Ranking Chemical Engineering Departments in Turkey Based on Academic Performance

Türkiye'deki kimya mühendisliği bölümlerinin akademik performanslarına göre sıralanması

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Özet

Bu çalışma, Türkiye'deki kimya mühendisliği bölümlerini son beş yıldaki akademik üretkenliklerine göre sıralamak amacıyla gerçekleştirilmiştir. Literatürde Türkiye'nin üniversitelerini bölüm düzeyinde değerlendirerek sıralayan ilk ve tek çalışma olma özelliğini taşımaktadır. Akademik üretkenliğin hesaplanması için yayınlanmış uluslararası makaleler, tamamlanmış TÜBİTAK destekli araştırma projeleri ve lisansüstü tezler kullanılmıştır. Bölümler hem toplam etkinlik sayılarına, hem de kişi başına düşen etkinlik sayılarına göre sıralanmıştır; toplam etkinliğe göre yapılan sıralamanın toplumun ve bilimsel çevrenin algılarını daha iyi yansıttığı görülmüştür. Değerlendirmeler Türkiye'deki en iyi kimya mühendisliği bölümünün İstanbul Üniversitesi bünyesindeki bölüm olduğunu işaret etmektedir, ilk on bölüm üç büyük şehirdeki (İstanbul, Ankara, İzmir) üniversitelerdedir. Sadece ilk üç sırada yer alan bölümlerin makale üretimleri yurtdışındaki benzer bölümlerin düzeyine ulaşabilmektedir. Akademik olarak aktif olmayan akademisyen ve bölüm sayısı dikkat çekici düzeydedir; akademisyenlerin beşte biri son beş yılda WoS veritabanında dizinlenen dergilerde makale yayınlamamıştır, dört bölümde hiç lisansüstü tez yapılmadığı görülmektedir, sekiz bölümün hiç tamamlanmış projesi bulunmamaktadır. Dikkat çekici bir başka bulgu da yıldan yıla bölüm ve akademisyen sayısının artmasına rağmen toplam akademik çıktı sayısının artmamasıdır.

Anahtar sözcükler: Akademik performans, araştırma değerlendirmesi, bibliyometri, kimya mühendisliği, sıralama.

Abstract

This study ranks the chemical engineering departments in Turkey based on their academic performances during the past five years. This is the first and only study that assesses and ranks the universities of Turkey at departmental level. Published international articles, completed TÜBİTAK research projects and graduate theses were used to calculate the academic performances. The departments are ranked based on both the total number of activities and the number of activities per academician; the ranking of total activities has been found to be a better reflection of public and scientific community perception. The results show that the highest ranked chemical engineering department in Turkey is in Istanbul University, and the top ten departments are located in the leading three cities (Istanbul, Ankara, and Izmir). Only the top three departments in Turkey had comparable publication outputs compared to their international counterparts. The number of departments and academicians which are virtually unproductive in terms of academic output is also significant; one fifth of the academics did not publish any article in a journal that is indexed in the WoS database within the last five years, no graduate theses were produced in four departments, and eight departments did not have any completed projects. Even though more departments and academicians are added to the academic pool every year, total academic output does not increase in parallel.

Keywords: Academic performance, bibliometrics, chemical engineering, ranking, research evaluation.

In contrast to other G20 countries, Turkey has focused on expanding the number and size of its universities in recent years (British Council, 2015): The number of universities increased from 71 to 179, total number of students increased from 1.6 million to more than 6 million between 2011 and 2016 (YÖK, 2016). While there are few number of universities performing well in the global university rankings, majority of the Turkish universities are classified as virtually 'research-inactive', a situation which requires attention (British Council, 2015).

University rankings that have been initially originated in the United States attracting considerable interest of countries. Ranking a university gives an overall picture of its quality. However, many universities are quite heterogeneous, thus,

ranking of individual departments is a worthwhile attempt, and such efforts are quite rare (Lazaridis, 2010).

