of them in all departments. The first issue we need to consider is whether the study should present the data in an(ly) normalized way. For instance, we could show the average number of PhD graduates of a particular supervisor, where the average would be over the time period starting from the year of first graduate’s graduation to the year of the last graduate’s graduation. We explained in Section 3 why we do not adopt this approach. Moreover, there is a second reason for this; such an approach would bias the results towards supervisors who are ‘active’ for very short periods of time. It would be fairer to normalize over the whole period of the supervisor’s appointment to the specific department; however, this information is not available. Thus, for the supervisors we choose to present raw ‘productivity’ performance results, but normalized over the number of graduated PhDs for the impact performance results.

Table 4 depicts the number of faculty members that have supervised at least one PhD graduate in each department. We cannot translate these numbers into percentages of the total number of faculty members in each department, because we are lacking the respective data. Besides, the number of faculty members in each department varies with time. Comparing the departments AUTH_DI, AUEB_DI and CRETE_CSD with similar number of supervisors, we observe that the former department’s supervisors are twice as productive as the other two departments.

| Department       | distinct supervisors | avg #PhDs per supervisor |
|------------------|----------------------|--------------------------|
| AEGEAN_CSDL      | 8                    | 3.87                     |
| AUEB_DI          | 25                   | 3.08                     |
| AUTH_DI          | 22                   | 5.95                     |
| AUTH_ECE         | 42                   | 4.11                     |
| CRETE_CSD        | 25                   | 5                        |
| CRETE_ECE        | 20                   | 2.15                     |
| IOAN_CSE         | 17                   | 2.52                     |
| IONIO_DI         | 6                    | 1.83                     |
| NTUA_ECE         | 89                   | 11.64                    |
| PATRAS_ECE       | 52                   | 6.55                     |
| PELOP_DI         | 9                    | 2.35                     |
| UA_DI            | 41                   | 5.07                     |
| UMBR_DI          | 18                   | 4.88                     |
| UTH_DIB          | 5                    | 1.2                      |
| UTH_ECE          | 12                   | 3.5                      |
| TOTAL            | 391                  |                          |

**TABLE 4**

Number of faculty members per department that have supervised at least one PhD graduate.

Concerning the top-productive supervisors, in Table 5 we present the top-3 for each department, whereas in Table 6 we present the top-10 across all departments. There are cases where the same person-supervisor has supervised PhDs in different departments; this is the case for instance of prof. Courcoubetis who has supervised PhDs graduates in CRETE_CSD and AUEB_DI. We do not aggregate these numbers, and ask for the understanding of our esteemed colleagues whose statistics might be slightly affected by this decision.

Table 6 shows the top-10 productive supervisors across all departments. It is expected, and at the same time frustrating for the rest of the departments, to see that only supervisors coming from NTUA_ECE — which however is the biggest, oldest department — populate this list.

In the series of plots in Figure 5 we illustrate the distribution of awarded PhDs per supervisor, after ranking the supervisors from the most to the least productive. There are some departments which illustrate a phenomenon where
very few supervisors account for the majority of awarded PhDs. Such departments are the following:  
a) AUEB_DI, where the top-3 accounts for more than 33% of all PhDs 
\((10 + 9 + 7 = 26 \text{ out of } 77)\), b) AUTH_DI, where the top-3 accounts for more than 35% of all PhDs 
\((18 + 15 + 14 = 47 \text{ out of } 131)\), and c) UTH_ECE, where the top-3 accounts for more than 66% of all PhDs 
\((14 + 10 + 4 = 28 \text{ out of } 43)\). Various factors can explain this observation; for instance, 
the high discrepancy in 'scientific quality' among the faculty members, and/or the significant discrepancies in 'seniority' among faculty members, and/or unequal funding among faculty members. On the other hand, there exist departments such as CRETE_CSD, AUTH_ECE, PATRAS_ECE, which present a more uniform distribution pattern.

