The Trend of the Bibliographical Output from Libyan Engineering Schools: A 30-Year Review From 1984-2013

Awad Bodalal* and Salah Mashite

Mechanical Engineering Department, Faculty of Engineering, Benghazi University, Benghazi, Libya

Abstract: In this study, the research output from the major Libyan engineering schools was gathered and compared for the period of thirty years (from 1984 to 2013). The Elsevier database, *Science Direct*, was used to gather these publications and only engineering articles were included. A comparative analysis was performed on three levels; first a local comparison between the different faculties of engineering across Libya and secondly, a broader comparison between Libya and the neighboring METAL (Morocco, Egypt, Tunisia, Algeria and Libya) countries and finally, the third comparison was performed between Turkey and the METAL countries. In the local comparison, the output was normalized by the number of teaching staff while in the broader regional comparison, gross domestic product and population were used as standardization factors. When analyzing the research output of the Libyan engineering schools, it was observed that most publications came from Tripoli (47.1%, n=131) followed by Benghazi (25.9%, n=72), Misurata (4.1%, n=12) and Omar Al-Mukhtar (4.0%, n=11). However, when the number of staff members was taken into consideration, Benghazi University and Omar Al-Mukhtar University had higher research productivity levels than Tripoli University and Misurata University respectively. The regional comparison showed a clear difference between Libya and its neighbors, having the lowest output among them. Finally, it was found that across the three decades under study, Turkey produced more research than all the METAL countries combined. More attention needs to be paid to research and publications in Libyan engineering schools. A number of recommendations were made to help improve the publication rate in Libyan engineering faculties.

Keywords: Education, Statistics, Bibliography, Conflict studies.

INTRODUCTION

Libya is a North-African Arab country located along the southern Mediterranean coast. It has an estimated area of 1,775,500 km^2 and a population of over 5.3 million [1, 2]. More than a third of the population lives in two cities, namely Tripoli (the capital) and Benghazi (the second largest city) with a distance of over 1200 km between them.

Since the discovery of oil in the 1960's, undergraduate and postgraduate engineering educational institutes have been set up and expanded over the years [3]. The first engineering school was established in Tripoli in 1970, followed by the school of engineering at Benghazi University in 1973. In the last two decades, there has been an explosion in the number of engineering faculties across the country without a serious effort for controlling the quality of the education processes – including the contribution of staff memberstowards research published in indexed scientific journals.

Due to the importance of scientific publications as an outcome of research, it is imperative to document and evaluate this activity on the national level and compare their publications outcome with other engineering educational institutes in the region.

*Address correspondence to this author at the Mechanical Engineering Department, Faculty of Engineering, Benghazi University, Benghazi, Libya; Tel: 094-500-3536; E-mail: awad.bodalal@gmail.com, awad.alwershafany@uob.edu.ly

To the best of the authors' knowledge, there has not been any study performed that covered the topic of engineering publications in Libya. Also, the recently published ranking of universities showed that Libyan universities exist at the bottom of the list. While the rate of publications is not the only parameter associated with the rank, data regarding the publication activities of the Libyan engineering institutes will be very useful for the educational planners as well the decision makers in the country.

METHODS

In this study, we explored the engineering publications affiliated with the METAL countries (*Morocco, Egypt, Tunisia, Algeria and Libya*) plus Turkey for a period of three decades – namely from 1984 till 2013. The Elsevier database, *ScienceDirect*, was used to gather these publications since it is among the most prominent, trusted bibliographical indexes available online; no other database permitted the free search of its contents with the full use of search limiters (engineering, author affiliation, time period). This particular database provides access to over 11 million scientific articles (between health, engineering and social sciences) [4]. In terms of journals, there were over 633 periodicals dedicated purely to engineering with its various branches.

The results were specified using the "Advanced Search" option and only engineering articles were

E-ISSN: 1929-6029/18

included that were published between January 1st, 1984 and December 31st, 2013. Furthermore, the author affiliation limiter was changed between the different METAL countries to only include publications from a specific country. Admittedly, these countries have studies that were published locally however, they usually do not undergo peer review (*and are hence not indexed*) or their particular index doesn't allow for the use of specific limiters.