Evaluations of academic departments through rankings have importance in decision making by government officials, university administrators, and department chairpersons. The first attempts to rate departments goes back to 1964, when survey questionnaire sent to experts were used to yield a rank ordering of departments for each discipline in the USA. The ratings were updated with another survey in 1970. Administrators in federal agencies have used these ratings when evaluating departments and they rapidly became a standard benchmark within the academic community. Simultaneously, numerous voices have been raised in criticism of these survey-based ratings and the methods used to generate them. The primary complaint was that the methods were basically subjective (Drew & Karpf, 1981) and vulnerable to measurement errors. However, most of the competing survey-based academic rankings ask highly consistent questions of those being surveyed, and make the questions sufficiently general in scope that the respondent can provide a meaningful answer. Also, they employ similar response and scoring systems, permitting facile side-by-side comparisons. All-in-all, these surveys pleasantly surprise in terms of the quality of their information. On the other hand, rankings of programs based on publication performance in peer-reviewed journals are appealing because academic journals remain, despite imperfections, the fairest measure of the quality of research (Dusansky & Vernon, 1998).

The h-index or g-index is usually used as indicators of publication performance, because they account not only for an aspect of quantity (the pure number of published articles) but also for an aspect of quality and scientific impact (the number of citations the articles received). The technical limitations of h and g indices have been the focus of a substantial literature; they operate with a limited informational basis that only includes the number of published papers and the number of citations they received. As a measure of research impact, these indices therefore only focus on a specific dimension of knowledge production and dissemination, while consciously disregarding other legitimate dimensions of research, for example patents, participation in research projects, engagement with public or private actors involved in innovation. Therefore, these indices should not be interpreted as an exhaustive measure of the quality of research (Miroiu, Paunescu, & Viiu, 2015).

There were also attempts to rank departments based on prizes, medals, awards, and poll for students (Dusansky & Vernon, 1998; Mixon & Upadhyaya, 2012).

Chemical engineering is a multi-disciplinary branch of engineering which combines natural and experimental sci-

ences along with life sciences. Its applications are not only limited to the design, development and operation of industrial processes, but also involve many biomedical advancements regarding faster disease diagnosis, more efficient drug-delivery mechanisms and improved biomaterials (Kazakis, 2015).

In this concept, this study aims to rank the chemical engineering departments in Turkey based on their academic performances between 2011 and 2015. Three different metrics were used for this purpose; scientific articles published, research projects completed, and graduate theses granted. The study covers the last five calendar years (2011–2015). The obtained rankings were also compared with the minimum national university entrance exam score required to enroll to these departments (Student Selection and Placement System, ÖSYS), which is an indicator of quality as perceived by the public. Finally, the departmental rankings were compared to the university rankings published by University Ranking by Academic Performance (URAP) Research Laboratory of Middle East Technical University in Ankara, Turkey in order to assess the performances of the departments relative to their institutions.

This is the first and the only study in literature that attempts to assess and rank the Turkish universities at departmental level. Even though it is limited to chemical engineering departments, the results provide interesting outcomes which may provide insight on academic performances of engineering faculties and Turkish universities.

Methods

The list of the chemical engineering departments was obtained from the Council of Higher Education of Turkey (CoHE) (YÖK, 2016). The academic staff rosters were retrieved from the official websites of the departments on June 15th, 2016. Only full-time academicians with ranks of assistant professor, associate professor and professor were included (lecturers, research assistants, technicians etc. are excluded from the study). A total of 34 chemical engineering departments hosting a total of 485 academicians were studied. The search was limited to between 2011 and 2015.

Thomson Reuters Web of Science (WoS) database was used to obtain the number of published full scientific (research and review) articles.

The Scientific and Technological Research Council of Turkey (TÜBİTAK) is the leading source of research funds for universities in Turkey, both in terms of number of projects supported and the total amount of funding. Even though there are other governmental and private funds used to finance the R&D projects, no ready-for-use database exist to obtain and evaluate these projects. Thus, TÜBİTAK projects database was used to collect the data for completed research projects.

All of the graduate theses completed in Turkish universities are registered to the database of CoHE. This database has an online interface with search functions, and was used to collect the data on MSc thesis and PhD thesis data of the departments.

Unfortunately, WoS and TÜBİTAK websites do not provide departmental search functions, therefore the searches were made through the names of the academicians and the hits were recorded, and summed up to obtain the relevant data of each department. Common challenges encountered during this laborious process were comparable to the ones reported in other comparable studies (Lazaridis, 2010): the transliteration of Turkish names (in WoS database), names shared by more than one person, names spelled in different ways, etc.