Figure 6 depicts the histogram of supervisors' productivity, i.e., how many supervisors 
\((y\text{-axis})\) have supervised a specific number \((x\text{-axis})\) of PhDs. The curve is highly skewed; we can see that 204 \((= 91 + 63 + 50)\) out of 391 supervisors, i.e., more than 52%, have supervised at most three PhDs. On the other hand, 18 supervisors (4.6%) have
supervised 527 PhDs (22.6%) – those at the far right end of $x$-axis (with value greater than 20).

Before proceeding to show the results about the top- and lowest-impact supervisors, we need to stress that these results do not necessarily reflect the scientific quality of the respective scientists. There are several reasons behind that, e.g., a) the supervisor does not conduct his/her research mainly with PhDs, but with post-doctoral researchers, with other faculty members, with research institutions’ or industrial personnel, b) the underperformance of the PhD, c) his/her research via PhDs has not received attention yet, but it will in the future, and so on.

Concerning the top- and lowest-impact supervisors, we present in Table 7 the top-3 – by total number of citations normalized to the number of PhDs (rounded to the closest integer value) for each department, and in Table 8 the lowest-3. The selection of top- and lowest-performers was done among those who have supervised at least three PhDs; we feel that this is a rational decision. Thus, we would not show as top-performer, for instance, someone who has supervised, say two PhDs and both of them are in the top-2 of a PhDs ranked list. Similarly, we would show as low-performer someone who has supervised, say three PhDs instead of someone with two PhDs irrespectively of their PhDs’ performance. One could challenge our decision by arguing that it is better to have supervised three PhDs with average or low impact compared to having supervised only one with high impact, and so on.

Nevertheless, our decision is based partly on statistical confidence and partly on our experience while processing these data. This latter factor taught us that the performance of PhDs of the same supervisor is relatively consistent i.e., for supervisors that had awarded three or more PhDs, we almost never observed a situation where a single PhD was responsible for the vast amount of productivity or impact of that specific supervisor; we encountered many cases where some PhD was by far the best of that supervisor, but not orders of magnitude better that the rest of the PhDs of that supervisor. At this point, we need to emphasize that this is the main reason that we have used ‘averages’ to quantify the impact of a supervisor.

| Department | top-1 | top-2 | top-3 |
|------------|-------|-------|-------|
| AEGEAN | Kormentzas (296) | Gritzalis (117) | Kambourakis (102) |
| CRETE | Papatheodorou (411) | Vazirgiannis (396) | Syianakoudakis (306) |
| AUTH-CSD | Filis (696) | Manolopoulos (518) | Vlahavas (417) |
| NTUA-ECE | Stergiou (354) | Karagiannidis (352) | Takoukis (298) |
| NTUA-ECE | Orphanoudakis (107) | Tziritas (925) | Kontakopoulos (425) |
| NTUA-ECE | Kalaitzakis (1065) | Stavrakakis (803) | Zervakis (250) |
| IOAN-CSE | Pitoura (273) | Lagaris (227) | Lykas (192) |
| IOAN-CSE | Vlamis (99) | — | — |
| NTUA-ECE | Papadopoulos (1060) | Sells (972) | Hizanidis (640) |
| NTUA-ECE | Groumpus (1307) | King (689) | Kotsopoulos (319) |
| NTUA-ECE | Simos (510) | Vassilakos (39) | Vlachos (18) |
| NTUA-ECE | Ioannidis (411) | Syvridis (410) | Fasoulis (293) |
| NTUA-ECE | Theodoulakis (294) | Vriviou (157) | Alexandri (107) |
| NTUA-ECE | Houstis E. (270) | Tassoulas (233) | Lalis (108) |

Table 7. Top-3 impactful supervisors per department. The number in parenthesis is the average number of citations received by his/her PhDs.

A consequence of our decision to consider the value of three supervised PhDs as the threshold to include a supervisor into Tables 7 and 8 is that the former table has no entries for UTH DIB (no supervisors has supervised more than two PhDs), and partial entries for IOAN DI (only one supervisor has supervised more than two). Additionally, there are empty entries in Table 8 in all cases where a department has less than 6 supervisors with more than three supervised PhDs, because we have used three of them as entries in Table 7.

