ORGANISATION OF ISLAMIC COOPERATION

STATISTICAL, ECONOMIC AND SOCIAL RESEARCH
AND TRAINING CENTRE FOR ISLAMIC COUNTRIES

OIC OUTLOOK

October 2011

CURRENT STANCE OF SCIENCE AND TECHNOLOGY IN OIC COUNTRIES

Attar Sokak No: 4, 06700 GOP, Ankara, TURKEY
Tel: +90-312-468 6172 (4 lines) **Fax**: +90-312-467 3458
E-mail: oicankara@sesric.org **Web**: www.sesric.org

OIC OUTLOOK

CURRENT STANCE OF SCIENCE AND TECHNOLOGY IN OIC COUNTRIES

INTRODUCTION

Research in science and technology is of great importance, and key to progress towards a knowledge-based and innovation-driven economy. It promotes better understanding on different aspects of life, and helps to improve the standard of living by generating new knowledge and technological innovation. Today, there is severe competition among countries to become the most competitive economy in the world. Gaining a comparative advantage against other countries, which is of particular importance to the OIC member countries in catching-up within this competitive world of knowledge economy, depends on how well they perform in research activities.

This report presents an overview of the current developments in the OIC member countries in the field of research and development (R&D) and science & technology (S&T). In particular, the current stance of the OIC member countries compared to the rest of the world, in terms of fundamental indicators of research and scientific development, such as human resources in R&D, R&D expenditures, high technology exports, scientific publications and patent applications, is analyzed.

Some broad policy recommendations are presented in the context of our comparative analysis. Most importantly, R&D should be stimulated through government and private sector initiatives, and coordination among OIC countries. Networking opportunities among the OIC member countries need to be facilitated through programmes such as the Framework Programme of the European Union, to support research and technological development in the Islamic world and to promote joint research initiatives among the member countries.

Additionally, joint research and investment in the emerging scientific fields and technologies, such as nanotechnology, should be initiated in a timely manner to make use of the immense benefits associated with early investment in the critical sectors. Higher education and academic research need to be supported through more government funds. There is also a dire need for promoting and enhancing patent development, particularly in small and medium-sized enterprises. Last but not least, infrastructure for information and communication technologies should be improved for a wider and effective participation of the society in general, and the youth in particular, in different components of research and development in OIC member countries.

The availability of abundant and highly qualified researchers is an essential condition to foster innovation and promote the scientific and technological development of a country. However, figures indicate that OIC member countries, on average, fall well behind the world average in terms of researchers per million people: 451 vs. 1,507, respectively.[1] The gap is much larger when compared to the EU that has an average of 4,481 researchers per million people and some other developed countries like Iceland, Finland, and Norway (see Figure 1).

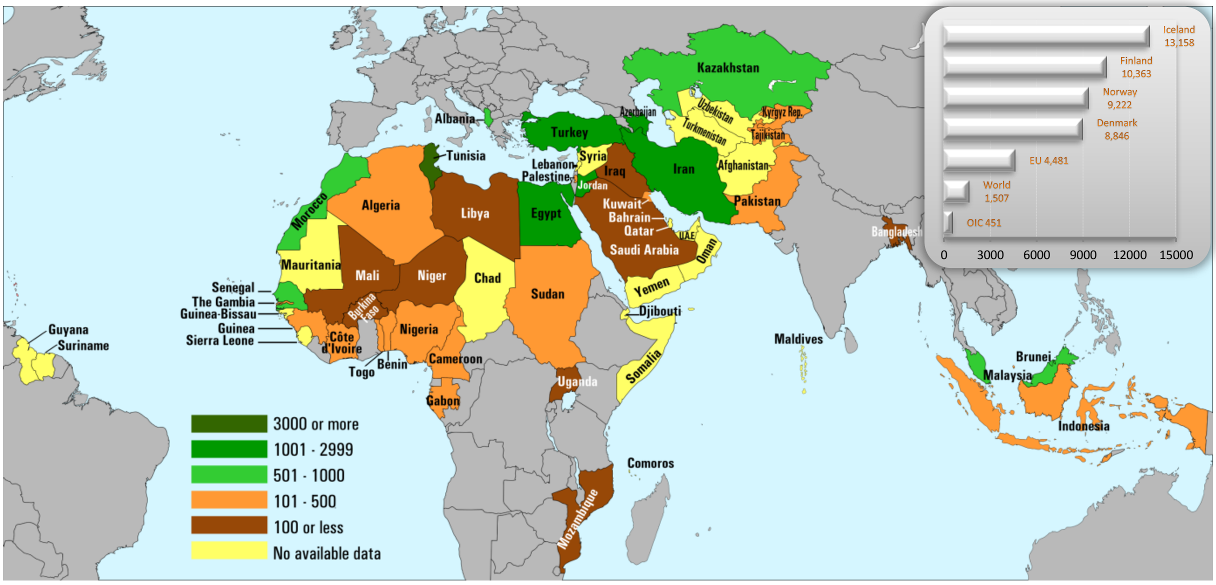

*Figure 1: Researchers per Million People**

* Headcount data for the most recent year available.

Figure 1 illustrates the OIC map of distribution of researchers employed in R&D and reveals the following observations:

- Only six of the 37 member countries with available data have more than 1,000 researchers per million people, three of which –Tunisia, Jordan, and Turkey– are above the world average.
- Nine member countries have less than 100 researchers per million people, most of which are in Sub-Saharan Africa.
- Large disparity exists among the member countries; Tunisia has 3,215 researchers per million inhabitants while Niger has merely 10.

WOMEN IN RESEARCH ACTIVITIES

In the last decades, women, with better access to training and education facilities, thanks to the rising awareness on gender in/equality, have become more qualified and motivated to participate in the labour force. Nevertheless, the progress achieved so far in the field of R&D seems unsatisfactory neither globally

[1] Figures are the weighted averages for the countries with available data.

nor at the OIC level. Women, in the OIC, represent around 32.6% of the total researchers, slightly higher than the world average of 30.3%[2]. The gap is larger when compared to some developed countries like Iceland and New Zealand but still the OIC average is higher than that of the EU average and some other developed countries such as Republic of Korea and Japan (see Figure 2).

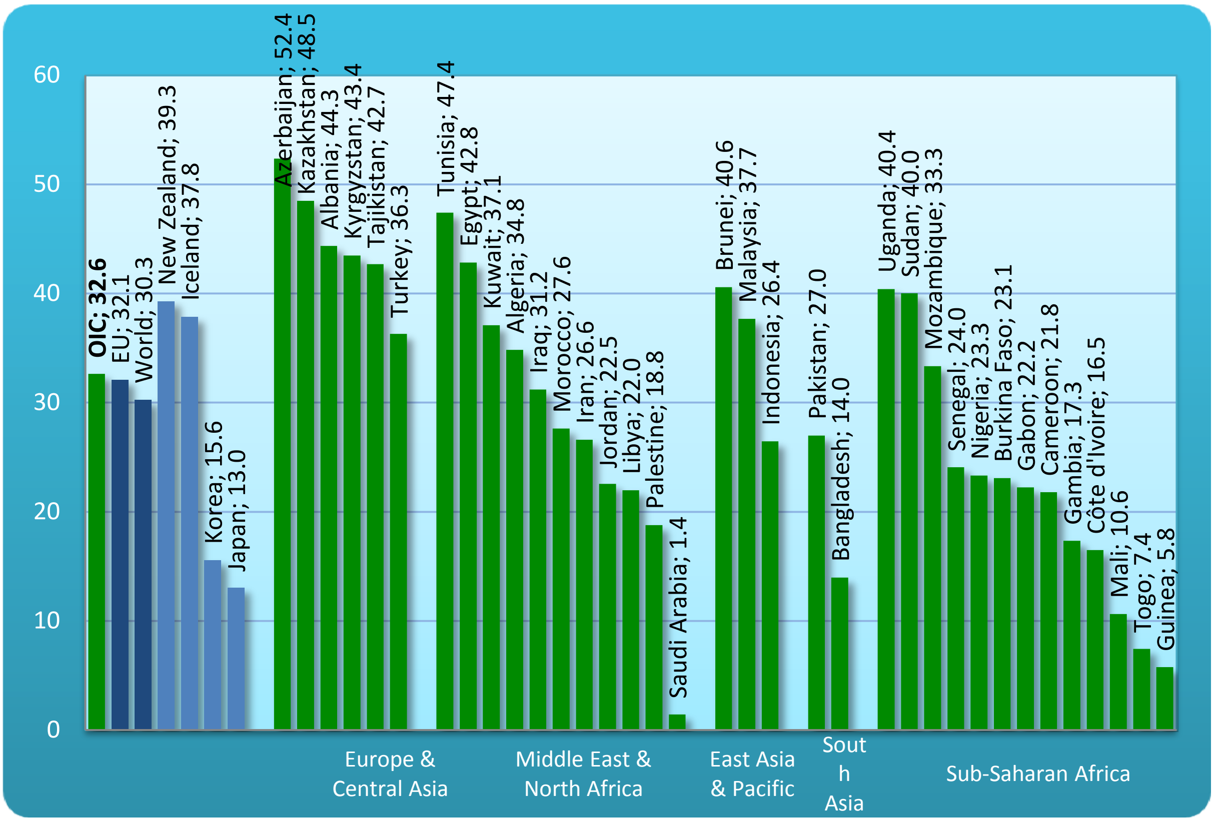

*Figure 2: Women as a Share of Total Researchers (%)**

* Headcount data for the most recent year available.

With respect to the data demonstrated in Figure 2, the following observations can be drawn:

- The share of women in total researchers is above the world average in 16 of the 35 OIC member countries with available data. Fifteen of them outperform the EU average as well.
- According to regional averages, OIC members in Europe & Central Asia, East Asia & the Pacific and Middle East & North Africa report higher rates of women researchers, often above the world average.
- Intra-regional difference is even higher in the Middle East and North Africa: On one hand, there are countries like Tunisia, Egypt, and Kuwait where women represent more than 35% of researchers while, on the other hand, there also are countries where women's share is less than 5% as in the case of Saudi Arabia.
- Azerbaijan is the only member country that has more women researchers than men. Kazakhstan, Tunisia, Albania, Kyrgyzstan, Egypt, Tajikistan, Brunei, and Uganda –all with over 40% women researchers– are also close to achieving gender parity.

[2] Aggregate calculations are based on countries with available headcount data – for the most recent year available between 1997 and 2010.

