Performance and progress of OIC countries towards building technology development capacity

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This study evaluates the technology development capacity of 21 Organization of Islamic Cooperation (OIC) countries based on technology achievement index. The state of four fundamental contributors of technology development capacity, i.e. technology creation, diffusion of old technologies, diffusion of recent technologies and development of human skills, essential for indigenous technology development or/and technology transfer and adaptation is studied for each of the 21 OIC countries. Each fundamental factor is represented by two indicators. Achievement gap, comparing with the highest achiever, has been calculated for all the countries. Based on the achievement gap analysis, progress of each country during the five-year period (2009–2014) in building technology development capacity has been assessed. Strong and weak areas have been mentioned for some selected countries. Technology development capacity and achievement gap analysis of individual countries present useful information for the policy makers and planners of the relevant countries to formulate appropriate policies and programmes for enhancing national capacity for technology development.

Keywords: Achievement gap analysis, OIC countries, technology achievement index, technology development capacity.

THE process of socio-economic development is not only based on the natural resources that a country possesses, but also on its scientific and technological capability[1]. Scientific and technological preparedness of a country to participate in knowledge-based economy helps improve its innovation and technology capability which is essential for socio-economic development of nations[2]. Technological developments have changed the entire process of manufacturing, agriculture and services[3]. The Industrial Revolution and emergence of the service sector were possible only because of the technological developments[4]. The process of research, creation and improvements of technology and use of knowledge to solve problems is called technology development. In the perspective of the present study, 'technology capacity' is defined as the ability of a nation to create, adopt, absorb and utilize technology for social and economic benefits.

Among the 57 high-income countries (on the basis of GDP per capita), there are only seven Organization of Islamic Cooperation (OIC) countries – all of these are petroleum-exporting countries. Why are there only a few 'oil reach' OIC countries among the high-income countries? And no OIC country is included among the developed countries? What differentiates OIC and other developing countries from developed countries? The answer is technological development. One distinct difference between developed and developing nations is the state of their technological development[5]. Technology is a crucial variable which can explain differences among countries in growth rates, productivity, competitiveness, job creation and well-being[6], and hence in socio-economic development as a whole. In a study conducted on the technology achievement of countries in 2010, only two OIC countries, i.e. Malaysia (23rd) and Bahrain (44th), were present in the top half of the list of 91 countries[2]. This indicates the state of technological development in the OIC countries. Under this scenario, the present study provides useful information to the policy makers and other stakeholders in the OIC countries about the current state of their technology development capacity, and their strengths and weaknesses in different aspects of technology development capacity, thus, helping them formulate more appropriate policies for their technology capacity building.

The Organization of Islamic Cooperation (formerly known as the Organization of the Islamic Conference) has 57 independent states as its members, which makes it the second largest inter-governmental organization after the United Nations[7]. Spread over four continents, the OIC countries account for almost a quarter (precisely 23%) of

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the total world population[8]. In general, the OIC countries are blessed with natural and human resources. They have 65% of the global reserves of crude oil, which is the main source for energy and petrochemical products that drive the world economy today. The OIC countries also have 58% of the global proven natural gas reserves. Many of the OIC countries rank among the top 20 producers of the major agricultural products[9]. Share of the OIC countries in the total world production of raw materials in jute, palm oil, natural rubber, natural gas, grain, cotton and sugar is 80%, 75%, 70%, 37%, 25%, 13% and 10% respectively[5]. They also have a young population which can be one of the key drivers of their socio-economic development. The share of people, in the age group 0–24 years, in the OIC countries is 53.49%, which is much greater than the world average (43.70%) and the average of developed countries (28.15%)[9]. However, to take advantage of this young population, the OIC countries need to invest more on development of human capital. Presently, this does not seem to be their top priority in general. The average gross enrollment rate (GER) in tertiary education in the OIC countries is only 18.2% compared to the world average of 28.8% and that of developed countries of 77% (ref. 9). The growth rate of Muslim population is much higher compared to the rest of the world[8]. The OIC countries must realize that the higher population growth rate coupled with lower education rate can be a destructive combination.

Share of the OIC in the world population is 23% but its share in the total world GDP is less than 11%. The total population of the Muslim world is 1.6 billion, whereas its total annual GDP is only US$ 9.9 trillion. Great disparities also exist among the OIC countries. For example, only 20% of the OIC countries have almost 80% of the Muslim population. On the other hand, Guyana has only about 6% Muslim population, but it is also a member of OIC. Similarly, large concentration of GDP exists among a few countries, e.g. per capita GDP of Qatar is 11 times higher than the average of all other OIC member countries. More than 50% of the OIC population lives in countries which have per capita GDP less than US$ 3500. Only 7% of the population lives in countries which have per capita GDP more than US$ 14,000. Disparities among the OIC countries also exist in various parameters of infrastructure development and ease of doing of business[8].

Scientific and technological developments in the field of agriculture, health, environment, telecommunication, applied engineering, etc. have made significant contributions to improve the living standards of people. Despite that, over 1.2 billion people in the world lack access to electricity, 2.6 billion are without clean cooking facilities[10], 783 million do not have access to clean water and almost 2.5 billion do not have access to adequate sanitation[11]. According to an International Telecommunication Union report, 60% and 68% of the world population is still without internet and mobile-broadband subscriptions respectively. In today's world these technologies are essential and must reach the entire world population. The situation is probably worse in the OIC countries.

In short, OIC countries are facing enormous challenges to keep themselves abreast with the developed nations in terms of growth rate and progress. Therefore, it has become imperative for them to take the necessary measures in order to increase their growth rate and catch up with the rest of the world[8].