Table 8. Bottom-3 impactful supervisors per department, normalized per number of supervised PhDs. The number in parenthesis is the average number of citations received by his/her PhDs.

Contrasting Table 7 to Table 8 we observe significant differences for many departments with respect to: a) the identity of supervisors comprising the tables, and b) the relative ranking of supervisors. This is not a surprising result however. The reader can make his/her own detailed observations.

As mentioned before, Table 8 illustrates the lowest-3 supervisors impact-wise per department. We can see that

2. On the contrary, the ranking of universities will be mainly based on median values, instead of means (averages) because of the evident power-law behavior of individual PhD performance with respect to the entire set of PhDs of a department (cf. Section 5).
even supervisors who have appeared in Table 5 are included in this table as well. A very interesting result (which will be explained in Section 6) concerns the significantly higher performance of the low-performing supervisors coming from CRETE_CSD, CRETE_ECE and AUTH_DI; these supervisors have four to five times the performance of their colleagues appearing in Table6.

Finally, for completeness purposes we include Table 9 to show the worse performing supervisors impact-wise. It seems that UNIPI_DI appears quite frequently on this list.

| avg # citations per PhD | supervisor | Department |
|-------------------------|------------|------------|
| 3                      | Papagioupolos, I. | UNIPI_ECE |
| 4                      | Dokouzianis | Siskos | UNIPI_DI |
| 6                      | Foundas     | UNIPI_DI |
| 11                     | Assimakopoulou | UNIPI_DI |
| 13                      | Ioannides Maria | NTUA_ECE |
| 15                      | Stamoulis G. I. | UTH_ECE |
| 16                      | Sideri      | AUEB_DI |
| 17                      | Bourkas     | NTUA_ECE |
| 18                      | Vlachos     | PEL_DIC |
| 20                      | Chritisoulidis | AUTH_ECE |

Table 9: Bottom-10 impactful supervisors across all departments.

5 PERFORMANCE OF PHDS

As explained in Section 5, impact and graduation year are not strongly correlated, thus we refrain to normalize the results based on time-based parameters. Normalizing by or showing the graduation year is not significant for one more reason; the duration of PhD studies of each PhD is not available to us, and simply normalizing by the year of publication or showing the graduation year is not significant for one reason; the duration of PhD studies of each PhD is not available to us, and simply normalizing by the year of publication

In the h-index based ranking, we show only those PhDs with h-index value greater than or equal to 10 (or the highest ranked PhD only, if there is none with h-index ≥ 10), because of the too many ties at lower values, and thus the low discriminative power of h-index at these levels of performance.

Tables 10-24 present for each department the top-10 ranking of the PhDs based on productivity and impact. We are not going to describe in details the table entries for each department, but will only summarize some generic observations.

- Many of the PhDs which made it into top-10 are now faculty members either in their department or other departments in national or international universities. One could argue that their current position explains their successful statistics, or that their statistics were important for their recruitment; we tend to believe that they are both valid explanations.

- Productivity and impact are not correlated, and thus many PhDs ranked high in terms of total number of published articles are found in lower positions when looking at the impact-based ranking.

- Apart from a couple of PhDs with outstanding performance (e.g., Dimitris Papadias, NTUA_ECE, now professor at HKUST), we do not recognize substantial differences among the top-performing PhDs relative to impact. This is a qualitative observation, however, that needs to be verified quantitatively in a future work.

- Some departments exhibit far stronger inbreeding than others. The analysis of the career paths of PhDs is a very interesting topic on itself. It would be interesting to record percentages of PhDs employed by national or international industries, by national governmental organizations; what percentage of PhDs becomes faculty member in its own department, or in other national or international departments, but this is a separate scientometric task beyond the scope of the current article.

Finally, Table 25 presents the top-50 PhDs based on impact. As expected we will recognize many current faculty members in national or international universities being in the top positions of this list.

Figure 7 presents the contribution of each department in populating the list of top-50, where NTUA_ECE is the dominant department, and CRETE_ECE has significant presence even though it has not awarded many PhDs.