As CoHE database allows departmental screening, the labor required for data collection was considerably reduced.

The ÖSYS data were obtained from official Measuring, Selection and Placement Center (ÖSYM) website (ÖSYM, 2016).

URAP Ranking of the institution that the chemical engineering department belongs to was retrieved from URAP center website (URAP, 2016).

It should be noted that the work conducted is potentially prone to errors due to manual collection and processing of large amount of data. Valuable efforts were put to minimize them, and it is believed that the results are quite reliable and will not affect the rankings obtained.

Results and Discussion

The departments can be ranked based on two criteria; the total number of activities, and the number of activities per academician. The first one shows the overall performance of the department; however, comparatively new and small departments obviously cannot match larger ones in this ranking. On the other hand, the second one shows the overall efficiency of academic staff.

In this study, the results are reported both in terms of the total activities of the department and activities per academician for a more comprehensive assessment.

■▌ Table 1 lists the basic information of the departments studied (institution name, location, and number of academicians) and their academic activities during the last five years by means of SCI articles published, completed research projects supported and financed by TÜBİTAK, and MSc and PhD theses granted. Academic activities are given both in total numbers and per academic basis. Last two columns of the ■▌ Table 1 lists ÖSYS and URAP data.

There are 34 chemical engineering departments in Turkey, eight of them are in Istanbul (the largest and the most crowded metropolis of the country), five of them are in Ankara (the capital city). Both in Izmir and Eskişehir there are two chemical engineering departments, while remaining 17 of them are established in different cities throughout the country.

Average number of academic staff at the chemical engineering departments is 14. With 38 academicians, Istanbul University has the biggest chemical engineering department of Turkey, whereas Osmaniye Korkut Ata University has the smallest department with only four academicians.

The total number of WoS database articles published is 2640, this means 1.1 article/academic year. Of course, the departments diverge greatly here; the highest ranked department produced almost 30 times more articles than the last department on the ranking. It should also be noted that some frequent article publishers increase the averages of otherwise non-productive departments, especially in small departments. This situation results in a misleading high score, since this is more of an individual accomplishment than a departmental one. Examples are departments of Osmaniye Korkut Ata, Marmara, Beykent, Afyon Kocatepe and Pamukkale Universities, where one productive academician published more than half of the articles produced by his/her department. On the other hand, it is also observed that 93 of the 484 academicians (19%) did not publish any article in a journal that is indexed in the WoS database within the last five years.

Previously, it was reported that the average number of publications per year for Chemical Engineering departments in Greece were in the range of 2.6–3.2, and that of Chemical engineering department of MIT was 7.4 (Kazakis, 2015). This study shows that only the three departments in Turkey had a comparable publication outputs: 4.1, 3.1 and 3.0 for the departments of Koç, Beykent and Pamukkale Universities, respectively. At this stage, it should be stated that the cited data were obtained by using a different database (Scopus); thus their direct comparison may not be accurate. However, it looks safe to conclude that most of the Turkish chemical engineering departments have lower publication output compare to their international counterparts.

Another study which ranked the scientific performance of 64 political science, sociology and marketing departments in Romania with the aid of the g-index revealed comparable situations, the researchers reported that the collective performance in a department is associated to a greater degree with a productive core of individuals who have higher individual performance than with the simple quantity of the human resources available to the department. In addition to these intradepartmental differences, strong polarization between the departments was also reported; the distribution of departments presented two clusters similar to the case in this study: one includ-

