CHAPTER FIVE
ARAB PERFORMANCE IN RESEARCH AND INNOVATION

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Introduction

The term "innovation" is used here in an expanded sense that embraces both the idea of "inventiveness," with its connotations of scientific and technical ingenuity, and "creativity," with its associations with culture and the arts, inspiration, intelligence, emotional sensitivity, and the imagination. This expanded definition makes the word that best suited to denote the subject of the current chapter and meet our goal of widening the significations of the knowledge society concept and the central concepts associated with it currently circulating among Arabs. This chapter will not, then, treat only the factors usually addressed with regard to innovation in the knowledge society and will not limit itself simply to monitoring the state of innovation in scientific and technical knowledge. Nor will it restrict itself to indicators derived from the social environment such as are commonly used in reports dealing with the knowledge society. Rather, it will seek to build upon these basic elements and develop other indicators applicable to the Arab world. It draws on research in the human and social sciences despite the problematic issues thus raised and despite the lack of the detailed data that would facilitate the study, classification, and formulation indicators. Cultural, imaginative, and symbolic production also have a role to play in the analysis, since this chapter surveys innovation in the art forms that we believe have contributed to enriching Arab sensitivities and developing the aesthetic and affective values of our societies. Our goal is to provide an overview of how innovation manifests itself and to diagnose where it is lacking in terms of the current state of Arab knowledge.

In this chapter, then, we set forth for discussion a number of points that will allow us to examine the limitations of the dialectics of absence and aspiration, of dependency and intimations of independence and development. Discussion of innovation in the context of Arab knowledge requires an interrogation of these dialectics, just as it does the construction of their components into an approximate picture of the current status and future trajectories of Arab knowledge.

INNOVATION AND THE KNOWLEDGE ECONOMY

The Arab world lacks a pan-national monitor that could prepare quantitative and qualitative indices for the Arab region and guarantee the credibility of data on research and the dissemination of science and innovation within it. International institutions similarly suffer from a severe shortage of information from the Arab world. Despite persistent follow-up from the United Nations Educational, Scientific, and Cultural Organisation (UNESCO), only six Arab countries have provided complete and official data on their status with regard to the dissemination of science and innovation (Kuwait, Algeria, Tunisia, Morocco, Jordan, and Sudan). Six other countries have provided partial information (Saudi Arabia, Bahrain, Oman, Egypt, Lebanon, and Mauritania) and data remains almost completely lacking for ten Arab countries.[1]

Regardless of precision and currency, the available data indicate that, in all Arab

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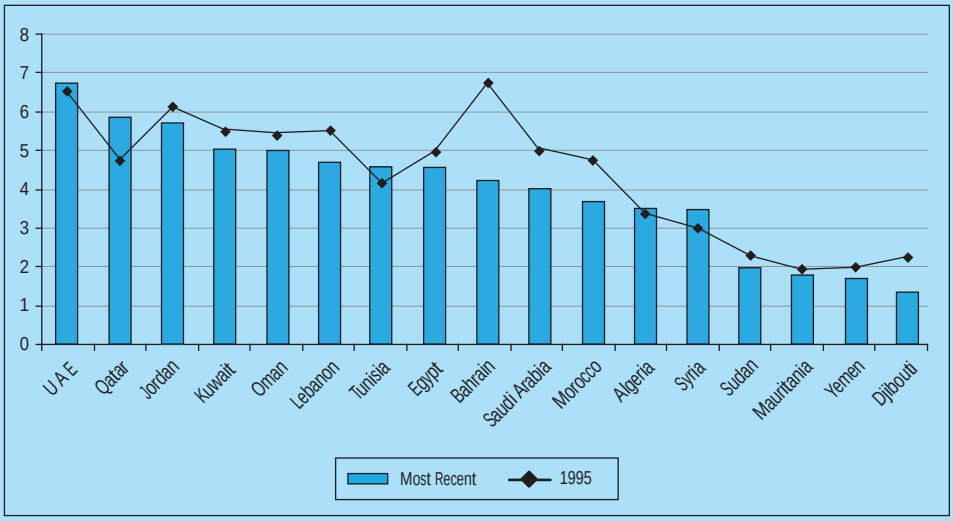
The available data indicate that, in all Arab countries, performance in the field of innovation is weak in comparison to that of the other pillars of knowledge

FIGURE 5-1

Innovation system index for the most recent period in comparison to 1995



Source: World Bank database, Knowledge Assessment Methodology (KAM), http://info.worldbank.org/etools/kam2/KAM_page5.asp.