3. We do not present the list of faculty members here, but this information is readily available on the Internet.
6 Rankings of departments

There are several hundreds of bibliometric indicators to describe different aspects of the research productivity and impact of a scientist, and then based on individuals’ performance to describe organizations’ performance, e.g., of a university. In this work, we have used the most common such measures, namely, the number of published articles as the productivity measure, the number of citations as the impact measure, and the $h$-index as a proxy for both productivity and impact.

For each department, we have calculated the median and average values for articles, citations, and $h$-index based on the respective PhDs’ data. We emphasize at this point two issues: a) we recommend the median as the most appropriate performance measure, and b) when there are a lot of ties, then we consider the average value as the most credible performance measure. The reason is due to the nature of the underlying distributions of the number of published articles and received citations. These distributions are high-skewed, i.e., power-law, and a few individuals are responsible for the vast majority of the performance. For such distributions, the mean is not a representative measure; median is preferable. On the other hand, in cases with many ties, e.g., the vast majority of the performance. For such distributions, the mean is not a representative measure; median is preferable.
case, then the average values can be used for comparison purposes. The results are presented in Tables 26-28. The most strong and obvious result is that there is a ‘winner’ department, namely CRETE_ECE, and the other two positions in top-3 are occupied by AUTH_D1 and CRETE_CSD. We were not surprised to see the ‘Cretan’ departments in the top positions, even though they are ‘peripherals’. We had established the research excellence of CRETE_CSD’s faculty in our past work [12], and here we confirm their steady dedication to breathe their excellence into their PhD students.

Focusing on median citation-based impact, which we consider a rather stable and very significant performance measure, it is promising to see ‘peripheral’ departments, namely CRETE_ECE and CRETE_CSD, perform well, especially CRETE_ECE. This is a strong indicator of the potential of these departments to attract and retain top-tier talent in the future.
The 'large', old engineering departments, namely AUTH_ECE, NTUA_ECE and PATRAS_ECE have moderate performance both in terms of productivity and impact, and are located at the middle of the ranking lists when examining their median values. Their performance is slightly better with respect to the average values. An interesting observation is that they perform rather bad with respect to the average h-index, which can be explained by the performance of their individual PhDs, i.e., very few of them have quite large h-index, and the vast majority of PhDs has a single-digit h-index value.

### Table 24

| #articles | #citations | h-index |
|-----------|------------|---------|
| Korakis (139) | Korakis (1419) | Korakis (17) |
| Gkoulalas-Divanis (65) | Georgakilas (1096) | Gkoulalas-Divanis (14) |
| Iosifidis (47) | Paraskevopoulos (818) | Iosifidis (13) |
| Sourlas (43) | Gkoulalas-Divanis (661) | Axenopoulos (12) |
| Maglaras (35) | Iosifidis (477) | Sourlas (11) |
| Athanasious (32) | Axenopoulos (404) | |
| Axenopoulos (30) | Sourlas (350) | |
| Syrivelis (30) | Gkatzikis (250) | |
| Katsaros (25) | Magoulas ( PATRAS_ECE ) | |
| Gkatzikis (22) | Athanasious (187) | |
| Poularakis (20) | Axenopoulos (183) | |
| Keranidis (20) | Poularakis (183) | |

**TABLE 24**

Top-10 PhDs of the UTH_ECE department.