Table 1. Academic records of Chemical Engineering Departments in Turkey.*

Institution	City	Number of academicians	WoS articles		TÜBİTAK projects		Theses				ÖSYS	URAP
			Total	Per person	Total	Per person	MSc	PhD	Total	Per person		
Afyon Kocatepe University	Afyon	9	14	1.56	2	0.22	8	0	8	0.89	236.3	46
Anadolu University	Eskişehir	15	32	2.13	1	0.07	28	6	34	2.27	297.6	35
Ankara University	Ankara	23	85	3.70	5	0.22	50	15	65	2.83	314.7	4
Atatürk University	Erzurum	26	64	2.46	2	0.08	27	11	38	1.46	221.3	12
Atılım University	Ankara	7	55	7.86	8	1.14	5	0	5	0.71	251.5	40
Beykent University	Istanbul	5	77	15.4	0	0	0	0	0	0	NA	125
Bilecik Şeyh Edebali University	Bilecik	8	16	2.00	0	0	3	0	3	0.38	223.3	128
Boğaziçi University	Istanbul	12	88	7.33	13	1.08	69	16	85	7.08	456.5	14
Bursa Teknik University	Bursa	5	36	7.20	0	0	0	0	0	0	282.6	NA
Çankırı Karatekin University	Çankırı	9	10	1.11	0	0	0	0	0	0	218.3	85
Cumhuriyet University	Sivas	11	40	3.64	1	0.09	31	3	34	3.09	203.1	57
Ege University	Izmir	26	130	5.00	0	0	42	12	54	2.08	334.5	9
Eskişehir Osmangazi University	Eskişehir	22	56	2.55	1	0.05	33	5	38	1.73	287.8	26
Gazi University	Ankara	31	118	3.81	9	0.29	70	25	95	3.06	301.7	7
Hacettepe University	Ankara	13	85	6.54	9	0.69	57	12	69	5.31	356.7	2
Hitit University	Çorum	11	43	3.91	1	0.09	13	0	13	1.18	200.5	78
İnönü University	Malatya	13	69	5.31	1	0.08	6	0	6	0.46	216.7	31
Istanbul Technical University	Istanbul	32	82	2.56	6	0.19	115	16	131	4.09	404.3	8
Istanbul University	Istanbul	38	286	7.53	17	0.45	85	16	101	2.66	342.3	3
Izmir Institute of Technology	Izmir	19	83	4.37	9	0.47	30	15	45	2.37	342.5	20
Koç University	Istanbul	9	186	20.7	7	0.78	27	4	31	3.44	401.9	10
Kocaeli University	Kocaeli	13	70	5.38	10	0.77	22	4	26	2.00	307.6	36
Marmara University	Istanbul	11	101	9.18	4	0.36	24	4	28	2.55	350.1	16
Mersin University	Mersin	7	26	3.71	1	0.14	13	0	13	1.86	241.8	45
On Dokuz Mayıs University	Samsun	7	46	6.57	3	0.43	1	0	1	0.14	251.7	23
Orta Doğu Teknik University	Ankara	20	168	8.40	11	0.55	99	24	123	6.15	412.1	1
Osmaniye Korkut Ata University	Osmaniye	4	14	3.50	0	0	1	0	1	0.25	201.8	80
Pamukkale University	Denizli	5	75	15.0	3	0.60	4	1	5	1.00	244.7	37
Selçuk University	Konya	12	103	8.58	4	0.33	37	6	43	3.58	243.6	15
Süleyman Demirel University	Isparta	8	35	4.38	2	0.25	2	4	6	0.75	247.0	25
Uşak University	Uşak	7	13	1.86	0	0	0	0	0	0.00	230.0	112
Yalova University	Yalova	8	29	3.63	0	0	7	0	7	0.88	233.9	92
Yeditepe University	Istanbul	11	21	1.91	2	0.18	3	1	4	0.36	247.3	43
Yıldız Teknik University	Istanbul	28	278	9.93	2	0.07	103	22	125	4.46	372.3	18

*Out of 130 institutions. **NA:** Not available.

ed a few top performers and the other consisted in poorer performers that make up the larger part of the departments and presented a slight differentiation. (Miroiu et al., 2015).

Total number of graduate theses granted by the departments is 1237, of which 18% were devoted to PhD theses. There is a significant difference between the departments in this category as well: top six departments granted more theses than the remaining 28 departments combined. Actually, 13 departments did not grant any PhD thesis, and 4 departments did not grant any graduate thesis at all.

Total number of completed TÜBİTAK projects is 134. This number is low compared to SCI articles and theses, and

Table 2. Ranking of Chemical Engineering Departments in Turkey based on overall departmental activity.

