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Building a knowledge-based economy in the Muslim world

The critical role of innovation and technological learning

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Abstract

Purpose – The purpose of this paper is to highlight the importance of innovation and technological learning in building a knowledge-based economy in the Muslim world. Despite abundant financial and human capital, most Muslim countries still lack adequate scientific and technological infrastructure to absorb, apply and create knowledge and disseminate information.

Design/methodology/approach – Using various major international institutions' databases (UN, World Bank, OCED, etc.), a holistic approach is used to analyse the critical role of science, technology and innovation to build a knowledge-based economy in Muslim countries.

Findings – This paper examines the main challenges facing Muslim countries to build a knowledge-based economy driven by innovation and technological learning. In doing so, a framework for building an effective innovation system that will achieve a knowledge-based economy in Muslim countries is presented, taking into account a variety of international, institutional and intellectual perspectives.

Originality/value – Given the scarcity of information and data about the subject area on Muslim countries, the study uses several sources of secondary data which are considered the most valid and reliable data available internationally about the subject.

Keywords Economic development, Knowledge management, Innovation, Learning, Information technology, Science, Technology, Arab countries, Muslim countries, Knowledge economy

Paper type Research paper

Introduction

In recent years, a substantial amount of literature has been written about the role that science, technology and innovation (STI) plays in building an enabling environment to foster economic growth and promote the knowledge economy (see Danofsky, 2005; Hamel, 2005; Ahmed, 2005; Mansell and When, 1998).

Hamel (2005) and Juma (2003) argue that education and knowledge are the chief currencies and the essence of modern age and can also be a strategic resource and a lifeline for developing countries' (DCs) sustainable development. Therefore, all nations, particularly those with limited natural resources and inadequate financial endowments, can benefit from the new economy by investing in knowledge creation and information dissemination. Knowledge has not only become an important factor input, but also a major source of employment and wealth creation. Thus investment in human capital, information and communication technology (ICT), research and development (R&D), STI provides an economy with an excellent opportunity to diversify production and sustain growth.

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The rise of globalization during the last few decades has increased interdependencies among nations concomitant with greater access to trade, finance, technology, knowledge and information. In addition, advancement in ICTs have improved information dissemination and enhanced knowledge absorption. DCs, including Muslim nations, can leapfrog and speed up the process of development by strengthening global linkages to acquire skills, knowledge and information. Muslim nations should focus on building capacity for learning and training to ensure technology transfer and knowledge diffusion. The path to development is no longer driven by traditional inputs but by the creativity of the human mind and the exploitation of society's tacit knowledge. Muslim countries have the ingredients to meet the challenges of the twenty-first century and reverse the current stagnation associated with underdevelopment.

In contrast to R&D, innovation entails the development of new methods more appropriate to local conditions. In the Muslim world, the models currently employed in development are largely of western construction largely divorced from the environmental and cultural values of the local society. Over the last several decades, these models have failed to alleviate poverty, protect the environment, increase economic diversification and sustain development. Economic development is largely driven by indigenous forces deeply rooted in the domestic knowledge system and, therefore, western models may violate the process of development by hindering rapid socio-economic transformation. By employing these models, DCs engage in R&D without generating innovation. Muslim countries must invest in building scientific and technological capacity to strengthen linkages between the global and local knowledge systems.

The Muslim world

In most Muslim countries governments heavily regulate most social and political activities and preserve an active involvement in business affairs. Therefore, relationship with government bodies and official has strong importance. The social systems within most Muslim countries include core values, ethics, behavior, etc. are all originated from Quran, Quranic principles and the saying and practices of the Prophet Mohammad serve as guides for individuals in conducting their daily activities.

Ali (1996) stresses that Islam is one of the most influential forces in the Muslim and Arab World, molding and regulating individual and group behavior and outlooks. Islamic and traditional values are therefore the core components of the Muslim social system, which are very different from the cultural values and social attitudes in the rest of the world. Furthermore, Islamic values and teaching put strong emphasis on obedience to leaders. In addition to Islamic teaching, tribal and family traditions have a strong impact on individual behavior. Therefore, one can argue that, the decisions relating to the introduction and application of any new technique or systems applications within society lie in the hands and interest of the social classes or groups who dominate government and the modern productive sectors tend to result in actions which are not neutral, but are carried out to the benefit of the richer members of society. Moreover, such direction will reinforce the existing inequities within the society to strengthen the control of the dominant groups.

Bartholomew (1997) argues that technology development is embedded in a country's history, cultural values and attitudes (also see Mellahi, 2003 for more discussion about the culture in Arab and Muslim countries). Therefore, attitude to IT could also have something to do with national culture. Therefore, in the case of

most parts of the Muslim world issues to do with freedom of information could be one of the reasons behind their lack of success as access to the internet brings with it free access to information and therefore if the political climate of the country does not permit such access, then rapid progress toward information society cannot succeed in that country. In Muslim societies, individual rights and freedoms are constrained by a wide range of political, social, cultural and traditional impediments, which limited individual contribution to creativity and innovation. Unlike western nations where conditions are conducive for the stimulation of scientific thought and technical progress, the Muslim world relegates creativity to a back seat relative to traditional methods of production characterized by low-productive activities. With the exception of a few countries, low industrial productivity and manufacturing production reflect inadequate scientific and technological capacity for development.

Historically, Islamic civilizations made significant contributions to the development of science. Early Muslims were able to advance human understanding and increase awareness about the importance of scientific discoveries and innovation in the development of human societies. Muslim contributions to sciences were noticeable in several fields including chemistry, medicine, astronomy, algebra, philosophy and geography. Muslims not only were able to create knowledge and apply it to advance human development, but also made use of external knowledge, mainly of Greek, Indian and Chinese origins, to build up scientific and technological capacity. Unfortunately, contemporary Muslims lack both the creativity to produce knowledge and the capability to integrate global knowledge in pursuit of their development. Almost, 200 years of colonial domination have handicapped Muslim nations from attaining major strides in scientific and technological development.

At present, almost all knowledge and technology used in Muslim countries is produced outside the Muslim world reflecting high dependency of Muslims on non-Muslims. A widening knowledge gap augurs poorly for future development of Muslim societies stymied by an inability to create knowledge economies that gain benefits from the opportunities offered by globalization. The rise of globalization has forced governments to introduce radical socio-economic reforms to meet people expectations and improve human development.