R&D INTENSITY

Today, almost 80% of the global R&D expenditures is spent by developed countries, of which 32.6% by the USA, 24.5% by the EU, and 12.2% by Japan (Figure 3). The OIC countries account for only 2.1% of the world total Gross Domestic Expenditures on R&D (GERD), or 17.4% of the total GERD of developing countries. Nevertheless, what is more important than the volume of GERD is its weight in the total expenditures or, in other words, in GDP. Accordingly, R&D intensity (GERD as a percentage of GDP) is a widely used indicator of S&T activities. It reflects the innovative capacity of a country in that a higher R&D intensity indicates that relatively more resources are devoted to the development of new products or production processes.

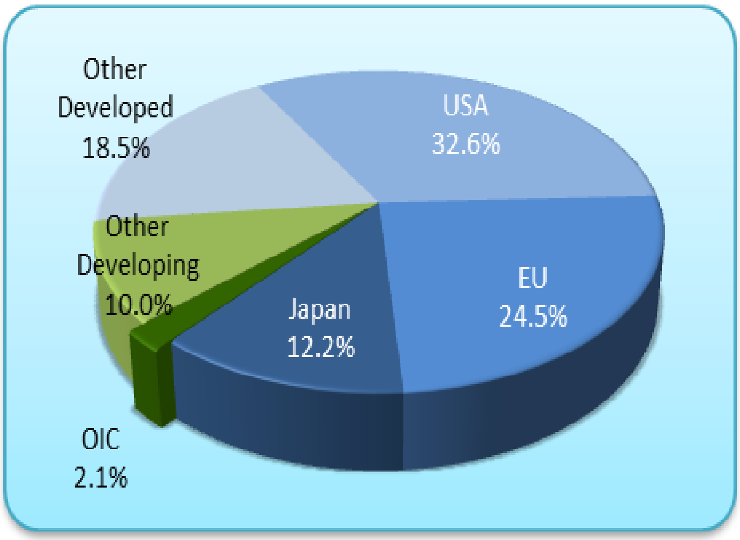

Figure 3: GERD, % of World Total

In this connection, the **OIC Ten-Year Programme of Action to Meet the Challenges Facing the Muslim Ummah in the 21st Century**, which was adopted at the Third Extraordinary Session of the Islamic Summit Conference held in Makkah al Mukarramah, Kingdom of Saudi Arabia, in December 2005, calls upon Islamic countries "to encourage research and development programmes, taking into account that the global percentage of this activity is 2% of the Gross Domestic Product (GDP), and request Member States to ensure that their individual contribution is not inferior to half of this percentage" (OIC-TYPOA, 1995, Part 2, Section V, Article 4). Nevertheless, available data show that OIC member countries' spending on R&D activities is significantly lower than the world average and still far away from the implied target of 1% of GDP by 2015 (Figure 4).

Regarding the R&D intensity in the OIC member countries, the situation can be summarized as below:

- Among the member countries with available data, Tunisia, Iran, Turkey, Malaysia, Pakistan, Gabon, Morocco, and Uganda have met the target so far, reports levels of R&D intensity above 1%. The lowest spending level is recorded for Gambia (0.05%).
- Most of the member countries spend less than 0.7% of GDP on R&D.
- R&D intensity for the OIC member countries averages 0.81%, which is quite lower than the EU average of 1.83% and the world average of 2.20% as well as the targeted rate of 1%.

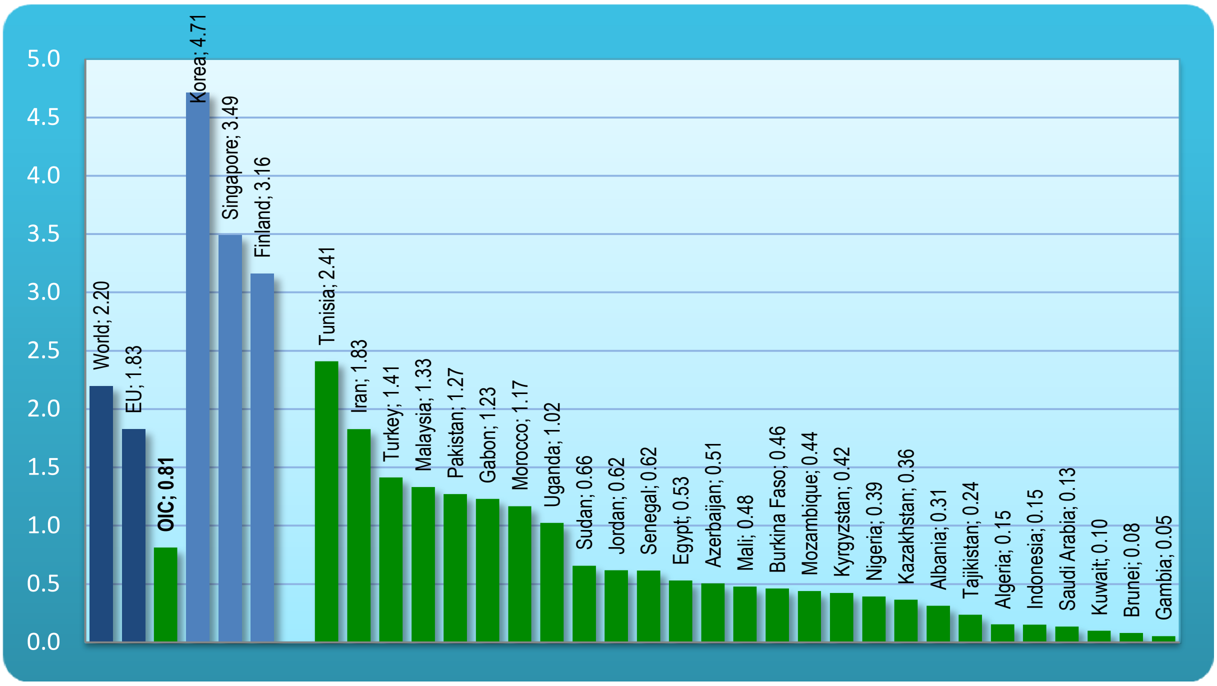

*Figure 4: R&D Intensity (%)**

* Data for the most recent year available between 1999 and 2010.

- Among the few Sub-Saharan members that can provide data, Uganda, with 1.02% R&D intensity, is the only country to spend above the OIC average.
- Considering the figures in some other developed countries like Korea (4.71%) and Finland (3.16%), both of which owe their economic development largely to investments in advanced technology, OIC member countries need to allocate much more resources to R&D activities to bridge the gap with developed countries.

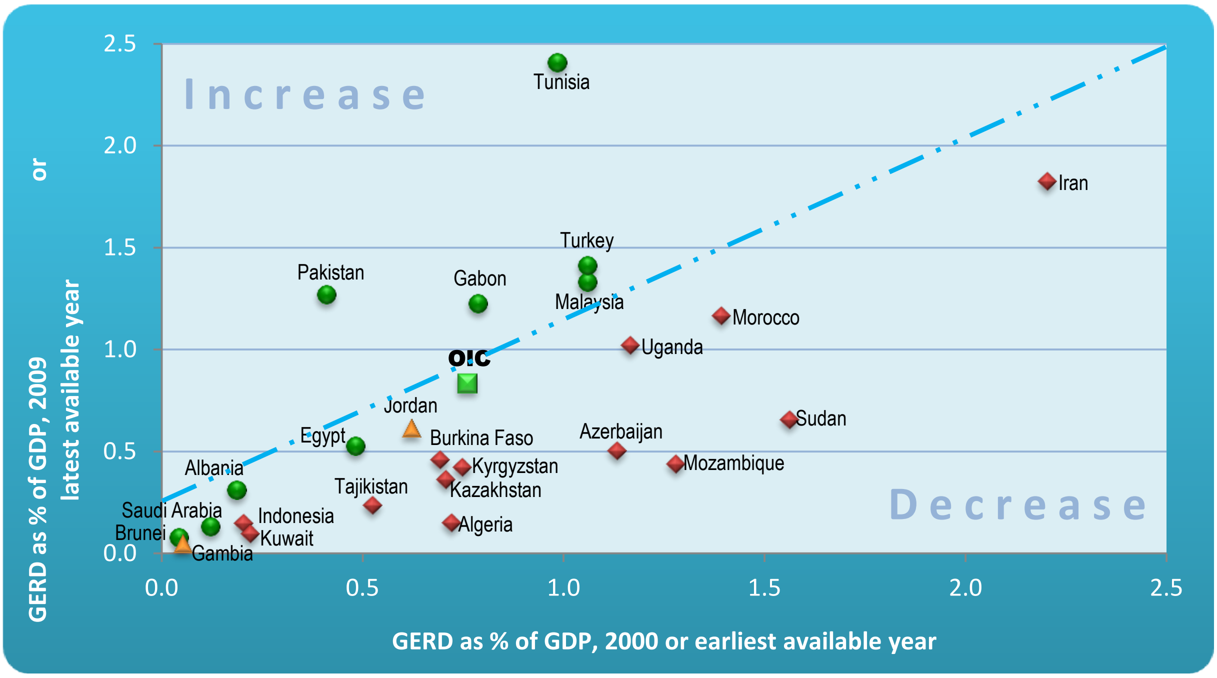

Figure 5: Trends in R&D Intensity

Figure 5 illustrates the change in R&D intensity between 2000 and 2009 for the OIC member countries for which data are available. Accordingly;

- In most of the member countries, R&D intensity showed a decrease.
- Pakistan, Tunisia, Brunei, Albania, Gabon, Turkey, and Malaysia managed to significantly increase their R&D intensity. It was more than doubled in Pakistan and the increase in Tunisia was almost over 1.5 folds. Accordingly, although Iran, Sudan, and Morocco had the highest R&D intensity rates in 2000, Tunisia outperformed them while Turkey caught up with Morocco by 2009.
- Algeria, Mozambique, Sudan, Kuwait, Azerbaijan, and Tajikistan reported a significant decrease in their R&D intensity.
- The average for the OIC countries increased by 0.08 percentage point in that decade. It is higher than that for the EU members (-0.36 percentage point) and that for the world (-0.03 percentage point).

R&D EXPENDITURES PER CAPITA

"R&D expenditures per capita" is a frequently used indicator to make comparisons among countries in terms of the level of spending on R&D. Accordingly, the following observations can be drawn for OIC countries from Figure 6, which presents data for the change in this indicator in the last decade.