For catching-up with the more developed countries, OIC countries would require to raise their technology capacity. The present article provides some useful insights into their current technology capacity. The concerned countries cannot only see their comparative position among the OIC countries, but also identify their strong and weak areas. The article also presents the overall progress made by the OIC countries in building their technology development capacities during the last five years between 2009 and 2014. It not only discusses whether their relative positions have changed or not during that period, but also tries to assess what progress they have made to catch up with the highest achiever; even if their relative positions in the rank have not changed. For some selected countries, their performances in the different contributors of technology development capacity have also been analysed to help them identify their strengths and weaknesses.

Methodology

Technology achievement index

Technology achievement index (TAI) was developed by Desai *et al.*[12] in 2002 (TAI-02) as a measure of a country's participation in creating and using technology. This index was originally developed for an UNDP Human Development Report 2001 ('Making new technologies work for human development'). TAI-02 included data of 72 countries which were divided into four groups, i.e. leaders, potential leaders, dynamic adopters and marginalized, on the basis of scores they had achieved in the index[12]. Nasir *et al.*[2] extended the list of countries included in the index to 91 in their study, i.e. TAI-09. They also presented a comparison of the technology achievement progress of 56 countries, which were common in TAI-02 and TAI-09. They proposed that in future studies, the 'standard deviation approach' may be utilized for mapping technological spread among countries[2]. Ali and co-workers[13] focused upon Muslim countries in their study and examined their technology progress, in terms of TAI-2013 (TAI-13-OIC). They developed TAI for 34 Muslim countries and also presented a comparison of TAI ranking of 22 countries, common to TAI-13-OIC and TAI-09 (ref. 13). However, in the comparison, they only briefly discussed the relative positions of the countries in the two indices. In a more recent study, in which TAI for 41 of the OIC member states was presented (TAI-14-OIC)[14]. The authors categorized the countries into four groups: (i) very efficient, (ii) active, (iii) passive and (iv) fragile. In their study, 10% of 41 countries was included in the 'very efficient' group. The author concluded that though most of the OIC countries are enriched with natural resources, they are unable to fully utilize them for the socio-economic development due to lack of scientific and technological capabilities[14].

TAI does not indicate which country is leading in global technology development or who the leaders in certain technologies are, but it assesses how well a country as a whole is participating in creating and using technology[12]. For developing countries, building capacity to understand and adapt global technologies for local needs is more important than to be on the cutting-edge of global technological advance[15]. In fact, this is a 'must do' for developing countries. Otherwise, they cannot make full use of what is available for the socio-economic benefit of their people. It is often mistakenly assumed that technology transfer and diffusion are relatively easy, and developing countries can simply import from machinery, equipment, technology, seeds, etc. But for firms or farms in the developing countries to use a new technology – to identify its potential benefits, to learn about it, adapt it and use it – requires new skills and ability[15]. The importance of learning in this context has been demonstrated by a study from Thailand, which showed that four years of education triples the chances that a farmer will use fertilizer effectively[16]. If the developing countries do not make continuous progress in building their technology development capacities, the gaps in technological advance can further widen developmental divides in the 21st century of rapid technological transformations that are driving the historic shift from the industrial to the network age, in which the rewards and penalties of global technological advances are increasing[17].

TAI is a measure of assessing overall performance of a country in creating and using technology[12]. It can also be stated that TAI is a measure of national technology development capacity of a country. The four dimensions of TAI[2,12,13] are the 'fundamental contributors' to national technology development capacity. Hence, in the present study, TAI is being used as a tool to assess national technology development capacities of the OIC countries for indigenous technology development or/and adaptation of technology from abroad. Table 1 provides details of the four fundamental contributors of national technology development capacity and their corresponding indicators and significance of the individual indicators. As the objective of the present study was not to develop a new index for evaluation of technology capabilities of countries, but to assess their progress in technology development capacity using TAI as a tool, no new indicators were included and the same indicators were used as in the baseline studies.

Methodology of the present study

The main objective of this study was to assess the progress of the OIC countries in terms of national technology development capacity during the five-year period from 2009 to 2014. For this purpose, using TAI as the tool for the assessment, a four-step methodology was adopted.

Step-I: Identification of countries to be included in the study.
Step-II: Development of indices and sub-indices.
Step-III: Assessment of progress of countries.
Step-IV: Achievement gap analysis of selected countries.

Step-I: Studies conducted in 2009 (TAI-09)[2] and 2014 (TAI-14-OIC)[14] were taken as the bases of this study. As the aim of this study was to assess the progress of countries over the five-year period between 2009 and 2014, only those countries which were present in both the baseline studies could be included in the present study. We found 21 OIC countries common in both the studies; hence, these countries were included.

Step-II: Two indices, i.e. TAI-09-OIC-C and TAI-14-OIC-C based on 2009 and 2014 data respectively, for the 21 countries have been developed using new goalposts (Table 2). TAI values of countries for the individual indicators were calculated using the following formula:

$$\text{TAI value of individual indicator} = \frac{\left[\begin{array}{l}\text{Actual value of indicator} -\\ \text{minimum observed value}\end{array}\right]}{\left[\begin{array}{l}\text{Maximum observed value} -\\ \text{minimum observed value}\end{array}\right]}.$$

Then, sub-indices for fundamental contributors were calculated by assigning equal weightage to individual indicators of the concerned fundamental contributor and taking their simple average. Similarly, TAI indices for both sets of data (2009 and 2014) were calculated by assigning equal weightage to all four sub-indices and taking their simple average.

Data of 2001, i.e. TAI-02 (ref. 12) were not included in the study as only six OIC countries were common in TAI-02 and TAI-14-OIC-C. Data of 2013, i.e. TAI-13-OIC (ref. 13) were also not included because there was only one year gap between TAI-13-OIC and the present study, which was too little for conducting any meaningful comparison.