Islam encourages Muslims to acquire knowledge as a prerequisite for understanding religion and for increasing material wealth. Seeking knowledge in Islam is a religious duty incumbent on both male and female. It is the incentive given by the rise of Islam that encouraged early Muslims to excel in knowledge and develop civilization which surpassed all human endeavors for centuries. Production of material goods, technology and innovation – all encouraged by Islam – represent, in effect, the ingredients for building a dynamic and progressive society. To forge ahead, Muslims need to draw on past experience and develop strategies for building scientific and technological systems to increase knowledge absorption and enhance innovation.

Muslims should take advantage of the existing knowledge-based and build institutional infrastructures capable of promoting technological learning and utilizing global knowledge for domestic development. Constructing joint national strategies for scientific and technological development holds the prospect of accelerating the process of catching up as well as creating enabling environments for conducting R&D that promotes innovation and sustains real economic growth. Muslim countries should link scientific and technological programs to national development with a view to facilitating knowledge-sharing knowledge and exchange of information.

Since attaining independence from Colonial powers, development in the Muslim world has revolved primarily around production and export of primary products, mainly agricultural-based products and minerals. Revenues from these resources have been used to finance the growing demand for consumer products with little investment in production of manufactured goods for the local market. In most Muslim countries, the share of manufactured goods to total GDP is very small indicative of a failure to undergo an effective transformation into industrialized economies. Not being able to expand industrial production reflects the failure of Muslim economic policies to restructure productivity and provide incentives for investment in human capital and innovation. The duality of the economic structure, especially in oil-producing countries, has weakened linkages and reduced the ability of non-energy sector to benefit from the growth of the energy sector (petroleum and natural gas industry).

At present, lack of such capacity has hindered efforts to speed up the process of development and reduce poverty. Approximately 1.5 billion people belong to the Muslim faith scattered over wide range of territories across the world. Almost two-third of them live in countries characterized as possessing medium to low human development. At this development stage, poverty, inadequate education, poor economic management, lack of public participation, ineffective institutions, inefficient administration and social intolerance are endemic. Economic development in Muslim countries is largely financed by revenues from low-value-added exports, mainly primary products neither the demand for which nor prices are under their control. Due to the high degree of commodity and marketing concentration of these exports, the economies of Muslim countries, with the partial exception of major petroleum and natural gas exporting economies, exemplify major vulnerability to external demand shocks. Despite the fact that Muslims account for about one-quarter of world population, their share in total world exports represent about 6 percent. As with regard to the share of Muslims in world GDP, the combined Muslim GDP accounts for about 5 percent reflecting low productivity and high dependency. In the Arab world, for example, during the period between 1970 and 2008 average real annual growth of GDP per capita was −1.1 percent reflecting deterioration of livings standard. The structural dependency renders domestic development both volatile and imbalanced while injecting substantial uncertainty into economic planning.

Were financial and human capital collectively pooled, Muslim countries could close the knowledge gap by building scientific and technical capabilities to enhance knowledge absorption, adaptation and creation. In tandem with the falling costs of communication technologies, acquiring knowledge has become relatively cheap – thus increasingly inducing knowledge dissemination and innovation. Muslims should establish linkages to harness global knowledge and create opportunities for accelerating economic growth. In the new economy, information and communication jointly occupy center stage in economic development. In this regard, cooperation and networking are vital to ensure knowledge sharing and innovation. Cooperation stimulates creation of local knowledge for development by pooling financial and human resources to build capacity for knowledge absorption and technology diffusion. Through knowledge sharing programs, Muslim countries possess the potential to stimulate leapfrogging via the creation and mobilization of appropriate technologies supportive of economically and environmentally sustainable development programs.

Innovation reflects a complex process of the interaction of scientific and technological forces unleashed by productive agents and institutions. Acceleration of

these processes that promote innovation requires dedicated national and regional policies designed to ensure the creation of strong linkages among various productive actors. Undertaking joint projects increases the prospect of rapid technological development through more efficient utilization of human and technical resources.

With a view to supporting joint programs for rapid technological development, Muslim countries declared 2009 "the year for renewal and innovation" entailing initiatives agreed upon at the Fourth Islamic Conference of the Ministers of Higher Education and Scientific Research held in Baku, Azerbaijan, in October 2009. Notably, Muslim countries agreed to establish an Islamic World Science Citation Center to enhance publication by Muslim scholars as well as to facilitate the registration of patents in the Muslim world. About 20 universities across the Muslim world were selected to build science capacity and create knowledge for development. Similar programs were also initiated aimed at empowering women to take part in scientific and technological development of Muslim societies (see www.sciencedev.net/fe/Article.aspx?Aid = 853).

Economic development

Economic development is a complex process of structural change comprising social, economic, financial, technological, educational, political, scientific and environmental factors. Muslim countries possess considerable economic potential; however, widespread corruption and poor political decisions have hindered economic growth and delayed the process of catching up with the industrialized world. Narrowing the knowledge gap and promote innovation demands collective and coordinated efforts to institute incentives for knowledge diffusion and investment in lifelong learning in all Muslim countries. Modern communication technologies could provide linkages among various productive actors and institutions which enable individuals, enterprises, organizations and governments to interact – sharing, distributing and creating knowledge as well as facilitating technology transfer and skills acquisition – engendering innovation.

Characterized by knowledge absorption and information dissemination, the new economy is knowledge based. In this economy, traditional factor inputs no longer suffice to support rapid socio-economic development enhancing global competitiveness. To benefit from the new opportunities brought by globalization, Muslim countries must build capacity for scientific and technological development as well as create an enabling environment for strengthening research activities and promoting innovation. Without new knowledge, Muslims will continue to lag behind the rest of the world in their development. The more relevant yardstick to measure the gap between rich countries and poor countries has become knowledge rather than income (see World Bank, 1999).

Economic development comprises a set of dynamic processes including both internal and external factors. Over the past several decades, the failure of Muslim countries to promote development has been attributed to low manufacturing productivity and inadequacy of macroeconomic policies to allocate resources effectively with a view to fostering economic growth. Muslim economies suffer from weak scientific and technological infrastructures handicapping propensities to induce innovation and generate linkages. Similarly, knowledge creation has been impaired by lacunae in incentive structures and inadequate networks for distribution, sharing and exchange knowledge and information. Interlinking political, technological, institutional, economic and financial impediments has largely stymied the flow to

Muslim countries of foreign direct investment, which contributes to technology transfer and skills acquisition. Only a small number of Muslim countries are benefiting from global knowledge and skill development through the activities of multinational corporations. As a consequence, Muslim countries, exemplifying reliance predominately on extraction and export of primary products, hardly experienced any long-term industrial productivity growth.