- Of the OIC countries with available data, Turkey has the highest R&D expenditures per capita ($123.1), followed by Tunisia ($100.5), Gabon ($91.1), Iran ($89.1), and Malaysia ($77.9).
- The lowest rates are recorded for Mozambique, Tajikistan, and Gambia, all with less than $2 of R&D expenditures per capita.
- The average for all OIC countries with available data is calculated as $27.7, which is well below the world average of $219 and the EU average of $601. In Luxembourg, this figure reaches up to $1,426, higher than GDP per capita values of twenty-seven OIC countries in 2009.
- In a decade, from 2000 to 2009, R&D expenditures per capita increased by an average of only $16 for OIC countries, compared to $83 for the world and $217 for the EU, which could be considered as another source and indicator of divergence between OIC countries and the rest of the world with respect to scientific development.
- In the same period, Turkey, Tunisia, and Iran were the top three countries to have most increased their GERD per capita, $ 80.4, $78.4, and $49.7, respectively.
- Four of the 25 OIC countries with available data reported decline in their GERD per capita. Algeria experienced the sharpest decline in this period so that its GERD per capita fell down to $4.8.

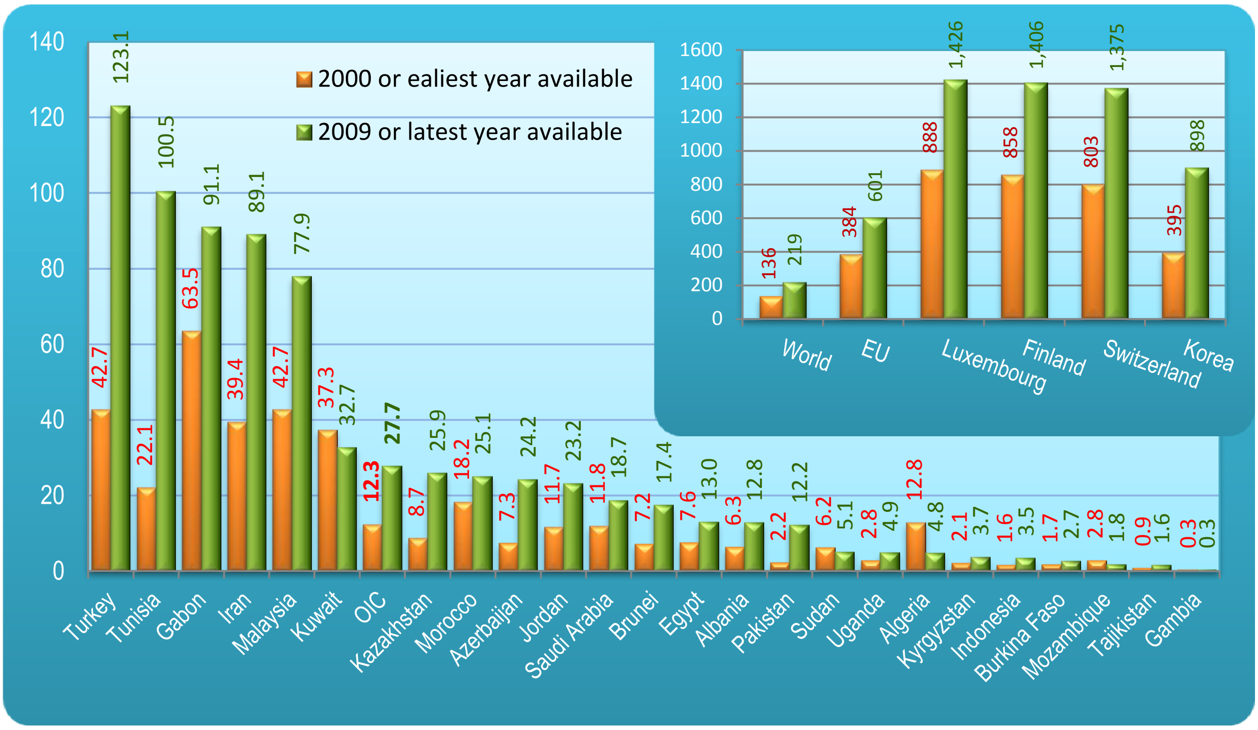

Figure 6: R&D Expenditures per Capita (PPP $)

R&D EXPENDITURES BY SECTOR

Given that GERD is the sum of R&D expenditures of the performing sectors, it is useful to disaggregate it into individual sectors to see how much R&D each sector performs. This sectoral disaggregation is based on the United Nations classification that defines four major sectors of performance: Government, Business Enterprise, Higher Education, and Private Non-Profit. In this respect, Figure 7 presents the distribution of GERD among these sectors in the OIC member countries for which data are available. The figures are based on total available resources, regardless of their source of funds.

As illustrated in Figure 7, sectoral distribution of GERD can be summarized as below:

- In most of the OIC member countries (13 out of 21 with available data), more than 50% of GERD is spent by government sector. This share reaches up to 100% in Kuwait and over 90% in Mozambique, and Brunei.
- Despite having a share of less than 50%, government sector in Sudan and Kazakhstan is the dominant sector, spending more on R&D than the other sectors do.
- The share of Business Enterprise in GERD is highest in Malaysia with 84.9%. Moreover, in, Turkey, Sudan, and Kazakhstan; Business Enterprise accounts for more than one third of the GERD.
- GERD of Business Enterprise is not available or at negligible levels in Kuwait, Mozambique, Brunei, Tajikistan, Pakistan, Burkina Faso, Albania, Nigeria, Senegal, and Mali.
- Higher Education is the leading sector in Mali, Nigeria, Morocco, Turkey, and Senegal, accounting respectively for 97.0%, 64.8%, 52.4%, 47.4%, and 40.7% of the total GERD. Furthermore, more than one quarter of the GERD in Iran, Sudan, and Pakistan is also performed by this sector.

- The share of R&D expenditures by the Private Non-Profit sector is at a negligible level in all of the member countries except in Senegal (25%), Burkina Faso (21.1%), Kazakhstan (13.5%), Uganda (9.9%), and Mozambique (4.6%).

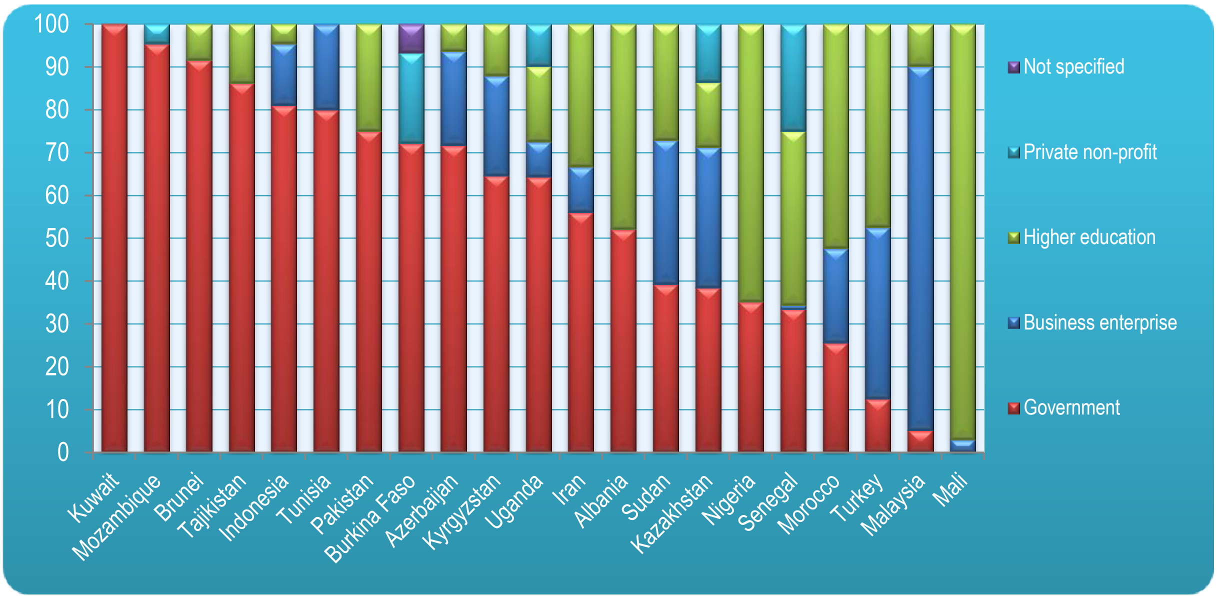

*Figure 7: Distribution of GERD by Sector of Performance (%)**

* Data for the most recent year available.

R&D EXPENDITURES BY SOURCE OF FUNDS

Figure 8 presents information on the funding sources of R&D in OIC member countries. Source distribution of the GERD has been made again on a sectoral basis as specified above, yet including additionally the funds from abroad.

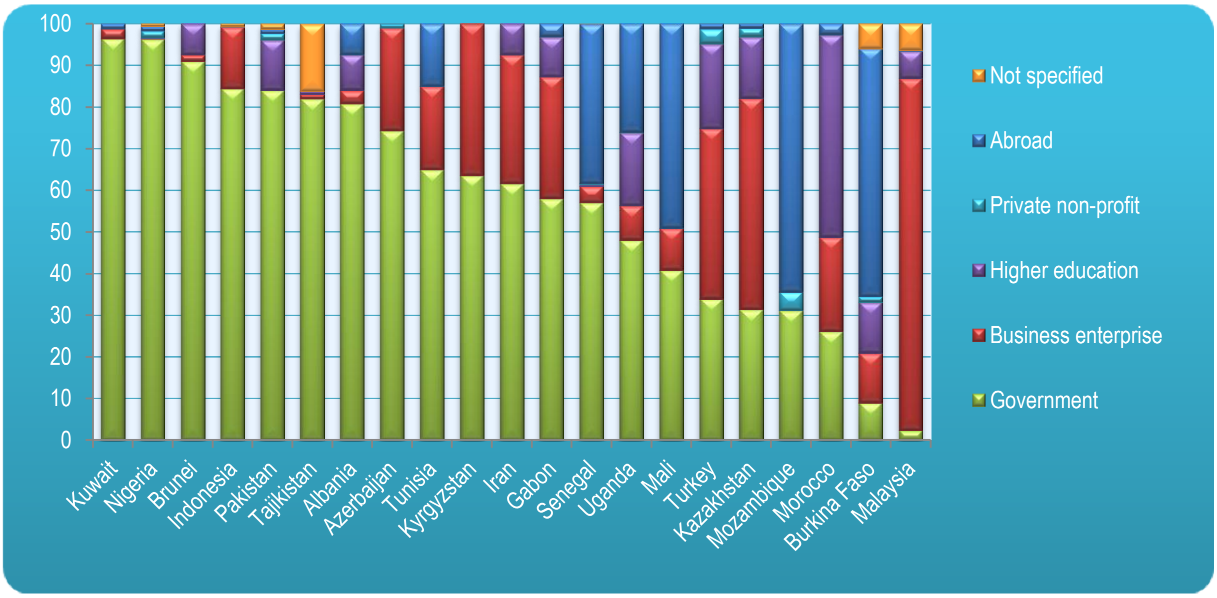

*Figure 8: Distribution of GERD by Source of Funds (%)**

* Data for the most recent year available.