The number of engineering publications per year was determined for each of the countries and was normalized to GDP, population and number of teaching staff at the Libyan faculties of engineering [5]. Population and GDP data for the studied countries were obtained from the World Bank databases [6]. Excel and SPSS based models were designed and basic statistical analysis was performed.

RESULTS

A total of 278 articles were produced that had at least one author affiliated with a Libyan engineering institute during the *last three decades* (1984 – 2013). The majority of these studies were produced in Tripoli University (47.1%, n=131) followed by Benghazi University (25.9%, n=72), Misurata University (4.1%, n=12), and Omar Al-Mukhtar University (4.0%, n=11), as shown in Table **1**.

In order to adjust for university size and faculty members, four major universities were compared, namely Tripoli University, Benghazi University, Omar Al-Mukhtar University (Al-Beida), and Misurata University. The research output in the last 30 years on the Science Direct database was compared and the number of permanent teaching staff at the Faculty of Engineering (for each respective university) was taken as the denominator in order to provide a baseline comparison. The figures for the number of teaching staff were for the year of 2013 and an assumption was made that this value would be constant throughout the years. This would serve as a crude figure for per capita research output.

When looking at the figures, it was found that for Libyan engineering institutes, the per capita (teaching staff) output was very low. For instance, in Tripoli University there were only 1.3 publications per 100 teaching staff annually whereas in Benghazi University there were only 1.43 publications per 100 teaching staff per year. Similarly the annual publication rates per 100 teaching staff in Omar Al-Mukhtar University and Misurata University were found to be 0.5 and 0.36 respectively.

Despite the large difference in absolute research output between Tripoli and Benghazi, the latter has a higher per capita productivity. This is further highlighted in Table **1**.

Most of the studies were published in the following journals; Desalination, Energy Conversion and Management, Renewable Energy, Applied Energy and the Journal of Materials Processing Technology. The major journals hosting Libyan engineering publications are shown in Table **2** along with their 2012 impact factor (Thomson-Reuters). The article with the highest impact factor (6.93) was from Omar Al-Mukhtar University which was published in a journal named Nanomedicine: Nanotechnology, Biology and Medicine.

When compared to the remaining METAL countries, Libya again had the lowest output both absolutely and relatively. The highest output was seen in Egypt when raw numbers were compared with a grand total of 11,511 studies (see Table **3**). However, if population and GDP are taken into account, Egypt takes second place while Tunisia becomes the number one producer of engineering research with an overall average of 14.566 publications per million citizens and 5.643 articles per billion USD of its GDP (see Tables **4** and **5**).

Table 1: Comparative Analysis of Per Capita Engineering Research Output within the Libyan Universities in the Last Thirty Years

University	Libyan Teaching Staff	Non-Libyan Teaching Staff	Total	Research Output	Per capita research output	Number of Staff per paper
University of Tripoli	330	5	335	131	0.39	3
University of Benghazi	152	15	167	72	0.43	2
University of Misrata	103	9	112	12	0.11	9
Omar Mukhtar University (Al-Beida)	50	25	75	11	0.15	7
Total	635	54	689	226	0.33	3

Table 2: The Main Journals on Science Direct that Hosted Libyan Engineering Articles and their 2012 Impact Factors

Journal Name	n	%	Impact factor
Desalination	43	15.5	3.041
Energy Conversion and Management	16	5.8	2.775
Renewable Energy	11	4.0	2.989
Applied Energy	10	3.6	4.781
Journal of Material Processing Technology	9	3.2	1.953
APCBEE Procedia	8	2.9	-
Journal of Nuclear Materials	7	2.5	1.211

Table 3: The Bibliographical Output in Engineering for the METAL Countries and Turkey in the Science Direct Database during the Last Three Decades