Emphasis in development should focus on indigenous factors in an attempt to increase local participation and make use of the domestic knowledge. In other words, modern development is a product of knowledge application in economic activities entailing the ability of the economy to leapfrog and sustain development, which depends on the country's capability to promote scientific learning and innovation. In the new economy, economic growth depends on the ability of the economy to produce knowledge-intensive products in a process of innovation designed to support the creation of new knowledge and diffuse new technologies. Reliance on inappropriate technological developmental models have put a drag on innovation so vital to balanced and sustainable economic growth in Muslim countries. As pointed out by the World Bank:

> Too many DCs are uncritically adopting the OECD model of technological development, and too many development institutions are unwittingly aiding and abetting this process. Technology policies in OECD countries generally focus on expanding the frontiers of scientific research […]. What is referred to as S&T in most developing countries is often reduced to R&D, rather than innovation. The process of innovation focuses on the diffusion of existing knowledge through goods and services and often relies on existing knowledge (see World Bank, 2008, p. 51).

Developing economies pass through three different stages encapsulated by key pillars of competitiveness that amalgamate institutions, infrastructure, macroeconomic environment and education. In the first stage of economic development, key pillars are fully factor driven. Moving into the second stage requires efficiency enhancers. Such efficiency enhancers include higher education and training, labor market efficiency, technological readiness, financial market development and goods market efficiency. In the second stage, key pillars are more efficiency driven than factor driven. Moving into the third stage requires a conducive environment for entrepreneurship and innovation incubation and key pillars are innovation driven. In the third stage, finally, development becomes innovation driven rather than efficiency driven (see World Economic Forum, 2010).

Table I illustrates the economies of different Muslim countries at different stages of their development. Almost 90 percent of Muslims are either in stage 1 or in transition from stage 1 to stage 2. This reflects the low productivity of Muslim economies. It is clear that Muslim countries have not yet built capacity to induce the creation of the knowledge economy. That the majority of Muslim economies have not yet reached to stage 2 reflects the serious structural obstacles inhibiting them from catching up with non-Muslim countries. In other words, to reach to stage 3, in which development is innovation driven, will require radical reform to empower the economy and enhance knowledge creation. Only the United Arab Emirates, representing 0.4 percent of total population of the Muslim world, is classified among the economies in stage 3.

Most Muslim countries rely on revenues from export of primary products to finance socio-economic development. Volatility in prices and global demand for these products could cause sharp unpredictability in revenues generated from these exports.

Stage 1	Transition from 1 to 2	Stage 2	Transition from 2 to 3	Stage 3
Bangladesh	Algeria	Jordan	Bahrain	UAE
Chad	Egypt	Lebanon	Oman	
Mauritania	Azerbaijan	Malaysia		
Nigeria	Indonesia	Tunisia		
Pakistan	Iran	Turkey		
Senegal	Kazakhstan			
	Kuwait			
	Libya			
	Morocco			
	Qatar			
	Saudi Arabia			
	Syria			
535 million	545 million	125 million	4 million	4.7 million

Source: World Economic Forum (2010)

Table I.
List of selected Muslim countries/economies at each stage of development

To reduce vulnerability, these countries need to formulate policies to build industrial base for diversifying exports and reducing dependency on primary commodities. The share of manufacturing industry as percentage of GDP has remained relatively low over the past several decades. For example, the share of manufacturing industry in Egypt currently account for 16 percent, in Turkey 18 percent, in Algeria 5 percent, in Nigeria 17 percent, in Malaysia 28 percent and in Saudi Arabia 8 percent.

The knowledge economy

Fostering growth in modern economies is not possible without knowledge creation and technological diffusion. In the new economy, balanced and sustainable economic development stems from production and export of high-tech products and services for global markets. Participating in global trade and finance requires countries to build enabling environment capable of enhancing competitiveness, increasing linkages, encouraging technology transfer, promoting innovation, disseminating information, acquiring skills and absorbing knowledge. Muslim countries should seize upon the new opportunities brought about by globalization and introduce radical reforms to diversify their economies and reengineer their institutional structures. These reforms demand substantial investment in training, R&D, innovation, technological learning and skill creation to provide the building blocks for the outputting of high-value-added knowledge-based products and services.

Knowledge economies produce, distribute and create knowledge. Important features of the knowledge economy are growth in technological diffusion, skills acquisition and lifelong learning – used to produce knowledge intensity products and creative ideas to foster rapid economic growth and sustainable development. Knowledge has become an important input not only in job creation, but also in economic diversification and wealth creation. It is not possible for an economy to compete and gain global access without knowledge support systems based on production and distribution of knowledge and technology. A knowledge-based economy revolves around investment in R&D and in innovation as the basis for capacity building necessary for knowledge absorption and information dissemination.

Technological diffusion involves technological learning in which knowledge workers augment their capabilities to absorb and adapt knowledge. Universities and

training centers should adopt programs that upgrading skill levels of workers – in turn, enhancing the economy's ability to distribute and share knowledge. Unfortunately, most universities in Muslim countries fall below the standard requisite to provide support for knowledge absorption and technology upgrading. Basic R&D – essential for innovation and invention of new techniques – remains inadequate to meet the challenges facing Muslim economies in the twenty-first century. In this regard, the Organisation for Economic Co-operation (OECD) (1996) has underscored that "Knowledge and information tend to be abundant; what is scarce is the capacity to use them in meaningful ways."

In almost all indexes measuring the knowledge economy[1] – be they based on innovation, education, ICT and economic incentives – Muslim countries lag far behind the rest of the world. Consequently, few Muslim countries are able to gain from opportunities offered by globalization and build capacity for technological learning and knowledge absorption. Unfortunately the majority of Muslim countries fall far below the leading (mainly EU member) countries. As shown in Table II, Qatar scored the highest among Muslim countries in the efforts to build capacity for knowledge creation (KEI = 6.73, KI = 6.63). In terms of KEI and KI (as reflected by mean + xSD two-tailed normal curve analysis below), between 0.15-2.5 percent of the Muslim population fares equivalently to the mean performance of leading indicator countries. In terms of EIR, slightly <2.5 percent of the Muslim population performs comparable to the leading country mean. These indexes reflect the non-readiness of Muslim