Institution	Articles rank	Projects rank	Theses rank	Overall rank
Istanbul University	1	1	4	1
Orta Doğu Teknik University	4	3	3	2
Gazi University	6	5	5	3
Boğaziçi University	9	2	6	4
Yıldız Teknik University	2	16	2	5
Hacettepe University	10	5	7	6
Istanbul Technical University	13	10	1	7
Izmir Institute of Technology	12	5	10	8
Koç University	3	9	16	9
Ankara University	10	11	8	10
Selçuk University	7	12	11	11
Kocaeli University	16	4	18	12
Marmara University	8	12	17	12
Ege University	5	27	9	14
Atatürk University	18	16	12	15
Eskişehir Osmangazi University	19	21	12	16
Atılım University	20	8	25	17
Pamukkale University	15	14	25	18
Cumhuriyet University	23	21	14	19
Anadolu University	26	21	14	20
İnönü University	17	21	23	20
Hitit University	22	21	19	22
On Dokuz Mayıs University	21	14	29	23
Süleyman Demirel University	25	16	23	23
Afyon Kocatepe University	31	16	21	25
Mersin University	28	21	19	25
Beykent University	14	27	31	27
Yeditepe University	29	16	27	27
Yalova University	27	27	22	29
Bursa Teknik University	24	27	31	30
Bilecik Şeyh Edebali University	30	27	28	31
Osmaniye Korkut Ata University	31	27	29	32
Uşak University	33	27	31	33
Çankırı Karatekin University	34	27	31	34

Table 3. Ranking of Chemical Engineering Departments in Turkey based on activity per academician.

Institution	Articles rank	Projects rank	Theses rank	Overall rank
Koç University	1	3	7	1
Boğaziçi University	10	2	1	2
Orta Doğu Teknik University	7	7	2	3
Hacettepe University	13	5	3	4
Selçuk University	6	12	6	5
Marmara University	5	11	12	6
Istanbul University	9	9	11	7
Pamukkale University	3	6	21	8
Yıldız Teknik University	4	24	4	9
Atılım University	8	1	25	10
Kocaeli University	14	4	16	10
Izmir Institute of Technology	18	8	13	12
Gazi University	20	13	9	13
Ankara University	22	15	10	14
Istanbul Technical University	26	17	5	15
Cumhuriyet University	23	20	8	16
On Dokuz Mayıs University	12	10	30	17
Süleyman Demirel University	17	14	24	18
Mersin University	21	19	17	19
Ege University	16	27	15	20
Hitit University	19	20	20	21
Beykent University	2	27	31	22
İnönü University	15	22	26	23
Anadolu University	29	24	14	24
Atatürk University	28	22	19	25
Bursa Teknik University	11	27	31	25
Afyon Kocatepe University	33	15	22	27
Eskişehir Osmangazi University	27	26	18	28
Yalova University	24	27	23	29
Yeditepe University	31	18	28	30
Osmaniye Korkut Ata University	25	27	29	31
Bilecik Şeyh Edebali University	30	27	27	32
Uşak University	32	27	31	33
Çankırı Karatekin University	34	27	31	34

results in a poor resolution during ranking the departments; i.e. eight departments did not have any projects completed, six departments had a single project completed.

An interesting observation is that four departments (Beykent, Çankırı Karatekin, Bursa Teknik, Uşak) have neither any projects nor any theses completed, nevertheless they published articles in journals that are indexed in WoS database.

The data given in █ Table 1 was used to rank the chemical engineering departments based on their total number of activities (█ Table 2), and on activity per academician (█ Table 3).

Here, the overall ranking of the departments was obtained by averaging the rankings of all three types of activities.