Year	Morocco	Egypt	Tunisia	Algeria	Libya	Turkey
1984	2	151	9	8	11	42
1985	1	150	4	1	16	55
1986	6	124	2	8	7	84
1987	5	138	6	13	7	79
1988	12	137	6	11	5	80
1989	12	166	10	14	8	103
1990	15	180	6	15	6	107
1991	20	201	16	18	8	150
1992	55	220	12	25	9	174
1993	31	251	15	31	8	177
1994	44	294	21	34	3	191
1995	53	295	23	45	4	287
1996	60	279	27	39	4	365
1997	73	272	44	60	4	402
1998	90	260	47	68	8	414
1999	101	253	71	64	3	490
2000	142	311	93	108	7	536
2001	162	331	109	113	7	611
2002	129	343	134	98	6	837
2003	114	386	145	143	11	957
2004	136	359	161	191	13	1352
2005	121	357	164	166	9	1443
2006	136	369	245	245	3	1615
2007	134	465	247	282	21	2090
2008	157	546	316	366	22	2165
2009	173	780	379	442	10	2470
2010	137	791	352	438	13	2182
2011	169	867	342	745	7	2738
2012	159	898	373	577	12	2605
2013	222	1337	489	611	26	2547
Total	2671	11511	3868	4979	278	27338

Table 4: Per Capita Engineering Research Output by Population (Per Million Inhabitants)

	Morocco		Egypt		Tunisia		Algeria		Libya	
Year	Population	Publications per million	Population	Publications per million	Population	Publications per million	Population	Publications per million	Population	Publications per million
1984	21776104	0.092	49190419	3.070	7042550.1	1.278	22150483	0.361	3613208	3.044
1985	22277541	0.045	50346551	2.979	7260361	0.551	22847437	0.044	3738814	4.279
1986	22772287	0.263	51545011	2.406	7492632.6	0.267	23539383	0.340	3854631	1.816
1987	23260094	0.215	52776850	2.615	7684751.4	0.781	24225748	0.537	3961787	1.767
1988	23739980	0.505	54011214	2.537	7857619	0.764	24904931	0.442	4062672	1.231
1989	24211718	0.496	55207254	3.007	7958694.4	1.256	25576596	0.547	4161093	1.923
1990	24674974	0.608	56336614	3.195	8154400	0.736	26239708	0.572	4259811	1.409
1991	25128064	0.796	57387589	3.502	8318200	1.923	26893663	0.669	4359515	1.835
1992	25569662	2.151	58370712	3.769	8489900	1.413	27535151	0.908	4459214	2.018
1993	26000345	1.192	59307778	4.232	8657400	1.733	28157560	1.101	4558021	1.755
1994	26421309	1.665	60231864	4.881	8815400	2.382	28752749	1.182	4654483	0.645
1995	26833093	1.975	61168397	4.823	8957500	2.568	29315463	1.535	4747619	0.843
1996	27237150	2.203	62123592	4.491	9089300	2.971	29845208	1.307	4837354	0.827
1997	27632321	2.642	63094069	4.311	9215000	4.775	30345466	1.977	4924347	0.812
1998	28013585	3.213	64084443	4.057	9333300	5.036	30820435	2.206	5009240	1.597
1999	28374203	3.560	65097777	3.886	9455900	7.509	31276295	2.046	5092939	0.589
2000	28710123	4.946	66136590	4.702	9563500	9.724	31719449	3.405	5176185	1.352
2001	29021156	5.582	67204189	4.925	9673600	11.268	32150198	3.515	5258677	1.331
2002	29311443	4.401	68302914	5.022	9781900	13.699	32572977	3.009	5340389	1.124
2003	29586937	3.853	69432477	5.559	9839800	14.736	33003442	4.333	5422612	2.029
2004	29855820	4.555	70591288	5.086	9932400	16.210	33461345	5.708	5507000	2.361
2005	30125445	4.017	71777678	4.974	10029000	16.353	33960903	4.888	5594450	1.609
2006	30395097	4.474	72990754	5.055	10127900	24.191	34507214	7.100	5686475	0.528
2007	30667086	4.370	74229577	6.264	10225100	24.156	35097043	8.035	5782108	3.632
2008	30955151	5.072	75491922	7.233	10328900	30.594	35725377	10.245	5876805	3.744
2009	31276564	5.531	76775023	10.160	10439600	36.304	36383302	12.148	5964325	1.677
2010	31642360	4.330	78075705	10.131	10549100	33.368	37062820	11.818	6040612	2.152
2011	32059424	5.271	79392466	10.920	10673800	32.041	37762962	19.728	6103233	1.147
2012	32521143	4.889	80721874	11.125	10777500	34.609	38481705	14.994	6154623	1.950
Total	800050179	3.339	1871402591	6.151	265725008	14.556	884315013	5.630	144202242	1.928