Accordingly, given the data illustrated in Figure 8, the situation in OIC member countries can be summarized by the following observations:

- In most of the OIC member countries, R&D is mainly financed by the government sector. Out of the 21 member countries for which data are available, 13 countries receive more than %50 of R&D funds from the government.
- In Kuwait, Nigeria, and Brunei, the share of government funding is over 90%.
- Despite having a share of less than 50%, government sector in Uganda is the dominant sector, providing more R&D funds than the other sectors.
- In Malaysia, government's share in R&D funding is as low as 2.4%, which is the lowest rate among all OIC countries with available data.
- Business Enterprise in Malaysia accounts for 84.5% of the total R&D funds. In Kazakhstan and Turkey, the business sector is also dominant, providing respectively 50.7% and 41.0% of the total R&D funds.
- Higher Education sector in Morocco provides 48.6% of the total R&D funds, which is the highest rate among all OIC countries with available data. Additionally, sector's share exceeds 10% in Turkey, Uganda, Kazakhstan, Burkina Faso, and Pakistan.
- Mozambique, Burkina Faso, and Mali deserve special attention as their R&D funds mostly come from abroad, 64.3%, 59.6%, and 49% respectively.

HIGH-TECHNOLOGY EXPORTS

High-technology exports (HTE) are products with high R&D intensity, including aerospace, computers, software and related services, consumer electronics, semiconductors, pharmaceuticals, scientific instruments and electrical machinery, which mostly depend on an advanced technological infrastructure and inward FDI in high-tech industries. World high-technology exports are estimated to have declined to $1.6 trillion in 2009, from its $1.9 and $1.8 trillion levels observed in 2008 and 2007, respectively. Around 65% of that amount originated from developed countries, of which 31.7% from the EU members, 8.9% from the United States, 6.2% from Japan, and 6.5% from Korea Republic (Figure 9).

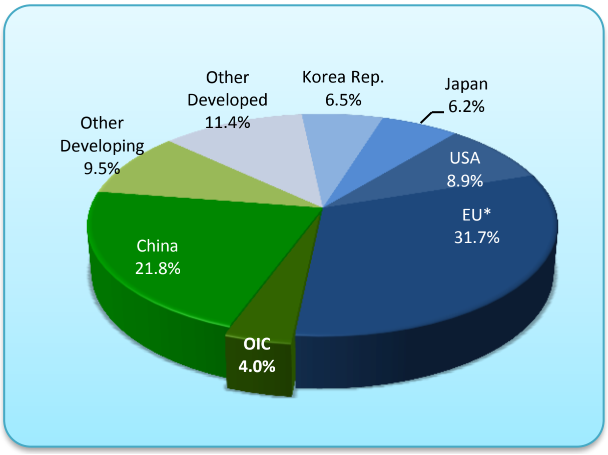

Figure 9: HTE, % of World Total, 2009
* Includes developed members only

China is the largest exporter of HTE, accounting for 21.8% of the world total HTE and 61.8% of the total HTE of developing countries. Confirming the lack of adequate infrastructure and FDI in most of OIC countries, it is observed that all the member countries for which data are available accounted for only 4% of the world total HTE (Figure 9), or 11.3% of the total HTE of developing countries. Data for OIC countries are illustrated in Figure 10, which yield the following observations:

- Malaysia and Indonesia are, by far, the top ranking OIC member countries by high technology exports, together representing 90.2% of the total HTE of the OIC.
- With $51.6 billion, Malaysia, on its own, accounts for 80.8% of the total HTE of the OIC. It is also the 10th largest exporter of high-technology products in the world, accounting for 3.2% of the world HTE.
- Kazakhstan, with around $1.8 billion of HTE, accounted for 2.8% of the total HTE of the OIC countries, rendering it the 3rd largest exporter of high-technology products in the OIC.
- HTE of the other leading member countries ranges from $100 million to $1.5 billion.
- Benin, Guyana, Iraq recorded HTE figures of around $50,000, and Comoros even less than $5,000.
- Cote d'Ivoire, with $187 million of HTE, gets far ahead of the other Sub-Saharan members. It also ranked as the 9th largest exporter of high-technology products in the OIC.

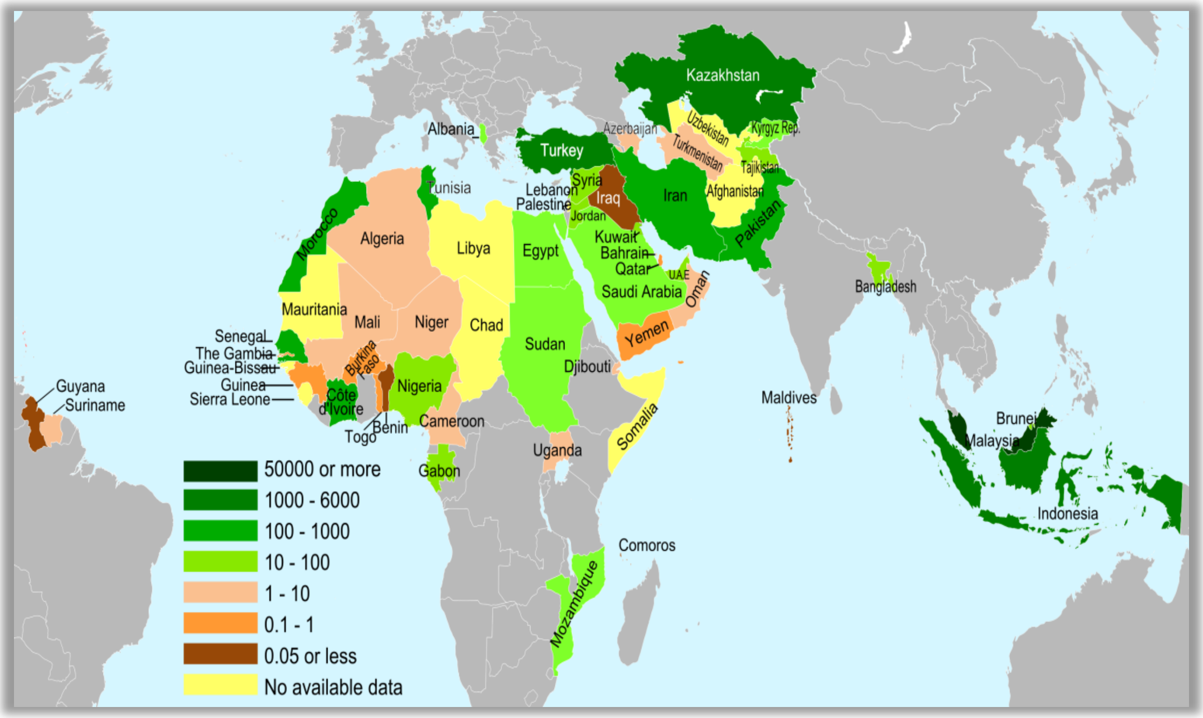

*Figure 10: High Technology Exports (Million US$)**

* Data for 2009 or latest available year.

Figure 11 depicts top 15 OIC member countries with the highest HTE. According to the latest data available as of 2009, Malaysia, with annual volume of $52 billion, is the largest exporter of high technology products among the OIC member countries. Indonesia, Kazakhstan and Turkey follow the lead with HTE volumes of $5.9 billion, $1.8 billion and $1.5 billion, respectively. Both Tunisia ($663 million) and Morocco ($646 million) have HTE of above half a billion, whereas Iran, Pakistan, Côte d'Ivoire, Lebanon and Senegal recorded HTE figures varying between $104 million (Senegal) and $375 million (Iran).

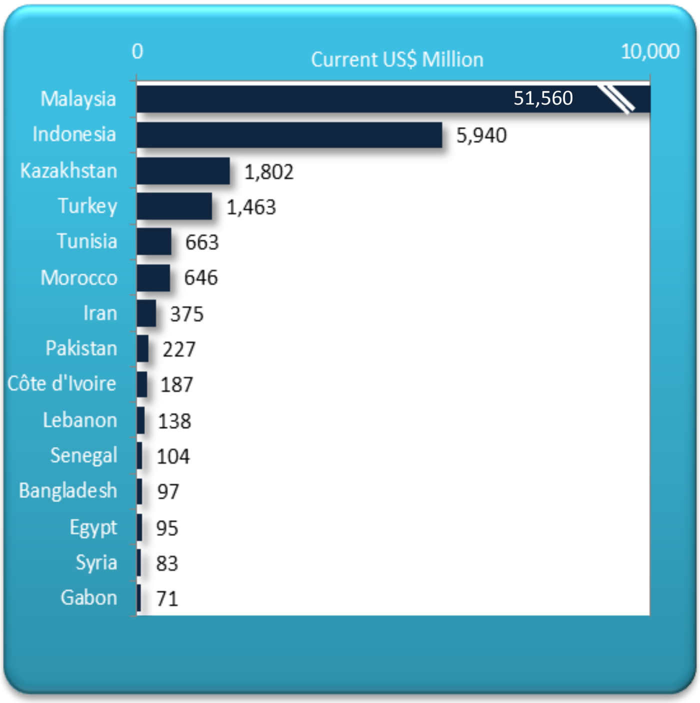

Figure 11: Top 15 OIC Countries wit the High Technology Exports, 2009 or latest data available

SCIENTIFIC PUBLICATIONS

Academic research is one of the most important components of research activities conducted in a country. To a certain extent, the performance in academic research can be well reflected by the number of scientific articles published in indexed journals. In this regard, the quantity and the growth of the research output, *i.e.*, articles, are indicators commonly used to measure the research performance of a given institution or country. Indeed, such bibliometric indicators have been widely used in national science and technology statistics publications to measure scientific capacity and linkages to world science[3] and particularly in national and international rankings of universities.[4]

PUBLISHED ARTICLES

OIC member countries as a whole published 78,044 articles[5] in 2010 in journals that are covered by Science Citation Index Expanded (SCI-EXPANDED), Social Science Citation Index (SSCI), and Arts & Humanities Citation Index (A&HCI), compared to 20,038 articles they published in 2000.[6]

[3] UNESCO Institute for Statistics, "What do bibliometric indicators tell us about world scientific output?", *UIS Bulletin on Science and Technology Statistics*, Issue 2, September 2005.
[4] For example, Academic Ranking of World Universities by Shanghai Jiao Tong University (SJTU), World University Rankings by the Times Higher Education Supplement (THES), and also the OIC University Ranking make use of the research output as an important indicator in their ranking methodologies.
[5] The total reflects the sum of individual OIC countries and it is not refined for internationally co-authored papers.
[6] Data are collected from the ISI Web of Knowledge maintained by Thomson Reuters. For further information, see http://isiwebofknowledge.com/

Although there is nearly four-fold increase in a decade, the amount reached is still below those of some individual countries in the world, such as the United States. China, and Germany (Figure 12).