For the TAI-09-OIC-C and TAI-14-OIC-C, goalposts were calculated by assigning equal weightage to all

Table 1. Fundamental contributors of national technology development capacity and their corresponding indicators

Fundamental contributors	Corresponding indicators	Significance
Creation of technology	Patents granted to residents (per million people)	An indirect indicator of (embedded) knowledge that has been developed and could be polished for future use. It also reflects the current level of creative activity.
	Receipts of royalties and license fee (US $/person)	Indicates the stock of successful innovations already done, but is also worth uses in future.
Diffusion of recent technologies	Internet users (per 1000 people)	Dispersion of internet is a pre-requisite for participation in the world economic activities. One of the most active and dominant tools to access the global information at relatively low cost.
	High-technology exports (percentage of manufactured exports)	This is the best yardstick for measuring the annual average growth rates in a country with high technology.
Diffusion of old technologies	Electric power consumption (kWh/capita)	It gives a reasonably precise indication about the diffusion of electricity within a society as it is the closest proxy used is the consumption of electricity. The indicator is important because of its use in new technologies and also for the accumulation of other human activities.
	Telephone mainlines + cellular subscribers (per 1000 people)	This shows the participation of people in the communication upheaval. Countries must adopt this old innovation to participate successfully in the present IT network era.
Development of human skills	Gross enrollment ratio at all levels (except pre-primary)	It is used as the proxy for the measurement of cognitive skills.
	Gross enrollment ratio in science, engineering, manufacturing and construction (tertiary)	Indicates the skills of a nation in construction, engineering, mathematics and science at the tertiary level.

Adapted from refs 8, 10 and 11.

Table 2. Goalposts for calculating TAI-09-OIC-C and TAI-14-OIC-C for 21 OIC countries

	TAI-09-OIC-C		TAI-14-OIC-C	
Indicator	Observed maximum value	Observed minimum value	Observed maximum value	Observed minimum value
Patents granted to residents per million people	17.00	0.00	18.01	0.00
Receipts of royalty and license fees in US $ per 1000 people	47.90	0.00	65.06	0.00
Internet users per 1000 people	488.73	2.41	900.00	50.40
High-technology exports (% of manufactured exports)	54.71	0.04	43.71	0.00
Telephone (mainlines and cellular) per 1000 people	901.00[a]	66.00	1589.10[a]	480.30
Electricity consumption, kWh per capita	6969.00[a]	135.56	9434.28[a]	1.00
Gross enrollment ratio, all levels combined (except pre-primary)	87.20	39.77	96.15	45.32
Gross enrollment ratio in science, engineering, manufacturing and construction (tertiary)	11.01	0.35	24.05	0.50

[a]Value capped at OECD average because this is assumed to be the saturation point.

four fundamental contributors and their corresponding indicators (Table 2). For a detailed methodology, see refs 8 and 10.

Step-III: For assessment of the progress of the national technology development capacities of countries, two types of comparison have been made. First, position of a country in 2014 has been compared with its position in 2009. Second, the progress of a country in relation to the highest achiever in 2014 has been compared with its progress relative to the highest achiever in 2009. Highest achiever's performance has been considered as 100% and performances of the remaining countries have been calculated accordingly using the following formula:

$$\text{Performance of country 'A'} = \frac{\text{TAI value of country 'A'}}{\text{TAI value of highest achiever}} \times 100$$

Step IV: For gaining insights into the strong and weak areas of technology development capacity of countries, achievement gap analysis for four fundamental contributors of national technology development capacity has been carried out for four top-ranked and four bottom-ranked

Table 3. Comparison of position of countries between 2009 and 2014

Country	2009 TAI-09-OIC-C		2014 TAI-14-OIC-C		Position change
	Value	Rank	Value	Rank	
Malaysia	0.727	1	0.668	1	0
United Arab Emirates	0.494	5	0.573	2	+3
Turkey	0.399	12	0.509	3	+9
Bahrain	0.496	4	0.486	4	0
Iran	0.497	3	0.483	5	–2
Kyrgyz Republic	0.506	2	0.483	6	–4
Oman	0.354	13	0.480	7	+6
Brunei Darussalam	0.461	8	0.477	8	0
Jordan	0.424	9	0.443	9	0
Tunisia	0.404	11	0.428	10	+1
Lebanon	0.469	7	0.426	11	–4
Morocco	0.300	16	0.393	12	+4
Albania	0.299	17	0.387	13	+4
Algeria	0.330	15	0.312	14	+1
Uzbekistan	0.350	14	0.306	15	–1
Guyana	0.491	6	0.296	16	–10
Tajikistan	0.404	10	0.288	17	–7
Mozambique	0.166	18	0.193	18	0
Cameroon	0.158	19	0.180	19	0
Pakistan	0.151	20	0.165	20	0
Bangladesh	0.121	21	0.157	21	0

+, Moved up; –, Moved down, 0, Retained its position.

countries. Achievement gap analysis has also been done for the four countries which have shown contrasting performance of fundamental contributors of national technology development capacity in the present study. Based on the sub-indices of TAI-14-OIC-C, achievement gap of a country in a fundamental contributor was calculated by considering the performance of the highest achiever in the same fundamental contributor as 100%, and comparing the performance of the concerned country against that value.

Limitation of the study

One of the most common problems faced in the studies using secondary data is the non-availability of complete data. The same was the case in the present study. Data of most of the OIC member countries were not available for both the years, 2009 and 2014. Therefore, the study had to be restricted to 21 countries which were common in both baseline studies. Despite this limitation, the study is a good sample of OIC countries and presents a realistic picture of their technology development capacities.