Turkey had an interesting trend in engineering research output. Initially, it had a lower publication rate than Egypt (less than one-third), however with the passage of time and the well-known economic/scientific rise of Turkey, these figures began to match in the mid-90's. Ultimately, across the three decades under study, Turkey produced more research than all the METAL countries combined.

Libya had the lowest figure with 1.928 publications per one million citizens and the lowest research output with 0.217 articles per billion US dollars of its GDP.

DISCUSSION

The findings of this study clearly show that Libyan engineering research output is lagging behind other countries in the region. Either as a raw output or adjusted (for GDP and population), Libya takes last place among the METAL countries – a fact which should highlight the importance of the inclusion of research methodology in engineering curriculums.

The two largest cities (Benghazi and Tripoli), and their universities, understandably contributed the bulk of engineering research (73.0%, n=203). Despite

Table 5: Per Capita Engineering Research Output by Gross Domestic Product (Per Billion U.S. Dollars)

	Morocco		Egypt		Tunisia		Algeria		Libya	
Year	GDP (billion USD)	Publications per billion	GDP (billion USD)	Publications per billion	GDP (billion USD)	Publications per billion	GDP (billion USD)	Publications per billion	GDP (billion USD)	Publications per billion
1984	12.75	0.157	30.64	4.928	8.25	1.090	53.69	0.149	-	-
1985	12.86	0.078	34.68	4.324	8.41	0.476	57.93	0.017	-	-
1986	16.99	0.353	35.88	3.456	9.01	0.222	63.69	0.126	-	-
1987	18.74	0.267	40.50	3.407	9.69	0.619	66.74	0.195	-	-
1988	22.19	0.541	35.04	3.909	10.09	0.594	59.08	0.186	-	-
1989	22.84	0.525	39.64	4.187	10.10	0.990	55.63	0.252	-	-
1990	25.82	0.581	43.13	4.173	12.29	0.488	62.04	0.242	28.90	0.208
1991	27.83	0.718	36.97	5.437	13.07	1.224	45.71	0.394	31.99	0.250
1992	28.45	1.933	41.85	5.256	15.49	0.774	48.00	0.521	33.88	0.266
1993	26.80	1.157	46.57	5.389	14.60	1.027	49.94	0.621	30.66	0.261
1994	30.35	1.450	51.89	5.665	15.63	1.343	42.54	0.799	28.61	0.105
1995	32.98	1.607	60.15	4.904	18.03	1.276	41.76	1.077	25.54	0.157
1996	36.63	1.638	67.62	4.125	19.58	1.378	46.94	0.831	27.88	0.143
1997	33.41	2.185	78.43	3.468	20.74	2.121	48.17	1.245	30.70	0.130
1998	40.02	2.249	84.82	3.065	21.80	2.156	48.18	1.411	27.25	0.294
1999	39.73	2.542	90.71	2.789	22.94	3.095	48.64	1.316	30.48	0.098
2000	37.02	3.836	99.83	3.115	21.47	4.331	54.79	1.971	33.89	0.207
2001	37.72	4.294	97.63	3.390	22.06	4.940	54.74	2.064	28.42	0.246
2002	40.41	3.192	87.85	3.904	23.14	5.790	56.76	1.727	19.84	0.302
2003	49.82	2.288	82.92	4.655	27.45	5.282	67.86	2.107	24.06	0.457
2004	56.94	2.388	78.84	4.553	31.18	5.163	85.32	2.238	33.38	0.389
2005	59.52	2.033	89.68	3.981	32.28	5.080	103.19	1.609	44.00	0.205
2006	65.63	2.072	107.48	3.433	34.37	7.127	117.02	2.094	56.48	0.053
2007	75.22	1.781	130.47	3.564	38.84	6.358	134.97	2.089	71.80	0.292
2008	88.88	1.766	162.81	3.353	44.73	7.064	171.00	2.140	93.16	0.236
2009	90.90	1.903	188.98	4.127	43.60	8.691	137.21	3.221	62.36	0.160
2010	90.77	1.509	218.88	3.614	44.37	7.932	161.20	2.717	-	-
2011	99.21	1.703	236.00	3.674	46.43	7.365	199.07	3.742	-	-
2012	95.98	1.657	262.83	3.417	45.66	8.169	205.78	2.804	-	-
Total	1316.53	2.029	2662.87	4.323	685.43	5.643	2387.72	2.085	763.34	0.217