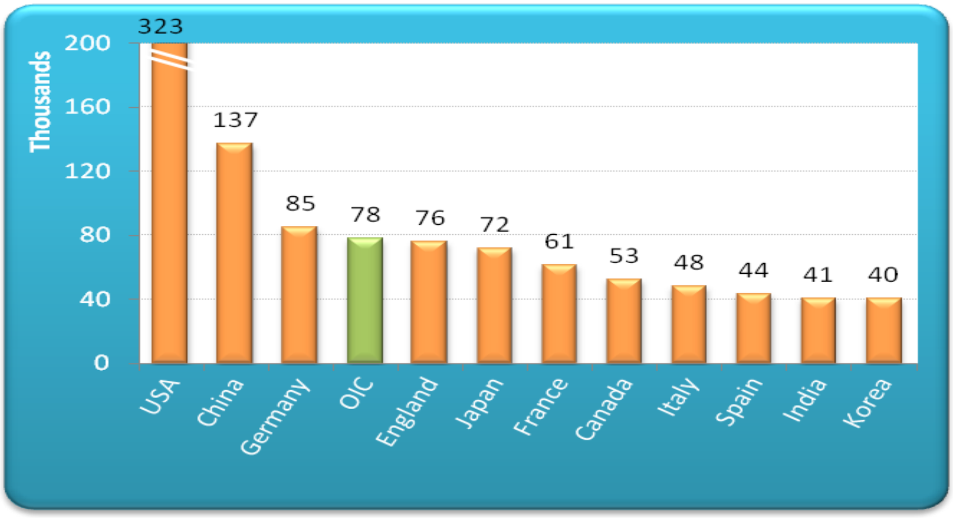

Figure 12: The Number of Published Articles, 2010

Figures 13 and 14 present information on the contribution of each OIC member country to this output. In this respect, the following observations outline the performance of the OIC member countries in publishing articles:

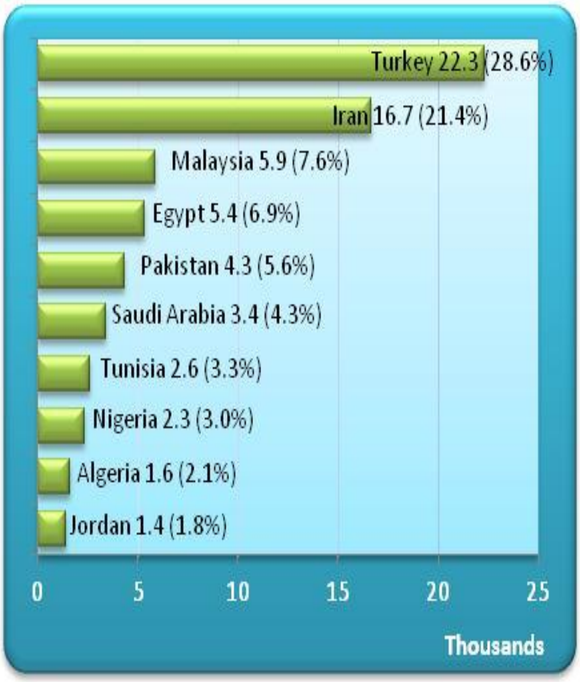

Figure 13: Top 10 OIC Countries by the Number of Published Articles, 2010

- Production of scientific publications –here articles– in the OIC is heavily concentrated in a few of the member countries.
- Half of the total articles (50.0%) originate from only two member countries, Turkey (28.6%) and Iran (21.4%). Together with Malaysia (7.6%), Egypt (6.9%) and Pakistan (5.6%), these five countries alone account for 70% of all published articles (see Figure 13).
- Some other member countries in the Middle East & North Africa, South Asia, and East Asia & Pacific also perform well while those in Latin America, Sub-Saharan Africa, and Central Asia are generally lagging behind.
- There are 8 countries that published less than 20 articles in 2010. These countries are not concentrated in one region but dispersed across regions: for example; from Suriname in Latin America to Somalia in Sub-Saharan Africa, and from Turkmenistan in Central Asia to Maldives in South Asia.

➢ The number of countries having published less than 100 articles is 20.

➢ Nigeria stands out as the only Sub-Saharan member to have produced over 1,000 articles (2,319), the closest ones in the region being Uganda and Cameroon with 610 and 561 articles, respectively.

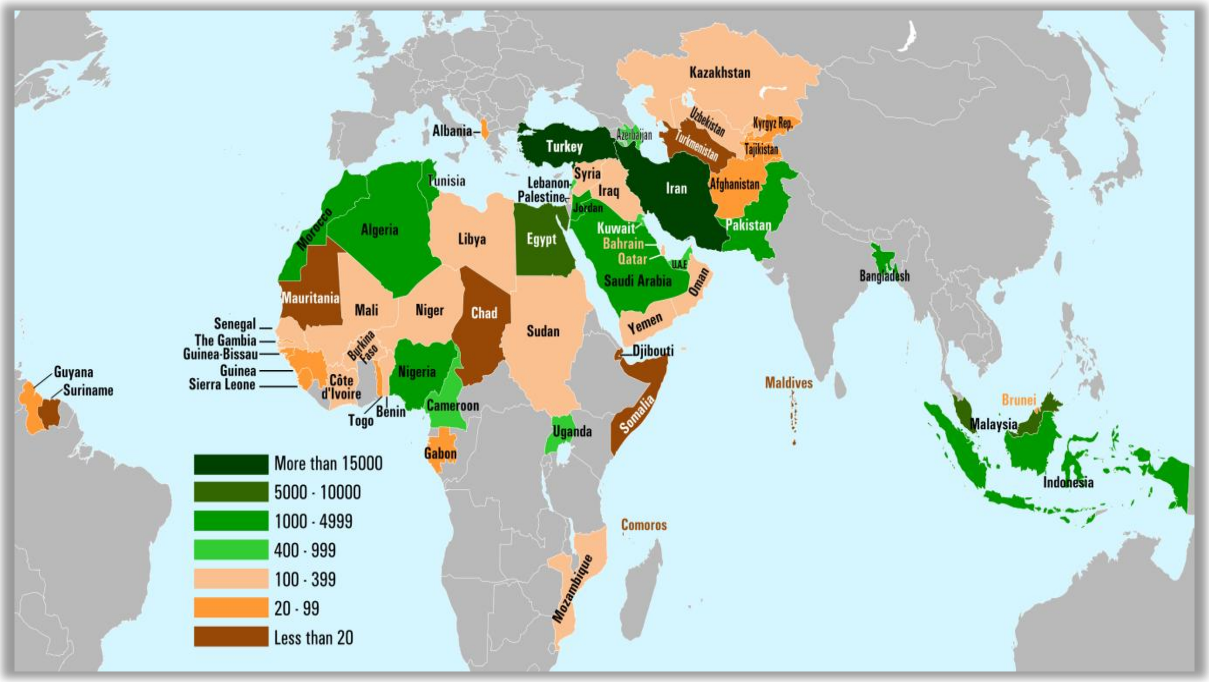

*Figure 14: Articles Published in International Journals, 2010**

* Total number of articles published in journals covered by Science Citation Index Expanded (SCI-EXPANDED), Social Science Citation Index (SSCI), and Arts & Humanities Citation Index (A&HCI).

THE EVOLUTION OF PUBLICATION OUTCOME

The growth in the number of articles on a per-capita basis reflects a better indicator of productivity in scientific publications as it takes into account the relative size of the population in the countries compared. In this respect, Figure 15 presents data on articles per million people (pmp) in OIC member countries in a manner to reflect the evolution in the period of 2000-2010. Accordingly:

➢ On average, OIC member countries produced only 16 articles (pmp) in 2000 while this number increased to 50 in 2010, which still could be considered low given that this number reached up to 1,547 in Canada, 1,224 in England, 1,041 in Germany and USA, 827 in Republic of Korea, 516 in Japan, and 187 in Russia and 102 in China.

➢ 50 out of the 57 member countries recorded an increase in that period, but the increase in 24 of them was no more than 10 articles (pmp). This implies that the expansion recorded in countries with low number of articles (pmp) remained quite limited compared to those with high numbers.

- Turkey, in absolute terms, took the lead in boosting scientific productivity with an increase of 232 articles (pmp), followed by Iran (202), Tunisia (185), Malaysia (172), and Qatar (127).
- Four other countries, namely Jordan, Lebanon, United Arab Emirates, and Saudi Arabia, recorded an increase of over 50 articles (pmp).
- Four out of the 57 members, namely Kuwait, Uzbekistan Mauritania, and Turkmenistan, recorded a decrease in their articles (pmp). The highest decrease was reported for Kuwait (46 articles), while the decrease for the others was by only two articles. However, Kuwait still continues to rank in the ninth place with respect to articles per million people in 2010.
- Overall, according to 2010 data, there are only 17 members performing above the OIC average in terms of articles per million people. Turkey, with 313 articles took the lead, and followed by Tunisia (244), Jordan (230), Iran (223), Malaysia (209), Lebanon (195), and Qatar (194). United Arab