The top departments are located in the three big cities (Istanbul, Ankara, and Izmir) of Turkey. This is because the oldest universities (thus the oldest departments) are located in these cities and they have a solid R&D infrastructure (labs, equipment, etc.) to conduct researches. Moreover, those universities attract the best graduate students and academic staff because of the high living standards that the big cities provide.
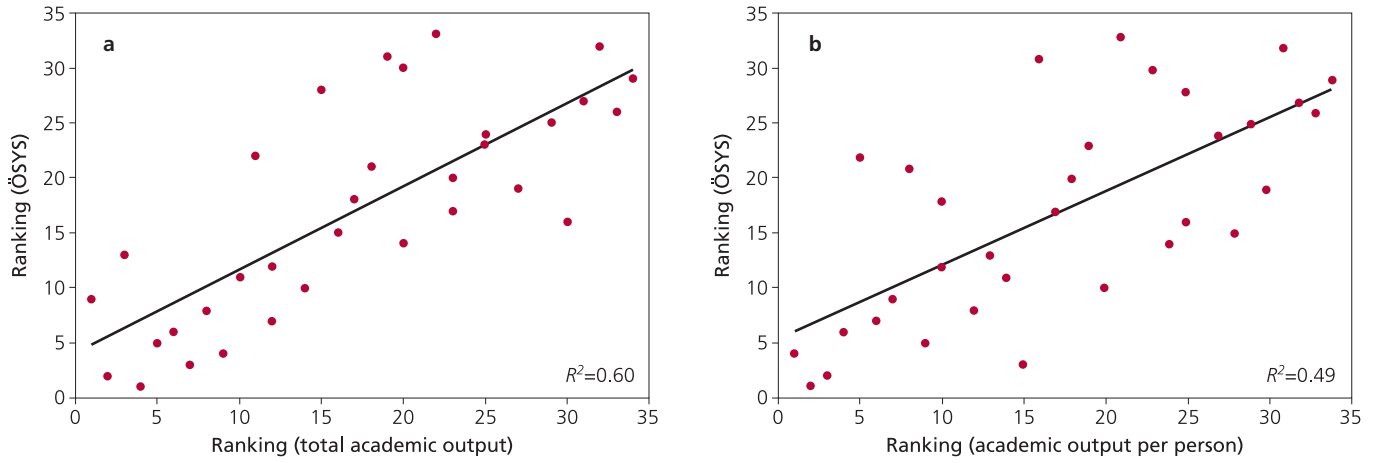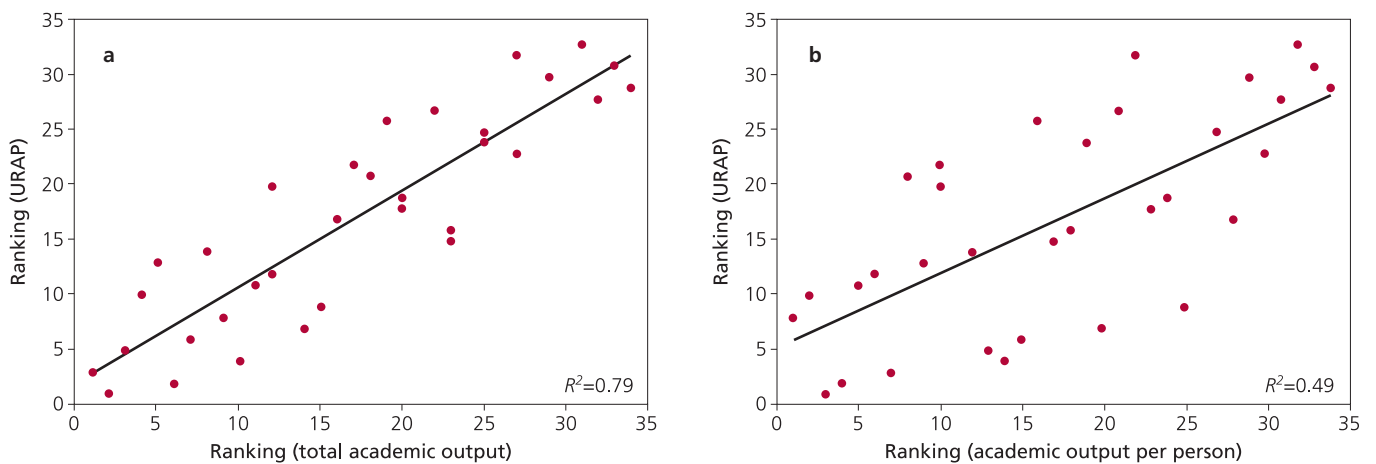
Figure 1. Departmental rankings compared to the ÖSYS scores.

On the other hand, the low academic performances of some departments may partially be attributed to the presence of an 'low level of knowledge on English language' in Turkish universities, which undermines both the quantity and quality of research produced in Turkish universities and the ability of Turkish academicians to access the research in their fields to support the quality of their own research publications (British Council, 2015).