having a larger number of faculty members, Tripoli University had a lower per capita research output than Benghazi University. Interestingly, there was a strong participation from Omar Al-Mukhtar despite being a relatively younger educational institute. Accurate figures related to faculty numbers were unavailable for other Libyan higher education institutes and hence the per capita teaching staff was not calculated.

There was an over-representation of mechanical engineering research in the ScienceDirect database for Libyan publications with a very low presence of articles from the other branches (i.e. electrical, civil, chemical and architectural engineering etc…). This could either be due to a preference of the publisher for mechanical engineering journals or quite simply a decreased participation of the other branches in indexed engineering journals.

One of the journals in ScienceDirect hosted almost one-fifth of the Libyan engineering research, namely Desalination. This is most likely due to the fact that this particular journal hosts publications from conferences. This is also true for a number of the other journals which could also be a potential cause for the dominance of mechanical engineering research.

When observing the trends of publications among the METAL countries, Libya was found to have the lowest output in terms of absolute number of publications with Egypt having the highest yield. This is understandable given the population differences among the nations. When population and gross domestic product were factored into the analysis, the situation did not change for Libya. Despite having a low population, Libya had the lowest per capita research output. Certain years (such as 1994 and 2006) yielded very low results (i.e. 3 articles only) whereas a peak productivity was seen in 2013 with 26 engineering articles being published in Elsevier's journals.

Despite having similar research output levels in the beginning of the analysis (i.e. in the early 1980's), the other METAL countries showed significant improvement in the trend of their publishing capacity. Libya however remained in a fairly constant since that time despite having a high GDP and low population. This reached such a point that in 2013, Morocco produced 9 times as many articles as Libya; Egypt 41 times as many studies; Tunisia 13 times the manuscripts, and Algeria 17 times the research produced in Libya.

Another interesting point is that in the last three decades, Turkey produced 17% more research than all the METAL countries combined (see Figure **1**).

By and large, Libyan academics (engineering or otherwise) prefer to present their work in conferences for a number of different reasons (easier acceptance, covered cost of travel, used in promotion applications etc…). These conferences meet the local needs of the researchers (primarily for promotion) however; there is very little contribution in the international research stage which will reflect negatively in the overall rank of the university.

The trend of engineering publications can be seen in Figures **2** and **3** and it provides us with an indication of how well different research programs have performed across the years. All the countries showed an upwards trend in engineering publications especially in the period from 2007 onwards. The most humble growth was seen in the Libyan scenario with a declining trend in later years.

Being a cross-sectional study, certain caveats need to be mentioned. Although Elsevier is the among the largest publishers of engineering research in the world, further studies need to be performed that span multiple publishing companies in order to draw a concrete conclusions regarding the state of scientific research output from the Libyan engineering schools. In the calculation of the annual per capita research output for the Libyan engineering institutes, it was assumed that all four centers (i.e. Tripoli University, Benghazi University, Omar Al-Mukhtar University and Misurata University) had been operating for the three decades under study.