Country	KEI	KI	Economic incentive regime (EIR)	Innovation	Education	ICT
(a)						
Denmark	9.52	9.49	9.61	9.49	9.78	9.21
Finland	9.73	9.39	9.31	9.67	9.77	8.73
USA	9.02	9.02	9.04	9.47	8.74	8.83
Singapore	8.44	8.03	9.68	9.58	5.29	9.22
Mean	9.18	8.98	9.41	9.55	8.40	9.00
SD	0.50	0.58	0.25	0.08	1.84	0.22
(b)						
Qatar	6.73	6.63	7.05	6.45	5.37	8.06
Malaysia	6.07	6.06	6.11	6.82	4.21	7.14
Bahrain	6.04	5.80	6.75	4.29	5.82	7.30
Turkey	5.55	5.07	6.98	5.83	4.46	4.92
Saudi Arabia	5.31	5.10	5.94	3.97	4.89	6.43
Egypt	4.08	4.24	3.59	4.44	4.35	3.92
Iran	3.75	4.67	0.99	4.56	3.80	5.65
Morocco	3.54	3.35	4.12	3.72	1.95	4.37
Indonesia	3.29	3.17	3.66	3.19	3.59	2.72
Pakistan	2.34	2.48	1.91	2.88	1.17	3.39
Nigeria	1.84	2.12	0.99	2.29	1.83	2.23
Bangladesh	1.48	1.55	1.28	1.60	1.53	1.53
Mean	4.55	4.57	4.49	4.55	3.91	5.24
SD	1.76	1.65	2.41	1.60	1.58	2.14
Mean + 1SD	6.31	6.21	6.90	6.15	5.49	7.38
Mean + 2SD	8.08	7.86	9.31	7.75	7.07	9.52
Mean + 3SD	9.84	9.51	11.72	9.35	8.65	11.66

Source: World Bank (2009)

Table II.
(a) Knowledge economy index (KEI) and knowledge indexes (KI), selected leading indicator countries, 2009; (b) Knowledge economy index (KEI) and Knowledge indexes (KI), selected Muslim countries, 2009

economies to take advantage of the new economy and speed up the process economic transformation. Performance trails even more with respect to innovation and education indices in which corresponding population data are, respectively, marginally less and marginally more than 1.5 percent. Only in the sphere of ICT do Muslim populations fare better with between 1 and 2SDs – exactly $+1.757$ or just <5 percent (1.645SD corresponds to exactly 5 percent) of the population performing equivalent to that of leading indicator countries. These performance score gaps reflect the non-readiness of Muslim economies to take advantage of the new economy and speed up the process economic transformation.

Analysis of selected Muslim countries 2012

Using the World Bank's Knowledge Assessment Methodology (www.worldbank.org/kam), Table III presents the recent performance of selected Muslim countries as illustrated by the World Bank's (2012) KEI 2012 including 146 economies across the world. Table III also compares the current performance with countries KEI 2000. It is therefore clear from the analysis below that the picture across most Muslim counties varies from economies with impressive progress toward the knowledge-based economies such as Saudi Arabia to economies with large decrease in their KEI such as Kuwait.

Country	KEI	Rank	Change[a]
Sweden	9.43	1	•
Economies with large improvements in KEI rankings since 2000			
United Arab Emirates	6.94	42	+6
Oman	6.14	47	+18
Saudi Arabia	5.96	50	+26
Tunisia	4.56	80	+9
Iran	3.91	94	+1
Algeria	3.79	96	+14
Pakistan	2.45	117	+5
Nigeria	2.2	119	+5
Yemen	1.92	122	+6
Sudan	1.48	138	+1
Economies with decreases in KEI rankings since 2000			
Bahrain	6.9	43	−2
Malaysia	6.1	48	−3
Qatar	5.84	54	−5
Kuwait	5.33	64	−18
Turkey	5.16	69	−7
Jordan	4.95	75	−18
Lebanon	4.56	81	−13
Egypt	3.78	97	−9
Morocco	3.61	102	−10
Syria	2.77	112	−1
Bangladesh	1.49	137	−3
Myanmar	0.96	145	−8

Note: [a]Changes in KEI ranks from 2000
Source: World Bank (2012)

Table III.
Selected Muslim countries KEIs with large improvements and reversals, 2012

According to the 2012 World Bank's KEI, Bahrain excels in ICT and, in this component of KEI, has scored 9.94 exceeding that of global KEI leader Sweden (which scored 9.49 on the ICT component). For, Bahrain's number of internet users per 1,000 populations has grown more than tenfold, rising from 60 in 2000 to 820 in the most recent year. Its telephone and computer penetration is also remarkably high, increasing from 580 to 2,290, and 150 to 750, respectively, between 2000 and the most recent year (see World Bank).

Saudi Arabia made the most progress since 2000 climbing 26 positions to rank 50th in the 2012 KEI (KEI of 5.95). According to the World Bank, significant improvements in gross secondary enrollment rates have enabled Saudi Arabia's education component to advance an impressive 30 spots to 58th place. In addition, the rapid growth in telephone, computer and internet penetration has led to a substantial strengthening of its ICT component.

Trailing in extent of improvement only behind Saudi Arabia, Oman, advancing 18 spots in the KEI rankings, to 47th place, has achieved across-the-board improvement in innovation, education and ICT. Moreover, substantial progress in telephone, computer and internet penetration has contributed to Oman's climbing 19 spots to 55th position in 2012 with respect to the ICT pillar.

Advancing in global rankings by nine places owing, in large measure, to strong performance on all educational indicators, Tunisia, which registered sustained improvement over the period 2000-2011 achieved, at its apex, a KEI of 4.56 and a rank at 80th. In 2012, however, Tunisia suffered a bouleversement. An elevation in tariff and non-tariff barriers coupled with a decline in regulatory quality accounts for Tunisia's EIR ranking plummeting 13 places in 2012.

Innovation

In western countries, the history of economic growth is linked to innovation driven by rapid institutional changes, increase in trade, industrialization and growth in financial services. In addition, the expansion of colonial trade and the rise of large enterprises were instrumental in opening up new markets and developing new products. Through these processes came scientific innovation and technological advancement which in turn increased capital accumulation and accelerated investment. The immediate impact of technological development was on income levels and poverty reduction in countries where innovation occurred. Human development is about expanding human capabilities to exploit human potential through the creation of knowledge, innovation and scientific development. In recent years, countries in Asia were able to capitalize on innovation to increase productivity and diversify the economic structure stimulating further the process of economic growth. Increase in innovation results from the adaptation of new technologies which develop in clusters driven by linkage creation and scientific progress. In DCs, building infrastructure induces innovation through augmenting propensity to share knowledge and diffuse new technologies among multiple economic actors (individuals, firms, industries, universities and governments).

Reflecting the ability of the economy to create new ideas and generate linkages capable of accelerating economic growth innovation is critical for the development of the knowledge economy. For, innovation connects various productive agents that interact to increase linkages within the domestic economy. In other words, innovation empowers the economy by increasing productivity, enhancing technological learning and creating knowledge. Technological change, and innovation of all kinds, is central

to economic growth, competitiveness and, for emerging economies, the ability to catch up with the advanced nations.