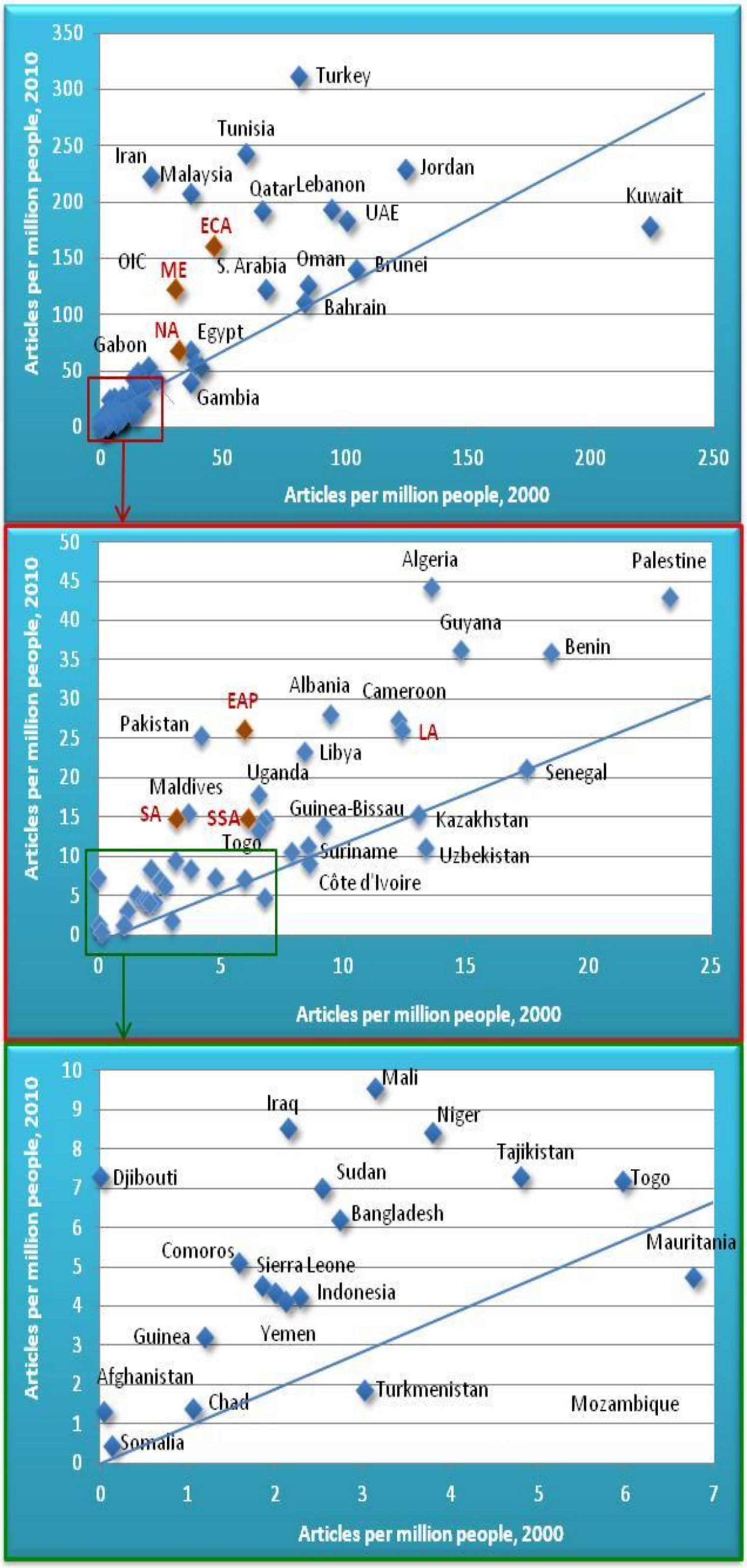

Figure 15: Articles per Million People: 2000 vs. 2010

OIC Regional Averages:

ECA: Europe & Central Asia	**NA:** North Africa
EAP: East Asia & Pacific	**SA:** South Asia
LA: Latin America	**SSA:** Sub-Saharan Africa
ME: Middle East	

Emirates, Kuwait, Brunei, Oman, Saudi Arabia and Bahrain also ranked at the top, having produced over 100 articles per million people. Egypt, and Gabon succeeded in entering the top 15 (see Figure 15 Top Panel and Figure 16).

- At the other side of the spectrum, there are member countries with even less than one article (pmp), like Afghanistan, Chad, and Somalia.
- Most of the high ranking member countries are located in the Middle East. Articles per million people averaged at 123 in this region in 2010, compared to 31 in 2000.
- The average for the members in Europe & Central Asia increased from 47 to 161 in that period. Excluding Turkey, these averages fall down to 12 and 17, respectively.
- The averages for the other regions also increased in the period under consideration (North Africa: from 32 to 68; East Asia & Pacific: from 6 to 26; Latin America from 12 to 26, South Asia: from 3 to 15; and Sub-Saharan Africa: from 7 to 13).

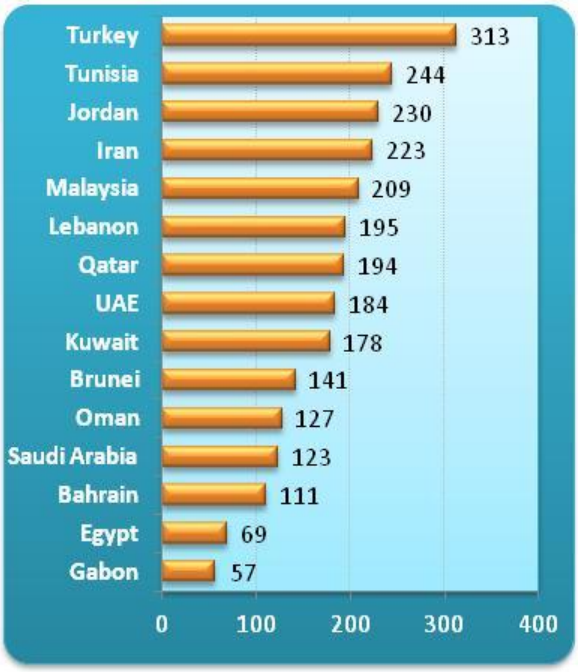

Figure 16: Top 15 OIC Countries by Articles Per Million People, 2010

PATENT APPLICATIONS

Intellectual property rights, especially patents, are the key factors contributing to advances in innovation and scientific development. As a product of R&D activities, patents strengthen the link between science and technology, as the outcomes of research translate into new products or services. In this regard, although not all inventions are patented, the quantity of patent applications may be considered as a proxy for the degree of innovative capability in a country.

According to statistics from the World Intellectual Property Organization (WIPO), the total number of patent applications around the world in 2010 is estimated to have been 1.86 million, and about 1.5% of them were filed in OIC member countries –for which data are available. USA, Japan, China, and Korea Republic accounted for about 69% of the total patent applications in the world. To shed light on the situation in individual OIC member countries, Table 1 presents statistics on patent applications in countries for which data are available.

*Table 1: Patent Applications by Office: Residents and Non-residents**

Country	Residents	Non Res.	Total	Year	Country	Residents	Non Res.	Total	Year
Iran	5,970	557	6,527	2006	Bangladesh	29	270	299	2007
Malaysia	818	4,485	5,303	2008	Syria	124	133	257	2006
Indonesia	282	4,324	4,606	2006	Azerbaijan	222	5	227	2008
Turkey	2,555	177	2,732	2009	Kazakhstan	11	162	173	2008
Egypt	490	1,452	1,942	2009	Kyrgyzstan	135	3	138	2008
Pakistan	170	1,375	1,545	2008	Brunei		42	42	2009
Morocco	177	834	1,011	2008	Mozambique	18	22	40	2007
Algeria	84	765	849	2007	Yemen	11	24	35	2007
Saudi Arabia	128	642	770	2007	Sudan	3	13	16	2007
Jordan	59	507	566	2007	Tajikistan	11	1	12	2009
Uzbekistan	238	174	412	2009	Uganda	6	1	7	2007
Tunisia	56	282	338	2005	Bahrain			3	2004
Lebanon			316	2006	Burkina Faso	1		1	2005

* Patent application numbers for the most recent year with available data are considered. Most recent year with available data is indicated in the "Year" column. Numbers of patent applications for most African OIC countries are not provided individually as these countries are members of the African Regional Intellectual Property Organization (ARIPO). Total number of patents filed to ARIPO in 2008 is 435. Resident/non-resident breakdown is not provided for Lebanon and Bahrain.

In this respect, the following observations can be made to summarize the situation in the OIC countries:

- Patent activity is highest in Iran, Malaysia, and Indonesia. In 2006, total patent applications (by residents and non-residents) amounted to 6,527 in Iran and 4,606 in Indonesia. In 2008, total patent applications amounted to 5,303 in Malaysia.
- In most of the OIC countries, applications by non-residents are higher than those filed by residents; in fact, in 12 of the 26 countries with available data, they account for more than 75% of the total applications. In quantity, they are highest in Malaysia (4,485) and Indonesia (4,324), accounting for, respectively, 85% and 94% of the total applications.
- Applications by residents dominate only in 8 out of 26, and, in quantity, they are highest in Iran (5,970) and Turkey (2,555).

KNOWLEDGE AND TECHNOLOGY

Two of the widely used measures of knowledge and technology are the Knowledge Economy Index (KEI) and Knowledge Index (KI), which were developed by World Bank in order to compare the performance of any country with other countries and/or group of countries. The KEI measures to what extent the environment is conducive for knowledge to be used effectively for economic development. It is calculated based on the average of normalized scores of a country on four pillars related to the knowledge economy: Economic Incentive and Institutional Regime, Education, Innovation, Information and Communication Technology. Figure 17 depicts the positions of the top fifteen OIC member countries vis-à-vis the rest of the world in terms of their performance related to the KEI.

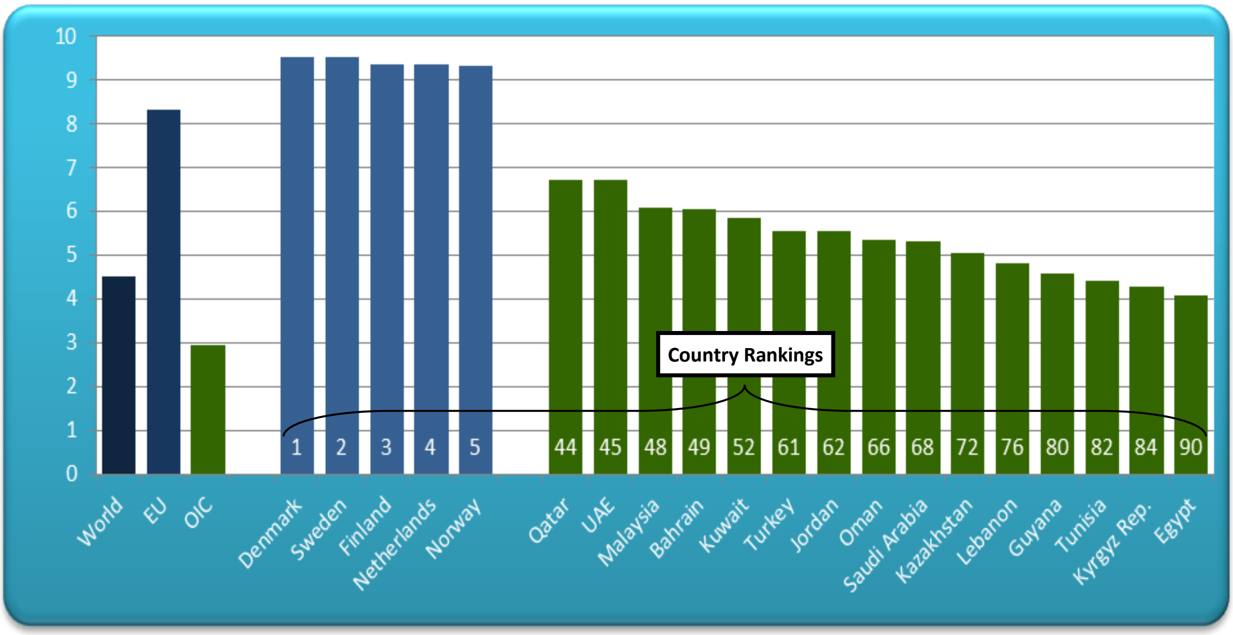

*Figure 17: Knowledge Economy Index (KEI) and country rankings, 2009**

* KEI is calculated for 145 countries and 41 OIC members. The index values for the world, EU and OIC are calculated by taking averages of index values for the relevant countries weighted by 2009 country populations extracted from IMF WEO Database.