CONCLUSIONS

Research output is an important indicator of scientific activity in any educational institute. Libyan universities (especially educational planners) need to

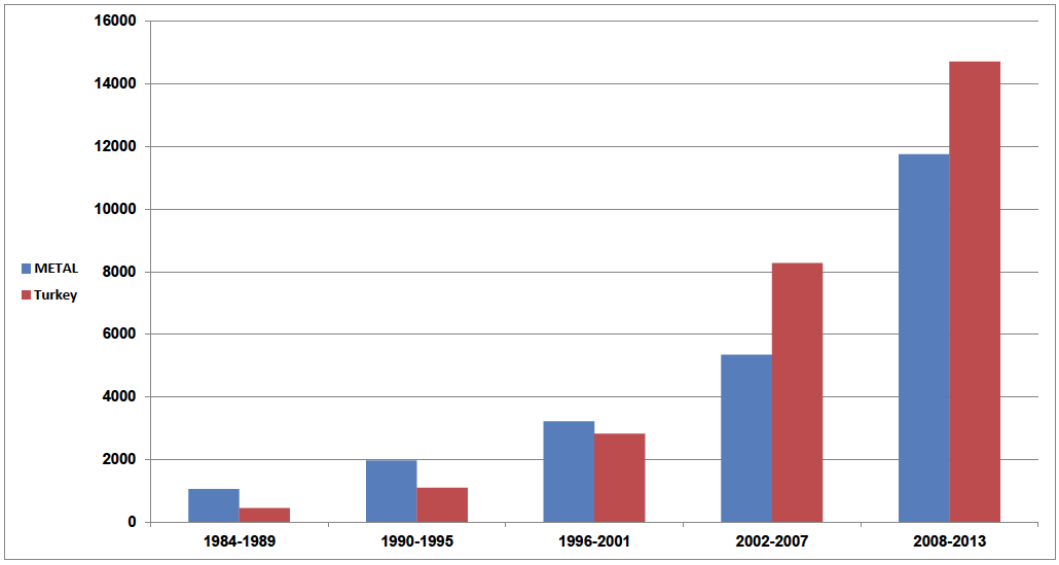

Figure 1: Graphical comparison of engineering literature output between the METAL countries and Turkey in six year intervals for three decades.

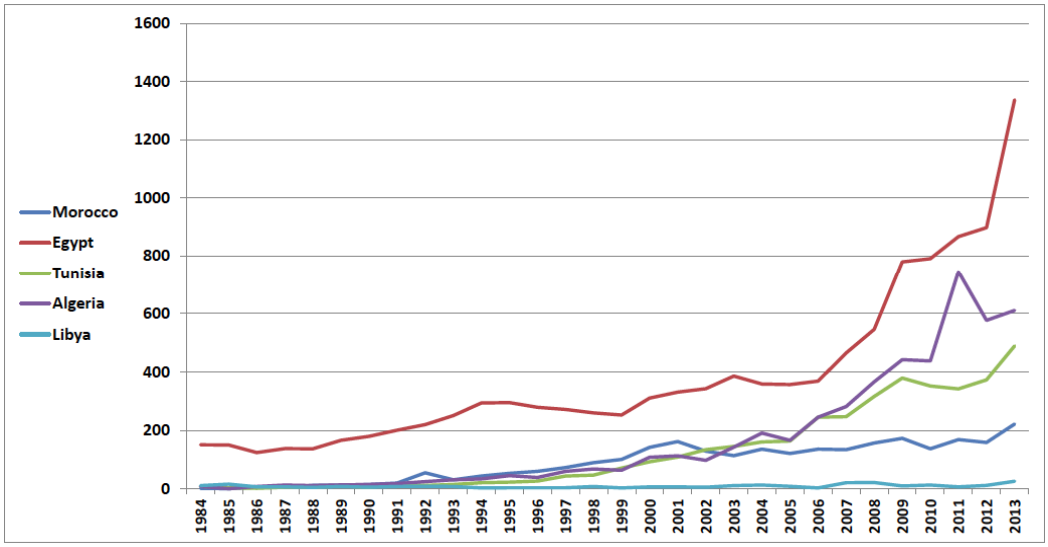

Figure 2: Graphical comparison of engineering literature output for the METAL countries for three decades.