Results and discussion

Overall performance of the OIC countries

The results show that Malaysia has performed best among all 21 countries which were included in the study in terms of building national technology development capacity. It has achieved top position in both the indices, i.e. TAI-09-OIC-C and TAI-14-OIC-C (Table 3). These results are consistent with most of the other studies which showed that Malaysia is one of the leading countries among all 57 OIC states in terms of technological development. In the study conducted by Desai *et al.*[12], Malaysia was placed at the 30th place among all 72 countries which were included in the study, and at the top among the 10 OIC countries which were included in the study. Malaysia was present at the top of the list of 21 OIC countries which were included in the TAI study conducted in 2009 (ref. 2). Comparison of 56 countries common in TAI-02 (ref. 12) and TAI-09 (ref. 2), given in that study, showed that Malaysia has improved its ranking from 26 in 2002 to 23 in 2009. In a more recent study conducted in 2013, Malaysia was ranked at the top of the ladder in terms of technology achievement index among 34 OIC countries[13]. In the latest study on technological capabilities of OIC countries, Malaysia was at the second place after Kazakhstan (TAI-14-OIC)[14]. Kazakhstan is not included in the present study as its data were not available for 2009. The results of the present study are slightly different from the study conducted by Archibugi and Coco[18] in 2002, in which Malaysia was placed at the seventh position among 52 OIC countries that were included in the total list of 162 countries. However, in that study, three different indicators (i.e. scientific articles, mean year of schooling and literacy rate) were used as compared with the present study (which used receipts of royalties and license fees, high-technology exports and gross enrollment ratio at all levels). Although this study placed Malaysia at the seventh position among the OIC countries, it reported that the country is making good progress in building its technological capabilities with more than 25% growth rate.

The United Arab Emirates (UAE) has performed better, by moving up from fifth position in 2009, to take second position in 2014. The results are consistent with the other studies on the technological capabilities of the OIC countries as UAE was two places behind Malaysia in 2013 (ref. 13) and one place behind Malaysia in 2014 (ref. 14). However, it was four places above Malaysia in the study conducted in 2002 (ref. 18). However, the study used different indicators as mentioned above. Growth rate of technological capabilities of UAE reported in that study[18] was about 2% less than Malaysia. Assuming the same growth rates for both the countries during the whole period (from 2002 to 2014) indicates UAE would lag behind Malaysia at the end of the period, i.e. 2014. Turkey has shown remarkable progress during the last five years, much better than the rest of the countries, as it has moved up nine places in 2014 compared to its position in 2009, i.e. from twelfth to third position (Table 3). Archibugi and Coco[18] showed Turkey at the ninth position among the OIC countries, while in other studies conducted on the OIC countries, i.e. TAI-13-OIC (ref. 13) and TAI-14-OIC (ref. 14), it was at the twelfth and tenth positions respectively. However, some of the countries included in those studies were not included in the present study due to non-availability of data for the year 2009.

Guyana has performed worst among the 21 countries as it has moved down 10 places, from 6th position in 2009 to 16th position in 2014. Guyana was at the 22nd place in the list of 52 OIC countries included in the study[18]. But its position has shown a decline, as it was at the 17th place among 34 countries in 2013 (ref. 13) and at the 21st place among 41 countries in 2014 (ref. 14). Pakistan and Bangladesh have retained their places at the bottom of the table, i.e. 20th and 21st positions respectively. These results were not much different from those of other studies. In the study of Archibugi and Coco[18], Pakistan was at the 31st and Bangladesh at 40th place respectively. In the TAI study[2], Pakistan and Bangladesh were at the 19th and 21st place respectively, among 21 OIC countries. Similarly, in the study of Ali *et al.*[13], Pakistan and Bangladesh were at 23rd and 26th place respectively, among 34 countries, and in another study by Ali *et al.*[14] at 30th and 31st place respectively, among 41 countries.

The results of the study showed that overall, seven countries have moved up, six have moved down, while eight countries have retained their places in 2014 compared to the position in 2009.

Progress of countries compared with the highest achiever

The results showed that Malaysia was the highest achiever in 2009 as well as in 2014. Other studies as mentioned earlier, have also shown that it is progressing rapidly in science, technology and innovation (STI) compared to other OIC countries. It has been successful in attracting the attention of both developing and developed economies due to its fast progress in technological development during the last two decades[19]. In a study conducted on the innovation potential in East Asia[20], it was included among the countries that have potential to create new technologies. Hence, it was logical to take its performance as maximum achievable (i.e. 100%) in the present study and compare the progress of other countries against this. Using this methodology, progress of all the countries, during the five-year period from 2009 to 2014, in terms of percentage was calculated (Figure 1). The results showed that Oman, which has jumped six places, from 13th position in 2009 to 7th position in 2014 (Table 3), has made more progress than all the other countries, as it has closened the gap with the highest achiever by 23.13% during the last five years (Figure 1). This progress is even better than that of UAE (placed second) Turkey – (third place) which itself has jumped nine places in 2014 compared to 2009. However, Turkey is not far behind the highest achiever, as it has closened the gap by 21.27%. UAE, Morocco and Albania have also made notable progress and have respectively, closened the gap with the highest achiever by 17.95%, 17.59% and 16.82%.

Guyana, which has suffered ten places relegation in the ranking (Table 3), has also shown alarming decline in its progress rate as its gap with the highest achiever has widened by 23.09%. Tajikistan is another country showing disappointing progress by widening its gap with the highest achiever by 12.39%. Mozambique, Cameroon, Pakistan and Bangladesh were at the bottom of the ranking in 2009 and they did not improve their positions in 2014 as well (Table 3). However, all these four countries have shown some progress in terms of closening the gap with the highest achiever by 6.11%, 5.33%, 3.93% and 6.85% respectively.