| #articles | #citations | h-index |
|-----------|------------|---------|
| Papadias ( NTUA_ECE ) | | |
| Karagannidis ( PATRAS_ECE ) | | |
| Efremidis ( NTUA_ECE ) | | |
| Vlassis ( NTUA_ECE ) | | |
| Papathanasiou Stav. ( NTUA_ECE ) | | |
| Koutoulis ( CRETE_ECE ) | | |
| Dimeas ( NTUA_ECE ) | | |
| Isoumakas ( AUTH_DI ) | | |
| Kontopanetis ( NTUA_ECE ) | | |
| Andirkopoulos ( PATRAS_ECE ) | | |
| Tsilis ( PATRAS_ECE ) | | |
| Kosmatopoulos ( CRETE_ECE ) | | |
| Zafeiriou ( AUTH_DI ) | | |
| Jetas ( AUTH_DI ) | | |
| Papageorgiou Eip. ( PATRAS_ECE ) | | |
| Kolokotsa ( CRETE_ECE ) | | |
| Stylos ( PATRAS_ECE ) | | |
| Komodakis ( CRETE_CSD ) | | |
| Halkidi ( AUEB_DI ) | | |
| Argyros ( CRETE_CSD ) | | |
| Nanopoulos ( AUTH_DI ) | | |
| Bografis ( UA_DI ) | | |
| Magoulas ( PATRAS_ECE ) | | |
| Georgakilas ( NTUA_ECE ) | | |
| Bakali ( AUTH_DI ) | | |
| Dalamagas ( NTUA_ECE ) | | |
| Rovitsikakis ( CRETE_CSD ) | | |
| Koziris ( NTUA_ECE ) | | |
| Maglogiannis ( NTUA_ECE ) | | |
| Katsaros D. ( AUTH_DI ) | | |
| Vassiliadis ( NTUA_ECE ) | | |
| Simitis ( NTUA_ECE ) | | |
| Vergoulias ( NTUA_ECE ) | | |
| Pieros ( NTUA_ECE ) | | |
| Avgiferiou ( NTUA_ECE ) | | |
| Giatropoulou Evg. ( TEL_DI ) | | |
| Demestichas ( NTUA_ECE ) | | |
| Petrakis ( CRETE_CSD ) | | |
| Argyris ( UA_DI ) | | |
| Isapatsoulis ( NTUA_ECE ) | | |
| Panagopoulos ( NTUA_ECE ) | | |
| Koutrakia ( UA_DI ) | | |
| Stamatakis ( PATRAS_ECE ) | | |
| Arvitis ( NTUA_ECE ) | | |
| Michalopoulos ( AUTH_DI ) | | |
| Pakotakis ( PATRAS_ECE ) | | |
| Siris ( CRETE_CSD ) | | |
| Korakis ( UTH_ECE ) | | |
| Doulimas A. ( NTUA_ECE ) | | |
| Mezaris ( AUTH_DI ) | | |

**TABLE 25**

Top-50 PhDs across all departments according to the total number of citations.

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**Fig. 7.** Departments’ contributions in top-50 impactful PhDs.

7 **DATA COLLECTION**

It is worth mentioning that very few departments maintain publicly accessible electronic files for their PhD graduates, namely AEGEAN_CSD [1], CRETE_CSD [24], UA_DI [23], and UTH_ECE [25]. Moreover, some departments do not maintain electronic files at all for their graduates. Thus, we asked for data – via our colleagues – from the administrative staff of the departments. Unfortunately, not all administrations were able to provide assistance.

We decided to gather the performance data from Scopus instead of Google Scholar or ISI Web of Science. There exist rich literature comparing these bibliographic databases, see for instance [4]. Our main criterion was that Scopus database is cleansed, and it contains both journal and conference publications, which is significant to our study taking into account that conference publications are considered equally important in computer science [19], [29] compared to other disciplines. Especially for Google Scholar, analysis of literature [9] concludes that it currently lacks quality control, clear indexing guidelines, and it can be easily manipulated.

We collected our data mostly manually (by browsing and searching). Scopus provides an API for retrieving data, but the offered data are not as up-to-date as those returned to user browsing. Manual data collection turned out to be the fastest and most effective method. Should we have