ÖSYS can further be used as an indicator of quality as perceived by public: the more reputable a department, the highest its ÖSYS score is. The departments were ranked based on their ÖSYS scores and compared to the rankings obtained in this study (■ Figure 1). The resulting correlation shows that

the ranking of departments found in this study is in compliance with the qualitative perception of these departments in the country. Ranking based on total academic output of a department shows a better correlation (R^2=0.60) than the ranking based on output per academician (R^2=0.49), suggesting that total academic activity of a department is more meaningful than activity per academician for assessment of departments. The results are also compatible with the qualitative perception in the engineering and scientific community as well.

Finally, the rankings of the departments and their universities were compared as seen in ■ Figure 2 where universities were re-ranked based on URAP data given in ■ Table 1 to

Figure 2. Departmental rankings compared to the URAP rankings of the universities.

exclude universities that do not have chemical engineering departments. Again, ranking based on total academic output of a department shows a better correlation (R^2=0.79) than the ranking based on output per academician (R^2=0.49), which confirms the previous conclusion that the total academic activity of a department is more meaningful than activity per academician. URAP combines both overall activities and activities per academician for ranking the universities. This figure also shows that some departments performed significantly poorer (i.e. On Dokuz Mayıs) or better (i.e. Kocaeli, Yıldız Teknik) than their universities.

Figure 3 shows the temporal evaluation of research performance of the departments. Here, it is observed that the annual numbers of published articles and completed theses are stable, whereas the number of projects decreased intensely over the years. This is interesting since there is no decline in the total number of projects supported by TÜBİTAK (TÜBİTAK, 2016). Unfortunately, number of academicians of the previous years is not available; however, it is more likely that total number of academicians is increasing every year, therefore more stable trends also translate to decreasing performance of academicians.

Conclusion and Recommendations

The following conclusions can be drawn from this study:

- When the ranking is based on overall departmental activity, the highest ranked chemical engineering department in Turkey is in Istanbul University. On the other hand, if the ranking is based on activity per academician, chemical engineering department of Koç University is the highest ranked department.

- The top-ranked departments are located in the leading three cities (Istanbul, Ankara, and Izmir).

- Turkish chemical engineering departments have lower publications than their international counterparts.

- Comparison of rankings obtained in this study to the ÖSYS scores suggested that ranking of departments should be based on total departmental academic activity and not on academic activity per academician.

- The number of departments and academicians which are virtually unproductive within the last five years in terms of academic output is significant; 19% of the academicians did not publish any articles in journals that are indexed in WoS database, no graduate thesis was produced in 12% of the departments, and there were not any completed research project supported and financed by TÜBİTAK in 24% of the departments.
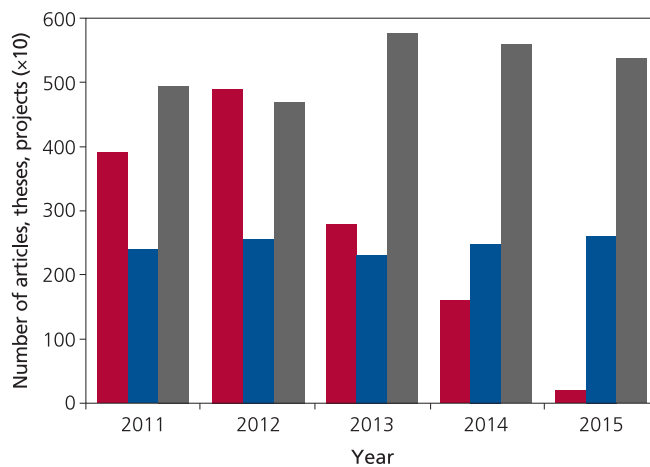
Figure 3. Temporal change of research performance of the chemical engineering departments: (■) number of articles in WoS database, (■) number of theses, (■) number of TÜBİTAK projects.

- The annual number of published articles and completed theses did not increase, whereas the number of projects decreased intensely over the years.

Since this is the first and the only study that assesses and ranks the universities of Turkey at departmental level, it may pave the way for further studies in the field. Recommendations for future works are listed below:

- Other departments may be ranked similarly.

- Interdepartmental comparisons (i.e. comparison of different departments in a faculty) can be made which may lead to interesting outcomes.

- In order to improve the accuracy of the results, other evaluation criteria (i.e. citations, conference proceedings, patents, awards) may be added into the study and longer time frames (i.e. ten years) may be used.

Acknowledgments

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