Based on the recent INSEAD 2011 published by Dutta (2011)[2], Table IV provides an overview of some selected Muslim countries with high performance in terms of innovation outputs surmounting weaknesses from the input side and those that lag behind in fulfilling their innovation potential. From the analysis in Table IV, only one country – Qatar (26th) – is ranked among the top 30. Other high-income economies such as United Arab Emirates (34th), Bahrain (46th), Kuwait (52nd), Saudi Arabia (54th) and Oman (57th) have rather disappointing positions in the INSEAD 2011.

The principal challenges facing DCs in general and the Muslim countries in particular revolve around an inability to create knowledge and generate innovation to support the knowledge economy. Building capacity for science and technology in Muslim countries by strengthening knowledge production, knowledge sharing, knowledge distribution, knowledge transfer, technological learning and skill development is an essential condition to create a knowledge economy. In this endeavor, collaboration on the part of the public and private sectors is essential to generate linkages within various sectors of the economy. Moreover, Muslim countries need to formulate carefully crafted policies that focus on creating linkages between the local and global knowledge systems without succumbing to the pitfall of falling into undue dependency on global knowledge. Such dependency risks sacrificing long-term interest in favor of short- and medium-term inasmuch as it entails forfeiting the building of capacity to generate indigenous knowledge. Without indigenous knowledge, development will be constrained, if not hobbled, by foreign knowledge in the long term.

Rank	Country	Score
26	Qatar	47.74
31	Malaysia	44.05
34	United Arab Emirates	41.99
41	Jordan	38.43
46	Bahrain	37.8
52	Kuwait	36.64
53	Mauritius	36.47
54	Saudi Arabia	36.44
57	Oman	35.51
65	Turkey	34.11
66	Tunisia	33.89
87	Egypt	29.21
94	Morocco	28.73
95	Iran	28.41
97	Bangladesh	28.05
99	Indonesia	27.78
105	Pakistan	26.75
115	Syria	24.82
123	Yemen	20.72
124	Sudan	20.36
125	Algeria	19.79

Source: INSEAD (2011)

Table IV.
Selected Muslim countries innovation index, 2011

For individual Muslim countries taken in isolation, due to human and financial capital constraints at the national level, development of new technology is problematic. However, scientific methods, once developed in one economy, are readily transferable to another provided that a minimum level of technical expertise needed for absorption is present in the "importing" economy. In this age of global interdependence, multinational corporations have facilitated access to, and transfer of, technology to DCs. Developing economies, be they Muslim or not, can choose among alternatives to select appropriate technologies which are environmentally friendly and economically feasible. Access to global knowledge empowers the ability of the local knowledge system to create linkages which increase interactions among various productive agents within the economic system. Innovation, locally effectuated, holds promise to mitigate the risk of wholesale "importation" of western technologies without potentially jeopardizing the environment or channeling economic resources into non-productive uses. Mobilizing indigenous knowledge would permit DCs to effectuate a better balance between the environment and development. In doing so, these countries require access to scientific methods and technological leaning about "best practices" available to speed up the process of development. Exploiting global knowledge facilitates innovation through rapid technological change and skill acquisition. Innovation and technological learning are products of institutional change and industrial development. According to the United Nations (UN) (2005), innovation can directly increase the ability of existing STI programs to reduce poverty and expand human capabilities. Innovation accelerates the process of development by increasing productivity and encouraging the invention of new scientific and technological methods for use in production.

Governments play a crucial role in technological development and innovation. Knowledge creation and technology diffusion depends on government support programs that implement economic incentive regimes and fund educational and training facilities. Without governmental intervention, the private sector, in most DCs, cannot feasibly jump-start technological diffusion and knowledge absorption. However, the government can empower technological development by enhancing the ability of domestic enterprises to apply new technologies and invent new products. As pointed out by the UN (2010):

> Traditionally, innovation is seen as the process of combining resources in new or unusual ways to generate new or improved products (goods and services) and processes. These improvements or advancements may range from slight improvements on existing ones to major leaps in performance and changes in technology systems and economic paradigms. These technological innovations will not be possible without significant investment in research and development (R&D) and education, which generate basic scientific and technological knowledge upon which innovations are based.

Digital learning

Learning is an important prerequisite for promoting the knowledge economy. The dynamic process of knowledge creation requires continuous learning to ensure upgrading skills and meeting human capital requirements. In the new economy, workers, involved in knowledge management and information handling, require special skills and continuous training to harness the benefits of the knowledge economy. Accordingly, formal education alone may not be sufficient to meet the skill requirements of the knowledge economy. Workers regularly need to update their skills to keep abreast of the most recent developments in scientific and technological

knowledge. Building capacity for digital learning requires investment in communication and information systems to facilitate linkages with the rest of the world. Competition in the global markets requires up-to-date information and collaboration with various actors and suppliers. Enterprises involved in R&D, to succeed in innovation, need access the most recent technological advances pursuant to the development of new products.

In the knowledge economy, focus is directed at exploitation of tacit knowledge to increase productivity and strengthen the domestic knowledge system. Through electronic networks, a substantial amount of information can be obtained and shared with various actors. The knowledge economy relies on absorption of knowledge and dissemination of information. In the case of Muslim countries, access to global information provides better choice of technology at cheaper cost. Interactions with global actors not only facilitate skills acquisition and enhance learning but also stimulate innovation. Benefiting from learning curve effects will facilitate the generation of linkages by enterprises and institutions through distribution and sharing of knowledge. Undertaking research often results in the development and production of new products, which, in turn, allow the exploitation of tacit knowledge and drive innovation. Knowledge transfer is essential for building an enabling environment to diffuse innovation and absorb knowledge in the local economy. Building technological capacity increases access to information for use in the knowledge economy to produce knowledge intensive goods and promote innovation.

Narrowing the technological and scientific gaps between knowledge-driven economies on the one hand relative to factor- or efficiency-driven economies on the other requires building domestic capacity for technological learning and innovation. Knowledge is the key to technological learning which requires an infusing of new skills into the labor force and building effective institutions to ratchet up the economy's absorptive capacity. Absorptive capacity refers to the "ability of local producers to access, absorb, use and diffuse relevant knowledge into enhancing productive capacity" (see UN, 2010 for more details). Technological learning stimulates innovation necessary for building a knowledge-based economy.