4. The following information is undocumented. There are two different databases that Scopus uses, one for the Web, and one for the API, and they do not return the same data. It is close, but not the same; the API database may not be updated as quickly as the Web database.
used Scopus ‘Search Form’ to search for a specific PhD, then we would have very frequently faced the case, where the Scopus maintains different profiles for persons with exactly the same name, making the disambiguation more time-consuming. Thus, we started our browsing from a supervisor’s profile which was relatively easy to discover, because of the wealth of publications s/he has accumulated over the years. Then, we sought for the names of his/her PhDs. This methodology allowed us to detect the correct PhD’s profile in the vast majority of the cases. A first problem arose with the existence of what we call the ‘mixed profiles’; a mixed profile is a single Scopus profile which contains articles belonging to different persons – who share exactly the same name though. We had to manually and very carefully cleanse such profiles (performing joins with other bibliographic databases), because their impact on the final data could be dramatic. For instance, NTUA_ECE’s PhD Ioannis Konstantinou shares a profile with others, and despite the fact that he has written 27 articles gathering a total of 219 citations, his mixed profile mentions 163 articles and 6129 citations. Similar cases appear for AUBB_D1’s PhD George Tsatsaronis, recording 286 articles and 5074 citations instead of the ‘correct’ 32 articles and 382 citations, for CRETE_CSD’ Maria Markaki, and so on. However, there were many cases where the supervisor had no joint publications with some of his/her PhDs. We even encountered a case where the supervisor had no joint publications with any of his PhDs(!). In this case, we had no alternative but to use Scopus ‘Search Form’, and deal with author disambiguation and mixed profiles issues.

The profile data used in this study, i.e., number of publications, number of citations and $h$-index of each PhD, were retrieved by the respective Scopus profiles during the days June 24-25, 2017. As far as we can tell, there were no updates in the Scopus database during these days, so the information gathered for all PhDs concerns the same ‘database instance’. An exception to the collection dates is the UNIPI gathering for all PhDs concerns the same ‘database instance’.

The data were collected in July 3rd. During this week there was a Scopus update, thus this department is slightly benefitted. However, since it performed moderately in the rankings, there is no substantial argument against the validity of the data as a whole. We need to emphasize here, that the Scopus profiles were discovered and processed (to perform author disambiguation, to cleanse ‘mixed’ profiles) in earlier time; during the aforementioned days, we just retrieved the data of interest. Despite the breadth (in areas) and depth (in years) of the Scopus database, we could not find all PhDs Scopus profiles. Table 29 shows the (approximate) percentage of missed profiles in our study. This is due to one or a combination of the following reasons: a) some PhDs have no profile at all in Scopus, because they have published no article(!) in any forum, i.e., journal or conference or collection indexed by Scopus (this holds for both recent, after 2005, and older, before 2000 PhDs); b) the articles of some PhD are quite old (around 1995) and the Scopus data are sparse for this period; c) the authors of the present article were not able to do proper browsing and/or form an appropriate query to find the profile – this is due to the really very different ways used by PhDs to spell their names, for instance ‘John’ versus ‘Ioannis’ versus ‘Gian-

5. https://www.scopus.com/authid/detail.uri?origin=AuthorProfile&authorId=660385934&affAffiliations=

6. At the time of collecting the data for this article.

7. But, not ‘Yanis’ (with one ‘n’).
8 Related work

There exist several articles whose focus is the evaluation of Hellenic universities faculty’s research quality using bibliometric data. After our pioneering work [12], many articles evaluated national departments of computer science/engineering [3, 21] (or international [2, 7]), national chemical engineering departments [14, 17], national civil engineering departments [13], economics departments [11], medical schools [15], or national and international departments from various – such as pedagogical, technological, political science, sociology, marketing – disciplines [3, 20, 26, 27].

To our knowledge this is the first article focusing in the evaluation of university departments’ PhD research programmes under the prism of productivity and impact quantification of the research work conducted in the ‘scientific lifetime’ of their former PhDs. The latent hypothesis of this article is that the research capacity of a PhD is (partly or significantly) shaped during his PhD studies.

9 Conclusions

This article has conducted a bibliometric evaluation of 15 departments of computer science/engineering of Hellenic universities. As a conclusion to the article we would like to record only the three most significant findings of our study: a) there is no correlation among graduation time and impact of the work of a PhD, b) there is no evident correlation among productivity and impact either in the supervisors or in the PhDs realm, and finally c) there is a clear ‘winner’ department across all our measures, and that is CRETE_ECE, followed by AUTH_DI and CRETE_CSD.

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