The following observations are made:

- The KEI is above the world average in only 12 out of 41 OIC member countries for which the KEI is calculated.
- Qatar and UAE are the top two OIC member countries standing only 44th and 45th in the world, respectively.
- Half of the bottom 50 countries for which the KEI was calculated are OIC members.
- To give a sense of the regional comparison between the OIC and EU, there is only one EU country with a lower KEI than Qatar and UAE, which are the top two OIC members in terms of the KEI.

The other widely used knowledge index, KI, measures a country's ability to generate, adopt, and diffuse knowledge. The KI is the simple average of the normalized scores of a country on three knowledge economy pillars: Education, Innovation, Information and Communication Technology. The only difference between the KI and KEI is that the former does not take into account economic incentives and institutional regime. Figure 18 depicts the positions of the top fifteen OIC member countries vis-à-vis the rest of the world in terms of their ability to generate, adopt, and diffuse knowledge.

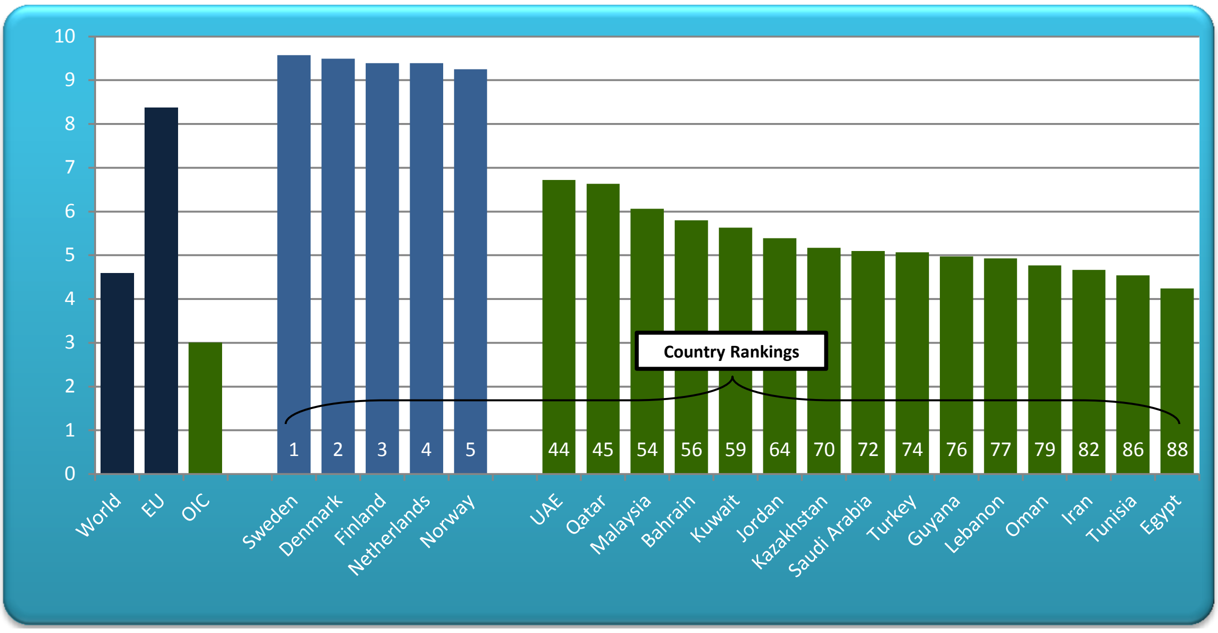

*Figure 18: Knowledge Index (KI) and country rankings, 2009**

* KI is calculated for 145 countries and 41 OIC members. The index values for the world, EU and OIC are calculated by taking averages of index values for the relevant countries weighted by 2009 country populations extracted from IMF WEO Database.

The following observations are made:

- The KI is above the world average in only 13 out of 41 OIC member countries for which the KI was calculated.
- As in the case of KEI, the United Arab Emirates and Qatar are the top two OIC member countries standing only 44th and 45th in the world in terms of the KI, respectively.
- 22 of the bottom 50 countries for which the KI can be calculated are OIC members.

The OIC member countries perform slightly better when KI is used as opposed to KEI. This indicates that economic incentives (tariffs and non-tariff barriers) and institutional regime (rules and regulations) are two main reasons for OIC members' poor performance in knowledge and technology.

Innovation Index and Information and Communication Technology (ICT) Index, two components of the KEI and KI, are also important indicators on science and technology. In the rest of this section, these two indices are analyzed for the OIC member countries. Innovation Index is the simple average of the normalized scores on three key variables: Total Royalty Payments and Receipts, Patent Applications Granted by the US Patent and Trademark Office, Scientific and Technical Journal Articles. Figure 19 compares the OIC member countries with the rest of the world in terms of innovation. As seen in Figure 19, the Innovation Index value is above the world average in only 5 out of 41 OIC member countries for which the index was calculated. Malaysia and the United Arab Emirates are the top two OIC member countries standing only 44th and 46th in the world, respectively.

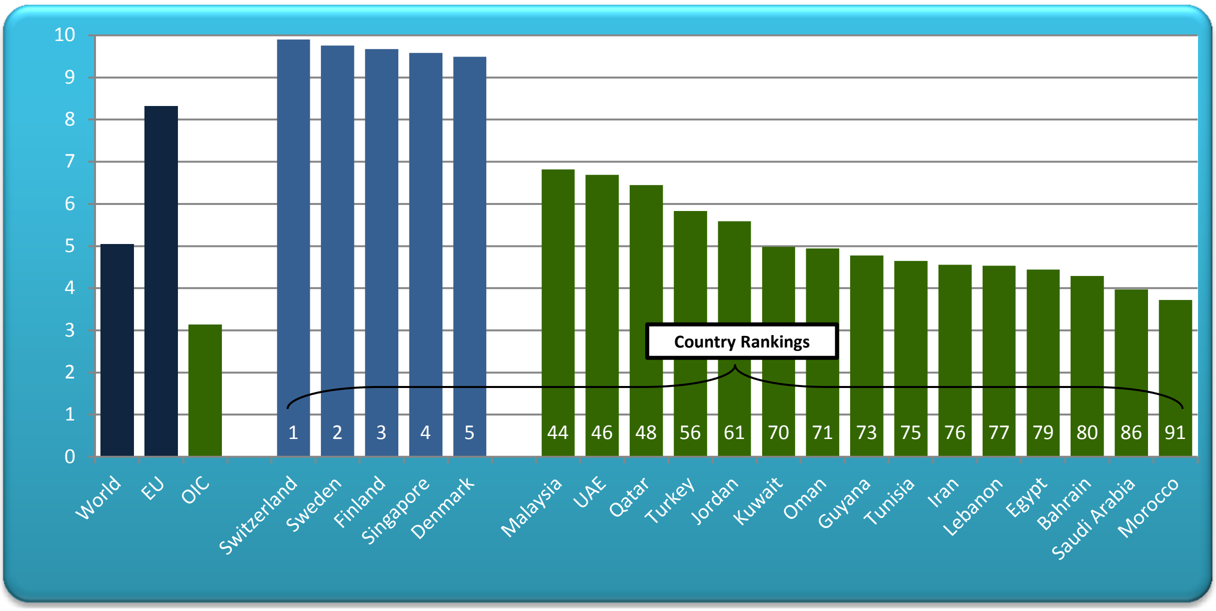

*Figure 19: Innovation Index and country rankings, 2009**

* Innovation index is calculated for 146 countries and 41 OIC members. The index values for the world, EU and OIC are calculated by taking averages of index values for the relevant countries weighted by 2009 country populations extracted from IMF WEO Database.

ICT Index is the simple average of the normalized scores on three key variables: Telephone, Computer, and Internet Penetrations (per 1,000 people). Figure 20 compares the OIC member countries with the rest of the world with respect to the usage of telephone, computer, and the internet. As seen in Figure 20, the ICT Index value is above the world average in 14 out of 40 OIC member countries for which the index was calculated. The United Arab Emirates and Qatar are the top two OIC member countries standing 21st and 27th in the world, respectively. The index value is above the EU average only in the UAE.

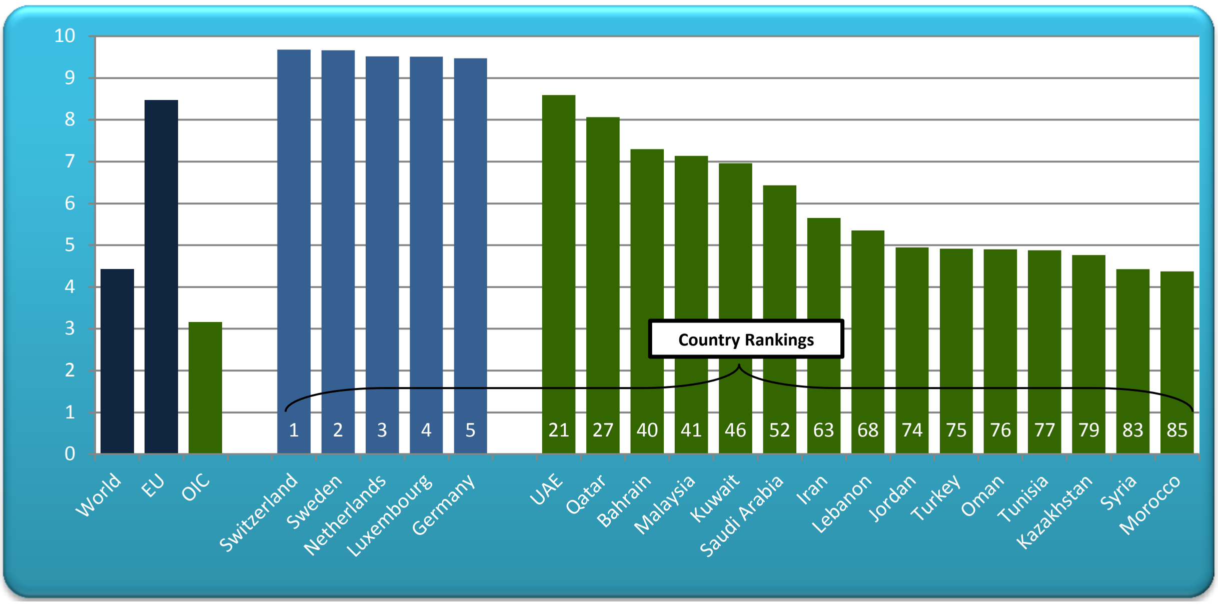

*Figure 20: Information and Communication Technology (ICT) Index and country rankings, 2009**

* ICT index is calculated for 146 countries and 41 OIC members. The index values for the world, EU and OIC are calculated by taking averages of index values for the relevant countries weighted by 2010 country populations extracted from IMF WEO Database.