Unfortunately, most universities in Muslim countries short shrift, if not entirely ignore, digital learning in favor of traditional approaches that place undue emphasis on general studies at the expense of research and knowledge creation. Using traditional teaching methods with curricular noticeably deficient in mathematics and science, these universities mint graduates lacking capacity to conduct the kind of creative research that begets innovation. Universities in Muslim countries, largely existing in an "Ivory Tower" vacuum or a time-warp reflective of a bygone educational model, conduct educational programs without paying heed (or at most paying lip-service) to the desiderata of the knowledge economy predicated on scientific application and technological learning that enhance global competitiveness through the creation of new knowledge and production of high-tech products. Oblivious to concepts of technological learning and knowledge diffusion which generate the ability of a knowledge economy to produce knowledge intensive goods on a sustainable basis, universities and tertiary training institutes merely inculcate basic knowledge rather than creative thinking. At best, tertiary training institutes provide services for operating the existing technologies but do not help workers become creative through modification and development of new technologies. In addition, access to modern communication technologies, the *sine qua non* of digital learning, remains subject to security issues and those who are willing to pay. Unsurprisingly, therefore, population

with sharp wealth inequalities subservient to governments that perceive security threats – real or imagined – trail their counterparts that enjoy more equitable wealth distribution and stability in terms of For example, internet users accounts for 0.4 per 100 population in Bangladesh, 8.7 in Indonesia, 11.3 in Pakistan, 13.5 in Algeria, 20.0 in Egypt and 38.1 in Saudi Arabia. This is compared to 93.5 in Iceland and 90.8 in Sweden.

Rather than being divorced from the process of innovation, universities in Muslim countries must play a central role in innovation by making sure that teaching and research are linked to the need of industry. Training students in technological learning facilitates the absorption of existing knowledge and adaptation of foreign technology; however, this is more central to the mission of training institutes than universities. Diffusion of foreign technology requires capacity building comprising technical and vocational skills is not a long-term substitute to conducting research, which is central to the mission of universities. In this context, universities will be more productive if strategically connected to national development projects. Educational policies must focus on the long-term need of the national economy and design programs capable of providing support for national development to catch up. Governments should take the lead in constructing educational policies backed up by the necessary financial and material support to ensure that universities contribute effectively to national development. Close relationships must be established between universities and local innovators to identify, design and produce technologies. Small and medium enterprises play a key role in the diffusion of new knowledge and, therefore, they have to be linked to universities to strengthen technological learning. In other world, increasing interactions between local entrepreneurs and research institutions will strengthen building productive capacity for innovation.

Building ICT capacity

Most recent reports by the World Information Society (2003-2012) indicates that the digital divide is narrowing in terms of internet usage and evolving from inequalities in basic access to ICTs and their availability, to differences in the quality of the user experience. Therefore, the debate over the future of the digital divide is now moving away from "quantity" in basic connectivity and access to ICTs to measures of "quality" and "capacity," or speed of access. Moreover Nulens *et al.* (2001) argue that technological innovation in ICTs and liberalization of the regulatory context of the media and telecommunications sectors have profoundly changed the global communications landscape. Although originally starting in the developed countries, these trends are crossing over to developing nations including the Muslim counties.

In this age of global interconnections, knowledge absorption and technological diffusion depend, to a large extent, not only on the existing of human skills and institutions, but also on physical facilities, particularly ICT capacity. ICT capacity provides an informational superhighway that channels the flow of technology for bridging the knowledge gap between local and global systems. To this end, a country's capacity to absorb knowledge and diffuse technology starts from existing digital architecture.

Bridging the link among various economic agents (universities, industries, governments and global enterprises) depends, initially at least, on the effectiveness of infrastructure to facilitate communication and exchange information. Such connection becomes possible with the use of ICTs. Building ICT capacity has the potential to enlarge national capabilities to absorb knowledge and create linkages between local

enterprises and global markets. External linkages provide domestic enterprises with new opportunities to enhance technological learning and diffuse knowledge. In other words, building ICT infrastructure renders possible scientific and technological innovation by accreting economic capacity to absorb knowledge and adapt new techniques in production.

Inasmuch as, in the short- and medium term, acquisition of external knowledge has become central to meeting the socio-economic challenges facing Muslim countries, investment in ICT to modernize existing infrastructure is vital to stimulate technology transfer. Without an effectively "wired" ICT network, Muslim economies will not be able to plug into the international knowledge based to create linkages and accelerate the process of knowledge diffusion and foster innovation. Moreover, improving communication assists an economy to gain access to global markets through networking and exchange information. It is observable that in recent years, ICTs, as a knowledge conduit, have made a substantial impact on both human capabilities and economic potential through the creation of new production opportunities and expanding markets.

These generalizations, however, ought not disguise the fact that there is enormous variety in the socio-economic context of Muslim countries in general and a related large variability between them in terms of their current status with respect to IT in particular. Existing equipment base, the availability of trained personnel and their current levels of usage of IT/S, for example, vary considerably. Discontinuities among Muslim economies still exist although, on the global level the digital divide has contracted. The recent ICT reports/indexes reveal an alarming picture for many Muslim countries.

Technological readiness in the Muslim world

Most manufacturing industries in Muslim countries are "passive technology learners," that depend largely on imported technology. Industrialization in the Muslim world has not been predicated on locally made technologies that meet local conditions. In Singapore, on the other hand, industrial development depends on "active technology learners" which focus on creating new and modified technologies. These technologies have made a substantial contribution to the growth of manufacturing through linkage creation and technology diffusion. Local manufactures were able to adopt the new technologies to promote innovation and build capacity for technological learning. In contrast, Muslim countries have not been successful in building such technological capacity driven by innovation. In these countries, industrial productivity is constrained by essentially "minor, adaptive and routine maintenance without creating and innovating new technological or scientific methods" to be used in production. Economic development in the Muslim world continues to rely on low-value-added output, mainly primary products, the revenues of which are characteristically used to finance luxury and consumer goods for local elites.

Innovation generates dynamic processes which require continuous creation of new knowledge and testing different techniques in order to meet the challenges of the new global economy. The static nature of the innovative system in Muslim countries has made only minor advancement in technological learning and, therefore, little contribution to the scientific and technological development has been achieved. Being static simply means that the Muslim world has not been a major producer of high-tech and capital goods. High-tech exports goods and knowledge intensity products account for about 3 percent of total Muslim exports of manufactured goods and services.

Muslim governments need to reverse these trends by investing in capacity building for creating, upgrading, absorbing and adapting new and existing technologies. Without adequate economic incentive regimes to encourage innovation, local enterprises, mired in a technological state of unreadiness, will not be able to compete against foreign firms.