Most studies on innovation place the performance of scientific research and research centres at the heart of the development process and production cycle

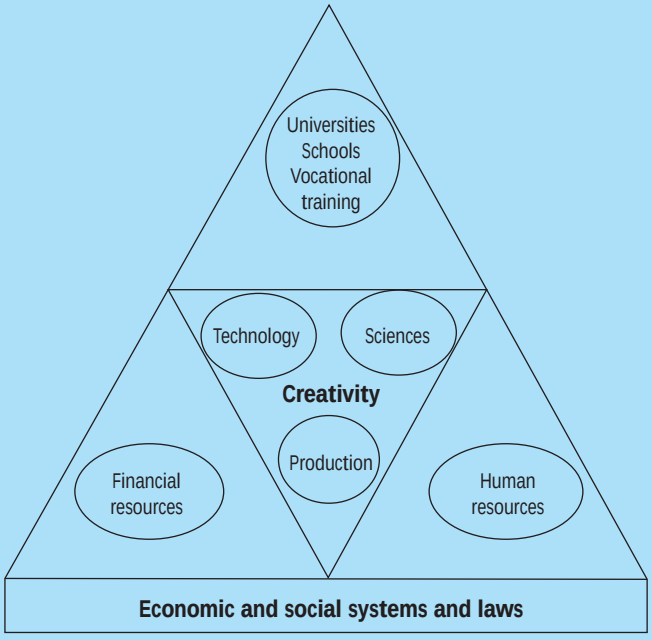
countries, performance in the field of innovation is weak in comparison to that of the other pillars of knowledge.[2]

Figure 5-1 shows that the UAE ranks highest among Arab countries on the innovation system index, followed by Qatar and then Jordan. In comparison to 1995, twelve Arab countries show a decrease in their index value for this pillar, and only five Arab countries show an increase. Three of these five countries are in the group of those with a high level of readiness for the knowledge economy, and two are in the group of those with a medium level of readiness for the knowledge economy. It should be noted that the innovation system index value of a number of developing countries rose in 2005 in comparison to 1995.[3] China achieved the highest increase in this value (1.06), followed by Turkey (0.71) and then Malaysia (0.63). Globally, the ranking of the Arab region decreased, whereas Southeast Asia achieved the highest increase due to the improved levels reached by India and Sri Lanka (Mohammed Bakir, background paper for the Report, in Arabic).

Most studies on innovation place the performance of scientific research and research centres at the heart of the development process and production cycle, as illustrated by Figure 5-2. This figure applies to innovation in science and technology more than to innovation

FIGURE 5-2

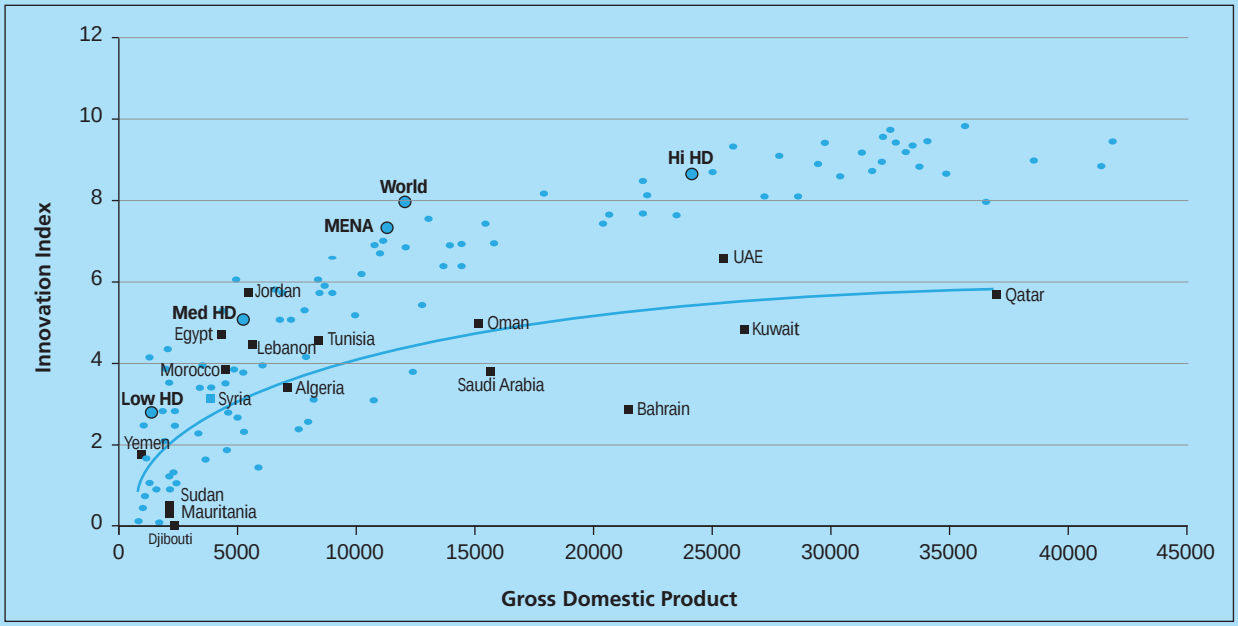
Innovation and development



Source: Estime Programme, 2007. http://www.estime.ird.fr, 2 September 2008

FIGURE 5-3

Per capita GDP and the innovation system index



Source: World Bank database, Knowledge Assessment Methodology (KAM), http://info.worldbank.org/etools/kam2/KAM_page5.asp

in culture and the human and social sciences.