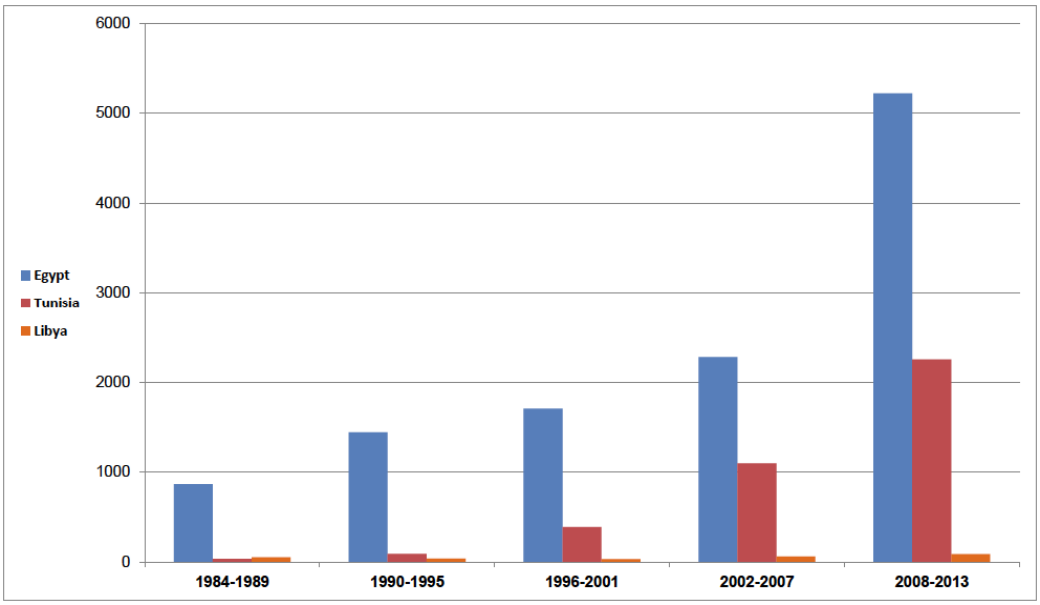

Figure 3: Graphical comparison of engineering literature output between Egypt, Tunisia and Libya in six year intervals for three decades.

focus on research methodology and means of motivating teaching staff and students to publish scientific articles in proper indexed journals. As a result, the rank of Libyan universities would improve and that would subsequently reflect positively on the standing of Libyan engineers worldwide.

This study is not designed to be a comprehensive analysis of Libyan engineering research productivity; however it can be used to provide a general overview of the status of scientific output. Based on the findings, the efforts of educational planners can be oriented towards our specific needs so that appropriate measures can be taken.

Most of the engineering articles were published in either low or medium impact journals. Only one study was published in a journal with a relatively high impact factor (6.93).

In order to increase the bibliographical output of Libyan academic institutes, certain steps should be made:

1) Annually, Libya sends hundreds of students abroad to complete their studies (at the Bachelor's, Master's, and Doctorate levels). They are studying at the government's expense and hence should mention their home universities (in

Libya) as one of the affiliations in any research that they produce. Financial incentives may be provided to those students who do publish under their Libyan university's name.

2) Conversely, non-Libyan staff members at Libyan universities should mention their hosting university (in Libya) as one of their affiliations in any published articles during the period of their contract. When their contract is renewed/extended annually, research output should be a major condition for approval.

3) Staff members should be encouraged to publish in journals by having promotions being associated with indexed journals and impact factor. A scoring system for promotion should be adopted in such a way that conference publications are not equivalent to indexed journal publications.

REFERENCES

[1] Libyan Department of Documentation. *Libyan Census: 2006*. Tripoli, Libya.

[2] WHO. *Health System profile: Libya.* 2007, Eastern Mediterranean regional health Systems Observatory.

[3] Benamer, H., A. Bredan, and O. Bakoush, Scientific Publication Productivity of Libyan Medical Schools: A Bibliometric Study of Papers Listed in PubMed, 1988-2007. Education for Health, 2009. 22(2).

[4] ScienceDirect. [cited November 21st, 2013; Available from: http://www.info.sciencedirect.com/.

[5] Direct communication with the respective universities.

[6] The World Bank group. Key Development Data & Statistics. www.worldbank.org.

Received on 22-11-2017 Accepted on 10-01-2018 Published on 02-02-2018

https://doi.org/10.6000/1929-6029.2018.07.01.2