In most Muslim countries, moreover, archaic industrial structures compound the economic drag imposed on balanced development by the dearth of technological innovation. Enterprises lack an adequate organizational base to stimulate, what might be dubbed, non-technological innovation that permits efficient operation. Initiating change to catch up with modern global organizations requires organizations to restructure their operations and reengineer their productive activities so as to ensure high degree of flexibility and robustness in operations. In the Muslim world, public enterprises, under the partial or complete control of governments, often monopolize key manufacturing sectors of the economy. By virtue of support to development through R&D, knowledge absorption, innovation and information sharing, the new organization stands in stark contrast – in terms of vision, mission and operation – to the traditional organization.

Table V highlights selected indicators for scientific and technological capacities. These represent the potential for capacity building to promote a knowledge-based economy. As the table illustrates most Muslim countries are scoring less than the industrialized countries in all indicators including capacity for innovation, university-industry collaboration, technological readiness and quality of scientific research institutions. The table also shows that most Muslim countries have adequate scientists and engineers but they are not fully utilized to contribute to scientific and technological development.

Country	Capacity for innovation	Quality of scientific research institutions	Availability of scientists and engineers	University-industry collaboration in R&D	Technological readiness
Germany	5.9	5.9	4.8	5.2	5.36
Japan	5.9	5.3	5.8	4.9	4.87
USA	5.3	6.0	5.7	5.8	5.10
Korea	4.3	4.9	4.9	4.7	5.05
Malaysia	4.1	4.7	4.7	4.7	4.19
Saudi Arabia	4.0	4.4	4.6	4.3	4.17
Indonesia	3.7	4.2	4.7	4.2	3.25
Turkey	3.1	3.3	4.5	3.4	3.85
Pakistan	3.1	3.4	3.9	3.4	2.94
Iran	2.9	4.0	4.6	3.2	3.19
Nigeria	2.7	2.8	3.9	3.1	3.04
Morocco	2.9	3.1	4.5	3.1	3.49
Egypt	2.5	2.9	4.9	2.8	3.32
Bangladesh	2.4	2.8	4.0	2.7	2.65
Algeria	2.3	3.1	4.5	2.9	2.98
Syria	2.2	2.5	4.2	2.3	2.92

Source: World Economic Forum (2010)

Table V.
Selected indicators for scientific and technological capacities, selected countries, 2010

Reaping the benefit of the technological and scientific capacity requires Muslim countries to allocate a greater share of financial resources to R&D. The share of GDP allocated to R&D in Muslim countries represents about 0.5 percent, which is too low to support rapid advancement in scientific and technological development. Despite the fact that the industrialized countries represent about 20 percent of world population, they account for about 90 percent of scientific knowledge. In effect, this R&D gap mirrors the gulf in wealth between rich countries and poor countries. In this context, investment in scientific research in rich countries has been a major source of wealth creation and a key factor in the long-term rise of living standards inasmuch as scientific development has increased the productivity of factor inputs allowing countries to diversify the productive structure and cash in on efficiency-inducing structural changes.

Building an innovation system

Building capacity for an effective innovation system requires creating an enabling environment that imparts efficient institutions, rules and procedures that help the country absorb knowledge, diffuse technology and disseminate information. The innovation system consists of a network of productive activities driven by linkages creation which allow the country to improve its scientific and technological learning. The development of new technologies through innovation, involving a complex process of interrelated activities among various economic agents to facilitate knowledge absorption, technology diffusion and information dissemination, requires a well-honed innovation system.

Linking productive enterprises together strengthen the innovation system by increasing their ability to undertake joint research and reduce the cost of innovation. Muslim countries should establish joint institutions to exploit the local knowledge and utilize the existing resources to enable them to cultivate appropriate scientific and technological methods suitable for local development. Among others, building educational institutions and research centers are vital for creating new knowledge and developing new technologies. To speed up the process of innovation and enhance scientific and technological development, governments must take an active part by providing the necessary technical, financial and physical facilities.

Cooperation among Muslim countries must be based on joint research to narrow the knowledge gap and support the catch-up process. In the knowledge economy, increasing linkages require sharing knowledge and information among various actors. This requires Muslim countries to reinvent their educational and training institutions and to restructure their national scientific and technological strategy to enhance creativity and support innovation.

Building enabling capacity for innovative requires a well-defined strategy which strives to restructure the productive structure to ensure knowledge absorption, technology transfer, information dissemination and global accessibility. Such a strategy needs strong backing from governments to provide the necessary financial and human resources. Public investment in human capital and credit financing could meet the real challenges facing development in these countries. Among the important elements of an effective strategy for building innovative system are:

(1) Creating enabling socio-economic environment capable of exploiting both local and external knowledge systems and make use of them for the creation and adoption of new technologies. The institutional structure of the state facilitates

the advancement of innovation by inducing changes to absorb knowledge and facilitate technological adaptation. Innovation requires educational institutions and research centers to conduct R&D. The state must participate in providing such facilities thorough special grants, subsidies and favorable loans. Similarly, economic policies could expand competitiveness through opening up of trade and expanding access to global markets. Local enterprises could take advantage of the new opportunities to develop new products and meet international standards. This requires the creation of a good business climate capable of promoting innovation and generating linkages.

(2) Adequate human skills and training programs to empower local workers are critical for building capacity for innovation. The creation and diffusion of new technologies depends on the skill of workers in order to upgrade and improve the existing technologies. The quality of education spurs the process of disseminating technology as well as facilitate the adaptation of global knowledge into the local knowledge system. Education is also important for preparing entrepreneurs and business leaders to take part in development. The complex nature of global business and the importance of knowledge diffusion underscore the need for knowledge workers capable of conducting R&D and creating enabling environment for innovation. Under such circumstances, establishing linkages between enterprises and universities for knowledge sharing and research is essential. In the linkage between enterprise and education, government could become a facilitator by instituting economic incentive regimes that foster such joint collaboration on the national, regional and international level. Building institutional capacity supports the knowledge economy by promoting technological learning and enhancing the economy's capability to absorb knowledge.

(3) Creating an enabling environment for technological learning and innovation. An enabling environment for innovation is defined as "one that provides the resources required for building a complex multidimensional and dynamic range of knowledge, skills, actors, institutions and policies within specific political-policy structures to transform knowledge into useful processes, products and services" (UN, 2010, p. 24). In this definition, enabling environment comprises several elements including the building of effective infrastructure, constructing sound socio-economic policies, establishing efficient institutions and investing in education and lifelong learning. Most DCs lacking enabling environments due to weak technological and scientific systems to promote knowledge intensity and encourage manufacturing production. Innovations do not occur in isolation from the rest of the socio-economic system and, therefore, an enabling environment must accommodate all national ingredients to facilitate knowledge creation and innovation. Policies must focus on providing comprehensive facilities to create enabling environment for innovation. In particular scientific research and technological learning which need to be advanced for inducing rapid technological change. "Creating an environment that encourages innovation requires political and macroeconomic stability" (UN, 2001, p. 79).