As a whole, most of the countries (16) have shown some progress during the last five years and have closened their gap with the highest achiever in 2014 compared to 2009. Only four countries show widened gap with the highest achiever.

Technology development capacity gap analysis and policy implications

In this section, four fundamental contributors of national technology development capacity will be analysed individually for some selected countries to identify their stronger and weaker areas. This would be useful for the policy makers and planners engaged in policy formulation and programme implementation for technology development in the concerned countries in particular and in other OIC and developing countries in general. Analysis has been carried out on the basis of the indices of

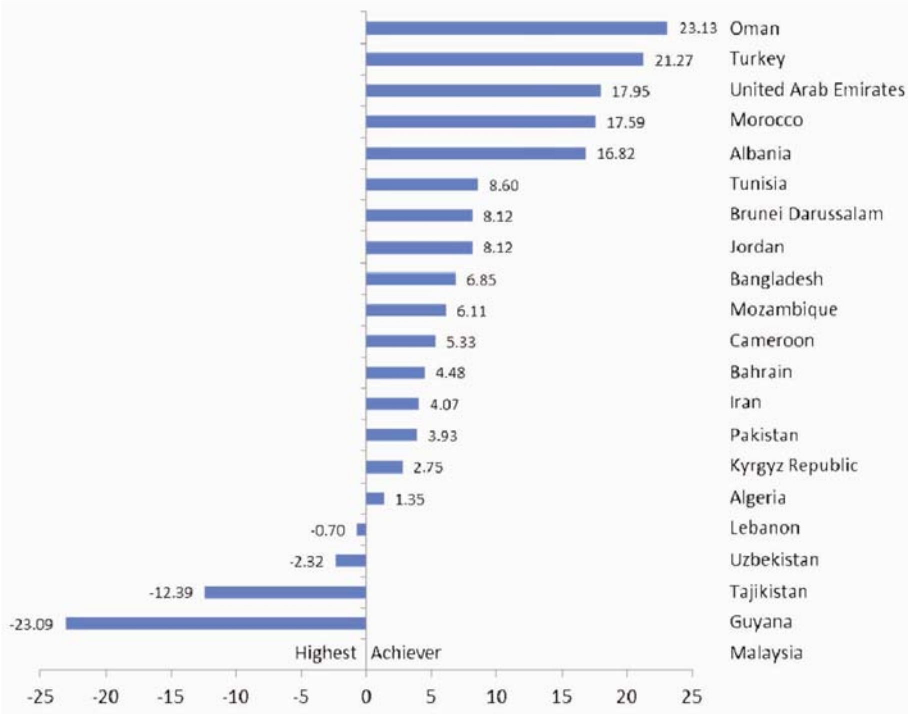

Figure 1. Progress made by OIC countries during the five-year period from 2009 to 2014. +, Closening of gap with the highest achiever; –, Widening of gap with the highest achiever.

fundamental contributors calculated for the present study, i.e. TAI-14-OIC-C.

Analysis of the fundamental contributors of national technology development capacity for individual countries indicates that Malaysia, which is at the top of the TAI ranking, i.e. TAI-14-OIC-C, has developed strong capacity in two fundamental contributors (Figure 2). It is the topmost achiever among 21 countries in 'diffusion of recent technologies'. It has also done reasonably well in 'diffusion of old technologies'. Malaysia has traditionally used manufacturing as a catalyst for growth and is now considered as a rising Asian tiger in high-tech production and exports among the newly industrialized economies of Asia[21–23]. However, the present study reveals that 'development of human skills' is the relatively weaker area for Malaysia, where its gap with the highest achiever is about 41% (Figure 2). Malaysian employers also rank workers' skills as the top constraint for improving productivity[24]. Lai and Yap[25] also indicated the inadequate availability of skilled human capital in Malaysia for technological development to progress.

'Technology creation' can be another area of concern for Malaysia, where its gap with the highest achiever is about 37%. Improving upon these two areas will consolidate Malaysia's position as the most advanced country among the Muslim nations. It will also help it join ranks with the other Asian giants like South Korea and Japan.

UAE has improved upon its position in the ranking as it has risen to the second place in 2014 from fifth place in 2009. It has also shown about 18% progress in terms of gap closening with the highest achiever. Most of this progress seems to have come from its performance in the 'diffusion of old technologies', where it is almost at par with the highest achiever, i.e. only 0.03% gap with the highest achiever (Figure 2). 'Development of human skills' is another area where it has performed well – it is placed second with only about 12% gap with the highest achiever. 'Technology creation' is its weakest area, in which it has done virtually nothing. It has also not performed well in the area of 'diffusion of recent technologies', where its gap with the highest achiever is about 57%. It is evident from this analysis that UAE needs to focus on research, development and innovation activities in its R&D and higher education institutions.

Turkey is in the third place in the 2014 ranking (Table 3) and has made tremendous progress in terms of closening the gap with the highest achiever (about 21%) (Figure 1). It has performed reasonably well in 'diffusion of old technologies', 'development of human skills' and 'technology creation' (Figure 2). However, there is room for improvement, as there is still about 22–31% gap with the highest achiever in these areas. 'Diffusion of recent technologies' requires urgent attention of the technology development policy makers in Turkey, as it has about 70% gap with the highest achiever in this area.