ENHANCING COOPERATION AND COLLABORATION IN NANOTECHNOLOGY

Nanotechnology is the study of manipulating matter on an atomic and molecular scale. It deals with developing materials, devices, or other structures possessing at least one dimension sized from 1 nanometre (one millionth of a millimetre) to 100 nanometres.

Nanotechnology is very diverse which gives humanity the opportunity to directly control matter on the atomic scale. Nanotechnology entails the application of fields of science as diverse as surface science, organic chemistry, molecular biology, semiconductor physics, microfabrication, etc. Nanotechnology also offers fascinating possibilities and solutions including producing many new materials and devices with a vast range of applications in medicine, electronics, biomaterials and energy production.

Although the OIC Member Countries are taking individual steps in this field, there is still a synergic potential to manage, develop and re-allocate available resources to excel in nanotechnology by enhancing cooperation and collaboration among the OIC member countries.

The following are recommended as ways and means for enhancing the networking among nanotechnology centres in the OIC Member Countries:

1. Establishing a world-class nanotechnology centre: In order to raise future nanoscientists for catering the human resources need of the OIC Member Countries in nanotechnology, a world-class nanotechnology centre should be established. Besides offering graduate nanotechnology programs, this Centre should also host an intellectual property and incubation office providing venture capital support to nanotechnology start-up companies.

2. Exchange of nanoscientists for long term between the existing nanocentres: For period ranging from 12 months to 24 months, an exchange of nanoscientists should take place between the existing nanocentres for targeted research areas. This exchange program should also give financial support to nanoscientists regarding salary, research grants, and equipment usage fees.

3. Support programs for individual nanoscientists to use existing nanocentres for short term: Similar to the long-term exchange program, under this scheme students working towards for a doctoral degree in nanotechnology or researchers should be given the opportunity to use existing

nanocentres for a period of one or two weeks. This program should also financially support the nanoscientists regarding their travel, accommodation, and fees for nanocentre usage.

4. Collaborative nanotechnology research projects: With the support of high technology firms, at least three OIC Member Countries should collaborate for targeted research areas in nanotechnology. The European Union's Seventh Framework Programme offers a sample model for such collaborative research projects.

5. An annual nanotechnology conference and project fair: In order to increase networking and collaboration opportunities among the researchers and investors of the OIC Member Countries, an annual nanotechnology conference and project fair should be organised. On the sidelines of this conference, a project fair and a researcher-investor business forum would also enhance the interaction among the OIC Member Countries.

6. Experience sharing between the existing nanocentres for training nanocentre technicians: By organising 4 to 6-week study visits, the technicians working at nanocentres should be trained under workshops focusing on clean room management, and materials analysis techniques of Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), X-ray Photoelectron Spectroscopy (XPS, ESCA) and X-ray Diffraction (XRD), Focused Ion Beam (FIB), Atomic Force Microscopy (AFM), etc.

POLICY RECOMMENDATIONS

The primary finding of this detailed analysis on the current stance of S&T in OIC member countries is twofold. First, major indicators on research and scientific development display a large disparity within the OIC member countries. Second, the OIC members, individually or as a group, lag far behind the rest of the world, particularly the developed countries, with a few exceptions. In line with the main findings of this analysis, some broad policy recommendations will be presented in this section.

While the availability of researchers varies considerably across the OIC member countries, most of these countries lag behind the world, with inadequate quantity of researchers employed in R&D activities. However, the OIC average for women researchers as a percentage of total researchers is slightly higher than the average of EU, and many individual OIC countries have higher shares than even the average for the EU member countries. On the other hand, spending on the research and development is significantly low in the OIC Countries. The low R&D intensity introduces major challenges for OIC member countries, as only eight member countries are spending more than 1% of GDP on R&D in comparison to the world average of 2.2%. While some countries have recorded significant increases in their R&D intensity in the last ten years, most of them reported stable expenditures on R&D. Although the OIC Ten-Year Programme of Action called upon the member countries to encourage R&D programmes and ensure their individual R&D intensity is not inferior to half of the world average, the OIC countries are still far away from this target and, with the current trends, it seems difficult to meet the Programme target on time. Therefore, there is a dire need for more efforts to be exerted in this area in order to close the gap with the rest of the world. To achieve this, R&D should be stimulated through government and private sector initiatives and coordination among the OIC member countries.

As another important indicator on research and scientific development, production of scientific articles is concentrated in a few of the OIC members. In 2010, the OIC member countries produced around 78,000 articles, 70% of which originated in only five countries, namely Turkey, Iran, Malaysia, Egypt and Pakistan. Moreover, the number of articles was less than 100 in 20 OIC member countries. From 2000 to 2010, the number of articles per million people, on average, increased by 34 articles to reach 50, which is still low given that in some countries it exceeds 1,000. To close the gap with the rest of the world and among the members, higher education and academic research should be supported rigorously by the governments. The establishment of universities and research centres through funds and financial incentives should be encouraged. OIC member countries should improve living standards for scientists to reduce brain drain from member countries to other countries and to lead brilliant minds to academic work. The participation of women in university education should be improved through the elimination of the obstacles that prevent them from attending higher education. Academic research should be promoted through research grants and lesser teaching loads.

In this connection, intra-OIC networking opportunities could be facilitated through projects, similar to the Framework Programmes of the European Union, to support research and technological development in the Islamic world and to promote joint research initiatives among the member countries. Additionally, joint ventures among companies in OIC member countries in research intensive sectors should be encouraged towards more effective and cost efficient R&D investments. OIC countries may also take advantage of R&D spillovers by rapidly learning about new technologies developed in other countries and improving them, and by importing technological goods and services from their high-tech trade partners.

Referring to the available data on 26 OIC member countries, the present report finds that patent applications are below the world average and mostly filed by non-residents, implying that indigenous innovation capability in most of these countries is at low levels. The OIC member countries have no choice but to adopt measures to encourage patenting and technology licensing. In particular, an initiative can be put in place to educate small and medium-sized enterprises about the benefits and regulations of the patent system. Additionally, an OIC level patent system, similar to African Regional Intellectual Property Organization or European Patent Organisation, can be developed to increase incentives for patent application in the Islamic world. Such a system not only brings higher benefits for patent holders through the right of being granted patents in a larger geography, but also will foster the establishment of relationships between the members in matters relating to R&D and patents, and promote exchange of ideas, research, and studies on industrial property matters.

As a result of the low R&D intensity coupled with inadequate technological infrastructure, high technology exports of the OIC member countries are quite limited, accounting for only 4% of the world high technology exports in 2009. Malaysia, with HTE of $52 billion in 2009, is the largest exporter of high-technology products among the OIC member countries. Indonesia, Kazakhstan and Turkey, each with HTE figures above $1 billion, exhibit good prospects for further increase in their HTEs. In this context there is a dire need to increase the share of high technology products in the exports of manufactured goods of the OIC member countries.

An important component of scientific development is the infrastructure of internet and other information and communication technologies. This is particularly important in the OIC member countries, which have a high density of youth population. First of all, telecommunication sectors should be liberalized for better products and services in the OIC member countries. Some countries such as Saudi Arabia and Turkey successfully liberalized their telecommunication sectors in the last two decades. However, there is a strong need to speed up the privatization and liberalization of telecommunication sectors in many other OIC member countries. Governments should also promote internet usage through tax reductions on internet services and transferring internet subscription charges from consumers to telecom sector and internet service providers. To meet human resource needs in information and technology related sectors, it is important to encourage technology related majors in higher education.

Finally, OIC Member Countries need to adapt to the very dynamic global market place in a timely manner, and take their part in the new phase of scientific development. As nanotechnology is envisioned by many scientists and researchers as the next major advancement in science and technology, it is very critical that special attention is given to this important area by the governments, science community and the private sector through public-private partnerships and OIC-wide networking. SESRIC has been raising awareness on this important topic in the Islamic world. The global market for nanotechnology products is estimated to reach $1 trillion by 2015. OIC member countries are at a cross road to be major players of this advancement. It is imperative that joint research and investment on nanotechnology is initiated among the OIC countries as the pioneers of this new technology will benefit enormously from their early investment in this area.

REFERENCES

IMF, World Economic Outlook (WEO), Online Database, September 2011.

ISI Web of Knowledge, Online Database, 26-28 September 2011

OIC-TYPOA, "Ten-Year Programme of Action to Meet the Challenges Facing the Muslim Ummah in the 21st Century", Third Extraordinary Session of the Islamic Summit Conference, Makkah al Mukarramah - Kingdom of Saudi Arabia, 7-8 December 2005.

Roco M.C., Bainbridge W. eds., 2001. Societal implications of nanoscience and nanotechnology. National Science Foundation Report, 2000.

UNESCO Institute for Statistics, "What do bibliometric indicators tell us about world scientific output?", UIS Bulletin on Science and Technology Statistics, Issue 2, September 2005.

UNESCO Institute for Statistics, Data Centre.

WIPO, Statistics on Patents, January 2011.

World Bank, KEI and KI Indexes.

World Bank, World Development Indicators, Online Database.

Statistical, Economic and Social Research and Training Centre
for Islamic Countries (SESRIC)

Attar Sokak No. 4, 06700 GOP, Ankara, TURKEY
Tel: (90-312) 468 6172 (4 lines) Fax: (90-312) 468 5726
E-mail: oicankara@sesric.org   Web: www.sesric.org