(4) Building ICT capacity for bridging the digital divide and encouraging knowledge transfer. Widening of the capacity for knowledge absorption and

application requires communication system capable of providing access to information, skills and technological learning. Communication technology provides solutions to DCs by allowing knowledge, resources and skills to flow among countries, especially from countries which experienced success with technological diffusion and transition. This leads to the creation of dynamic "innovation system" through access to sharing, interaction and exchange of knowledge and ideas. In countries where the industrial base and institutional structure are inadequate to encourage innovation, local enterprises can make use of global knowledge and skills to upgrade technology and restructure organizational activities. Rapid changes in technological development make it essential for DCs to open up for global markets and exploit the benefit of global knowledge.

(5) Building capacity for appropriate technology which is economically and environmentally sound. In DCs technology may not be easily accessible, especially for small and medium enterprises, to encourage innovation and increase productivity. A national agency could be established to select and identify suitable technology for development. Collectively, Muslim countries possess considerable financial and human capabilities that could be mobilized to create indigenous technologies appropriate for development. Research institutions might provide the lead in providing guidance and support for local enterprises to encourage them to develop indigenous technologies that are suitable for local development. Efficiently building capacity requires organizational restructuring to better enable enterprises to deepen integration in the global markets. Muslim countries should focus on building institutions that provide support and facilitate the use of the knowledge available externally to help entrepreneurs and productive actors rapidly acquire skills and technological learning that will be used in innovation in the short- and medium term.

(6) Muslim countries need to strengthen their STI policy making and development institutions. In doing so they must build an efficient STI infrastructure that mmaximizes the impact of research knowledge for society and promotes the transfer of knowledge (generated by and held in higher education institutions and public sector research establishments) to the wider economy to increase economic growth as well as to enhance regional scientific co-operation. To this end, all Muslim countries should have the capacity to access and contribute to the shared knowledge base ensuring open access to data, information and knowledge. However, Muslim countries, particularly those economies heavily dependent on oil, must embark on the diversification of their economic resources such as approaching development from a knowledge management perspective by adapting policies to increase know how and knowledge attributes that can improve people's lives in myriad ways (see World Bank various reports for more analysis).

(7) Without a solid capacity to innovate and produce quality services and products, Muslim countries will struggle to become more productive and develop more knowledge-based products and services. This will have consequences for overall economic growth, and demand for high-skill jobs will not increase. Therefore Muslim countries must not remain essentially a

producer of primary goods for the rest of the world and ensure embedding the culture and concepts of sustainable development in all their developmental strategies.

Conclusion

A "pure" knowledge economy generates creativity to produce new ideas instead of making use of existing knowledge. This creativity is innovation. Innovations contribute to knowledge creation and technological learning which represent the core fundamentals of the knowledge economy. Focus in national strategies should be on investment in R&D and training to strengthen the capacity for knowledge absorption and information dissemination. Long-term priorities in research should be oriented toward solving problems to meet the challenges facing local development through solutions that make use of indigenous knowledge. Imported technologies provide support to meet short- and medium-term capacity building for innovation and creation of new ideas to strengthen the autochthonous ability to develop appropriate technologies. Resources should be developed to obtain comparative advantage and increase that value added of national output.

In the knowledge economy, universities and vocational training institutes play a vital role in interacting with various productive actors in the economy because competition among countries is largely revolves around production of knowledge-intensive goods and services and development of technological competencies. Unfortunately, most exports from Muslim countries consist of primary products, the earnings of which are highly volatile. However, globalization is offering new opportunities for DCs to exploit, as well as to tap into, knowledge and information.

Due to inadequate knowledge absorption and innovation, technological development in the Muslim world lags behind other regions. The majority of Muslim countries are mired in the very early stages of their development. Neither digitally nor politically is the Muslim world well-positioned to leverage factor endowments in financial and natural resources in a productive way that foster the development of knowledge economies. Linkages among Muslim countries are limited to political decisions without taking real initiatives to implement programs and support science and technology. Because of low industrial productivity in most Muslim countries, innovations have not been taking place at a rate adequate to promote knowledge creation. However, scientific and technological capacity of Muslim countries is at least less backward than other determinants of progress to the knowledge economy as encapsulated by KEI and KI indices.

Governments have an important role to play in constructing plans and allocating the required resources to implanting them. In the knowledge economy, production of high-tech industries and knowledge intensity products are essential for fostering economic growth and sustaining development. It will be waste of time and resources on behalf of DCs to create new knowledge without the existing capacity to utilize and use this knowledge, i.e., building capacity to promote industrialization, agriculture and services is essential for making use of the new knowledge. In other words, the country needs to increase the supply of knowledge in order to meet the demand of local entrepreneurs and enhance the economy capabilities to innovate.

In order to catch-up with the industrialized countries, Muslim countries need to allocate larger portions of their technical and financial resources to promote technology diffusion, linkage, leverage and learning. Newcomers benefit from global

markets through spillover effects which have positive externalities on domestic enterprises. Linkages provide access to external technology, skills, information and knowledge to support the knowledge economy. The tendency to acquire external skills and technical knowledge provides the economy leverage to expand and exploit tacit knowledge for building capacity to innovation. This, however, will increase the economy capabilities to apply and adapt the knowledge and upgrade the technologies which acquired through linkage and leverage. Local enterprises could capitalize on the new knowledge to build capacity for R&D and innovation taking advantage of the new opportunities of absorption, adoption and adaptation. In other words, skills obtained through linkages can be utilized to conduct R&D as well as to apply knowledge and make use of foreign technology. Local enterprises must develop technologies aiming at empowering the economy capabilities to innovate and create new knowledge through linkages, learning, acquiring, assessing and selecting, implementing and searching. These represent the important components of technological capacity.

Notes

1. The World Bank's knowledge economy index (KEI) is an aggregate index representing a country's or region's overall preparedness to compete in the knowledge economy (KE). The KEI is based on a simple average of four sub-indexes, which represent the four pillars of the knowledge economy: economic incentive and institutional regime (EIR); innovation and technological adoption; education and training; and ICT infrastructure.
2. Global innovation index (INSEAD) 2011 published by INSEAD in collaboration with its knowledge partners (Alcatel-Lucent, Booz and Company, the Confederation of Indian Industry and the World Intellectual Property Organization), covers 125 economies, accounting for 93.2 percent of the world's population and 98.0 percent of the world's gross domestic product (GDP) (in current USD). INSEAD ranks 125 countries/economies across the world in terms of their innovation capabilities and results.

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