Bahrain was in the fourth place in 2009 and it has retained this place in 2014 as well (Table 3). It has made little progress (about 4%) in closening the gap with the highest achiever (Figure 1). The strongest contributor to

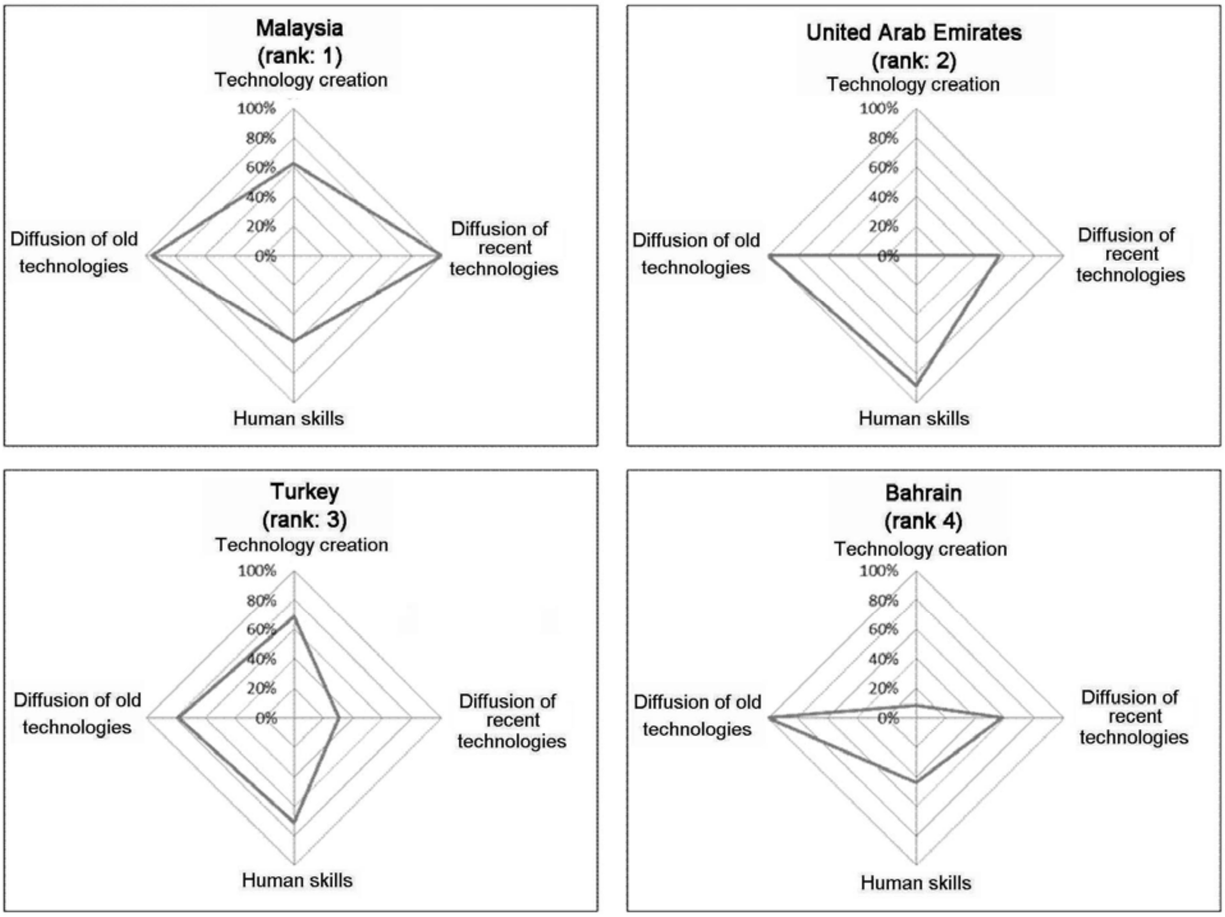

Figure 2. Performance in four fundamental contributors of national technology development capacity of four top-ranked countries in the 2014 index (TAI-14-OIC-C).

its technology development capacity is the 'diffusion of old technologies', where it was the highest achiever in 2014 among the 21 countries included in the study (Figure 2). 'Development of human skills' and 'diffusion of recent technologies' are relatively weaker areas with about 56% and 42% gap respectively, with the highest achiever. Like UAE, 'technology creation' is also the weakest area for Bahrain in which it has about 92% gap with the highest achiever. Bahrain also needs to build R&D and innovation capacity of its R&D organizations and higher education institutions.

Mozambique, Cameroon, Pakistan and Bangladesh were at the 18th, 19th, 20th and 21st position respectively, in the 2009 ranking and remained at these positions in 2014 as well (Table 3). However, they did show some improvement in terms of closing the gap with the highest achiever (Figure 1) with 'diffusion of old technologies' as the fundamental contributor to this progress in all of these four countries (Figure 3). 'Technology creation' and 'diffusion of recent technologies' are their weakest-of-the-weak areas. They all have 'diffusion of old technologies' as their stronger area compared to other three fundamental contributors to technology development capacity, however, even in this area they have a huge gap with the highest achiever. This is in contrast to the top four countries, which were among the top three highest achievers in at least one fundamental contributor of technology development capacity. These countries need urgent focus on all the fundamental contributors for building their national technology development capacities. According to a study conducted by World Bank, if the South Asian countries (including Pakistan and Bangladesh) continue to invest in their human capital at the same rates as they currently are, they will not be able to reach the education levels of Malaysia. Alarmingly, the differences between South Asian countries and Malaysia are larger for younger than for older people, which suggests that the gap is widening[26].

Iran is at the fifth position in the present study with almost 28% gap with the highest achiever (Table 3 and Figure 1). It is the highest achiever in the 'development of human skills', which indicates that human resource development is the strongest contributor to its technology development capacity (Figure 4). It has also done well in

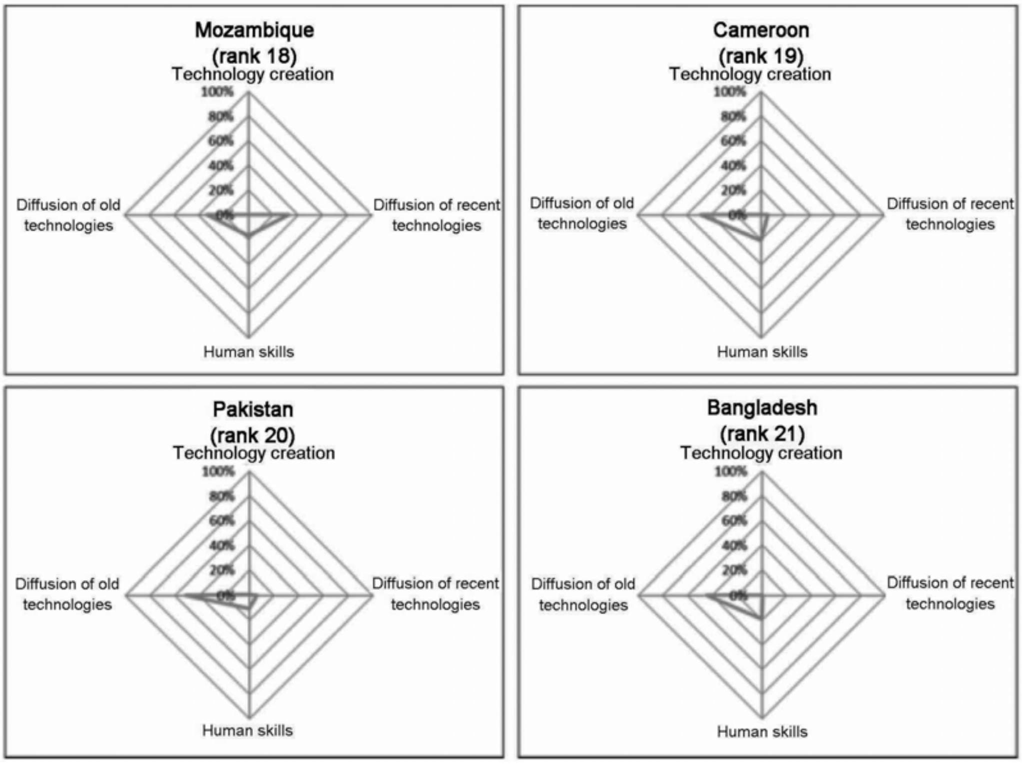

Figure 3. Performance in four fundamental contributors of national technology development capacity of four countries ranked at the bottom in the 2014 index (TAI-14-OIC-C).

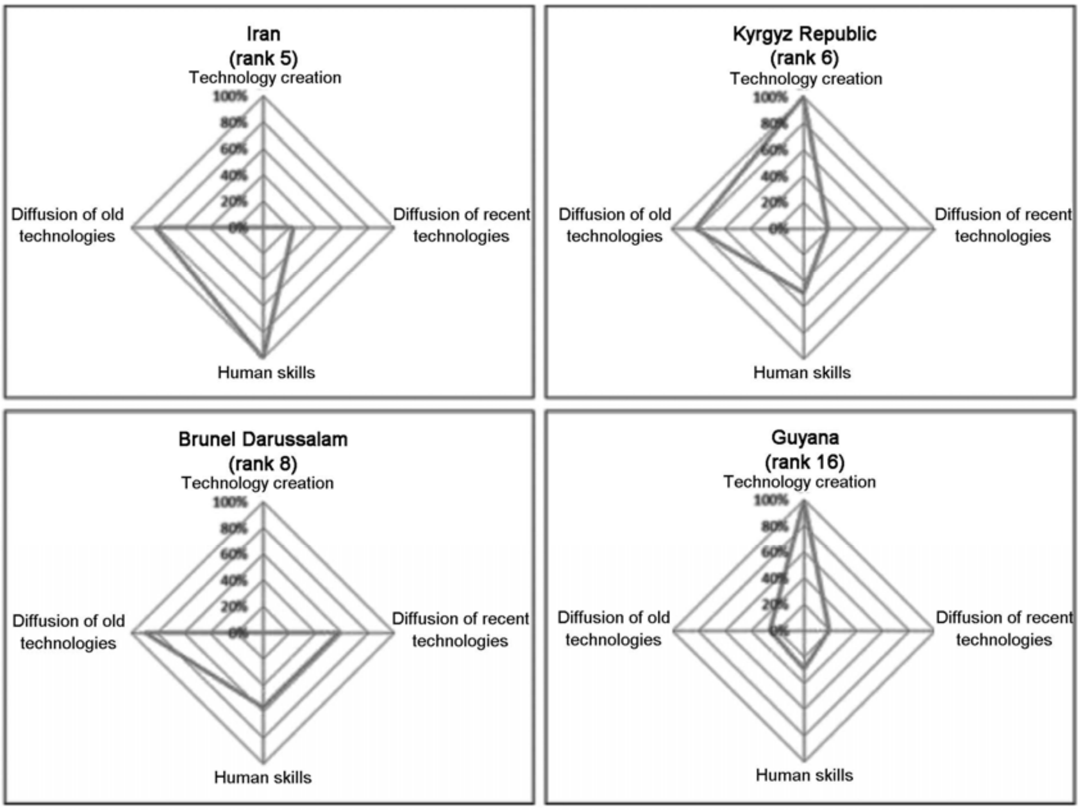

Figure 4. Contrasting performance of countries of four fundamental contributors of national technology development capacity in the 2014 index (TAI-14-OIC-C).

the ‘diffusion of old technologies’ with about 18% gap with the highest achiever. However, its performance in ‘diffusion of recent technologies’ is not too good, with almost 77% gap with the highest achiever. Apparently ‘technology creation’ seems to be its weakest area; however, this may be due to the fact that data of ‘technology creation’ indicators were not available for Iran. With data for these indicators available, it may have attained a much higher position in the ranking.

The Kyrgyz Republic is at the sixth place with almost 28% gap with the highest achiever (Table 3 and Figure 1). Like Iran, the Kyrgyz Republic is also strong in one fundamental contributor to technology development capacity, i.e. ‘technology creation’, where it is the highest achiever (Figure 4). Similar to Iran, ‘diffusion of old technologies’ is its relatively stronger area. However, due to weak performance in the ‘diffusion of recent technologies’ and ‘development of human skills’, it has not attained a high position in the rank.

Brunei Darussalam is at the eighth position with more than 28% gap with the highest achiever (Table 3 and Figure 1). However, in the ‘diffusion of old technologies’ it is at the third place with only about 10% gap with the highest achiever (Figure 4). ‘Technology creation’ is its weakest area with ‘diffusion of recent technologies’ and ‘development of human skills’ being relatively weaker areas.

Guyana, which has become an OIC member more recently, is at the 16th position with a big gap (almost 56%) with the highest achiever (Table 3 and Figure 1), but in ‘technology creation’ it has performed better than other countries included in the study, except the Kyrgyz Republic. In ‘technology creation’, Guyana has achieved second position with only less than 1% gap with the highest achiever (Figure 4). However, in the other three fundamental contributors to technology development capacity, its gap with the highest achiever is more than 70%.

Conclusion

TAI does not indicate which countries are the leaders in certain technologies. However, it provides a reasonable measure of the overall state of technology development capacity of a country. For developing countries, like the OIC countries, the latter is more important than the former because all countries do not need to be on the frontline of global technological advancement. But every country needs to have the capacity to derive the benefits from the global technologies. In order to derive full benefits from advance technologies, the developing countries should have the capacity to identify their potential benefits for them and to adapt those technologies for their local environments. This requires knowledge, skills and the ability to continuously absorb new knowledge and new skills.

The results of the present study show that Malaysia has performed better in building its national technology development capacity than all other countries which were included in the study. It was at the top of the ranking in 2009 and has retained its position in 2014. It has performed reasonably well in all four fundamental contributors of national technology development capacity. However, ‘technology creation’ and ‘human skills’ are the relatively weak areas of technology development capacity of Malaysia. Therefore, future efforts of technology development capacity building in the country should focus on these areas.

Among other countries, Oman, Turkey, UAE, Morocco and Albania have shown more progress in closening the gap with the highest achiever, i.e. Malaysia, during the five-year period between 2009 and 2014, than the rest of the countries. However, for catching up with Malaysia and with the developed countries, they need to focus on their weaker areas of technology development capacity. In case of Oman, UAE, Morocco and Albania, they should pay urgent attention to the area of ‘technology creation’ in which they are extremely weak. While Turkey should make efforts for the widespread diffusion of recent innovations, such as the internet, in order to further close the gap with Malaysia or even surpass it.

Technology development capacity gap of Guyana, Tajikistan and Uzbekistan with Malaysia has widened during the period 2009–2014. The reason is their poor progress in at least three out of four fundamental contributors of technology development capacity. Guyana has shown lack of progress in ‘diffusion of recent innovations’ as well as ‘diffusion of old technologies’ along with ‘human skills’. Tajikistan and Uzbekistan have shown extremely poor performance in the areas of ‘technology creation’, ‘diffusions of recent innovations’ and ‘human skills’. The gap between Lebanon and Malaysia has also increased; however, it has shown better progress in two areas, i.e. ‘diffusion of old technologies’ and ‘human skills’. To close the gap with Malaysia, these countries need to formulate and implement policies for enhanced capacity building in their weaker areas. Although Pakistan, which is the only declared atomic power among the OIC countries, has made some progress in closing the gap with Malaysia during the five-year period 2009–2014, it has not made any improvement in its ranking. There has been some progress in the areas of ‘diffusion of old technologies’ and ‘human skills’, but it has been static in ‘technology creation’ and ‘diffusion of recent innovations’. The policy makers in Pakistan need to take prompt measures in the latter two areas. Placement of Iran below UAE and Bahrain, despite being the highest achiever in ‘development of human skills’, is a little surprising; however, it may be due to the fact that data were not available for ‘technology creation’ indicators for Iran. However, it has also not performed too well in the area ‘diffusion of recent innovations’ which indicates that measures for nation-wise spread of new inovations area required. The Kyrgyz Republic and Brunei Darussalam are the other countries which have not achieved very high ranking despite performing extremely well in one or two fundamental contributors of technology development capacity. They are very strong in some areas, but very weak in others. The Kyrgyz Republic is the highest achiever in the 'technology creation', but it has performed extremely poorly in development of 'human skills' and 'diffusion of old technologies', which has resulted in its relatively lower ranking. These areas should be targeted by the policy makers in the Kyrgyz Republic for enhancing its technology development capacity. The case of Brunei Darussalam is almost opposite in terms of strengths and weaknesses – it has performed better in 'diffusion of old technologies', but is at the bottom in 'technology creation'. Therefore, improvement in 'technology creation' must be the focus of policy makers and planners in Brunei Darussalam.

The present study reveals the strengths and weaknesses of OIC countries for technology development capacity, which shows that the OIC countries have not progressed equally well in all the four fundamental contributors of national technology development capacity. They need to focus on improving upon their weak areas along with building on their strong areas. Most of the countries are weak in the 'technology creation' indicators, i.e. patents granted to residents per million people and receipts of royalty and license fees in US $ per 1000 people. High-technology exports (% of manufactured exports) is another weak area for many countries. Weakness in these areas is due to the fact that most of the OIC countries are spending much less than recommended by UNESCO for the developing countries. Governments in OIC countries are required to enhance allocations for education and R&D. They need to realize that it is only by building their national technology development capacities they can better utilize their natural and human resources for economic growth of their countries and social development of their societies.

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