THE CORRELATION BETWEEN GROSS DOMESTIC PRODUCT AND INNOVATION IN THE ARAB REGION

The world's countries can be classified according to the correlation between their Gross Domestic Product (GDP) and innovation. In Western industrial countries and those with growing industrial economies, this typically is a positive correlation, for these countries' positions on the innovation index rise in step with their GDPs. Arab countries, however, do not show a positive correlation between GDP and innovation. Despite the high GDP in oil-producing Arab countries, their ranking on the innovation and scientific research index remains low in comparison to other Arab countries with lower incomes but which are more productive with regard to research and innovation (Figure 5-3).

DEMOGRAPHICS AND THE CHALLENGE OF INCLUSION OF YOUTH

Arab countries face the challenge of a population whose youth and adolescents (ten to twenty-four years of age) now form two thirds of the total and who are expected to number between 120 and 150 million by 2025 (Population Reference Bureau, 2006). Under ideal circumstances, this high percentage would translate into the creative energy of a youthful society, yet many of these Arab young people suffer from unemployment and a brain drain that includes even professionals and highly-qualified individuals.

In early 2008, experts confirmed that the Arab countries were expected to spend more than $3,000 billion in the following few years on construction, development, and infrastructure projects that would require innovation and reliance on scientific products and services and advanced technology. Effective employment of the capacities of youth would alleviate the unemployment crisis in the Arab world,

Despite the high GDP in oil-producing Arab countries, their ranking on the innovation and scientific research index remains low in comparison to other Arab countries with lower incomes but which are more productive with regard to research and innovation

but the integration of innovation, youth, and accumulated wealth requires innovative policies for improving Arab knowledge performance (Zahlan, background paper to the Report).

The extremely low amounts spent by Arab countries on research and development have had a negative impact on Arab innovation performance in both quantitative and qualitative terms

SCIENCE AND TECHNOLOGY POLICIES

Despite the efforts exerted by Arab scientists and researchers, the extremely low amounts spent by Arab countries on research and development have had a negative impact on Arab innovation performance in both quantitative and qualitative terms. Another outcome of this situation is the weak impact of this performance and the limited applicability of its outcomes. In most Arab countries, scientific research agencies are attached to higher education systems rather than to production and service sectors as they are in industrial countries. This has contributed to the creation of a wide gap between education and research on the one hand and economic and social needs on the other.

Science and technology policies require cultural, social, and economic environments that promote participation in a competitive economy and the presentation of outstanding products based upon the outcomes of scientific research. This is what will make a reality of the complementary relationship between innovation and development, allowing innovation to feed the development process and serve as a permanent source for regeneration and progress. At the same time, development will embrace innovation and realise its primary role in both encouraging development and deriving maximum benefit from its results. Creating policies that support science and technology is thus one of the most important steps that Arab countries need to take in order to respond practically, competently, and seriously to the challenges of unemployment among youth, human capital flight, and the increasing drain of financial resources to

BOX 5-1

Official Arab Initiatives for Invigorating Research and Development

The Arab Economic and Social Summit, convened in Kuwait from 19 to 20 January 2009, affirmed the Arab countries' commitment to continue working towards economic and social integration, the encouragement of the private sector and civil society institutions to play a greater role in the advancement of the economy and development; and the initiation of projects that support infrastructure and protect the environment, as well as electricity and road network extension projects. The Kuwait declaration granted particular importance to improving education, human development, and health, while reducing unemployment and combating poverty. It also granted importance to the development of trade and industrial cooperation, as well as to the encouragement of youth and the empowerment of women. Among its most important recommendations were the following:

- Attention to the development of national statistics agencies and the provision of the detailed data and statistical indices necessary for formulating policies and taking appropriate decisions in the fields of development.
- Strengthening the role of the private sector and providing economic and environmental legislation appropriate for it and removing obstacles that prevent the private sector from playing an active role in economic development and in working towards economic integration.
- Pursuing the goal of human development and raising the human capacity of Arab citizens within the framework of the Millennium Development Goals while expanding the scope of empowerment of women and youth and increasing their work opportunities.

Developing educational and scientific research to keep pace with global developments while improving and equipping educational institutions to allow them to perform their missions competently; supporting implementation of the education and scientific research development plan approved at the Khartoum and Damascus summits; funding scientific research budgets; strengthening ties between Arab research centres; indigenising modern technologies; and making optimal use of the skills of scientists. On a separate front, ministers of higher education and scientific research in the Arab world meet every two years to discuss issues of common concern. They have agreed that "the Arab world faces a serious challenge in the fields of higher education, scientific research, and information technology as it enters an era of comprehensive advancement and integrated knowledge. International and regional circumstances call on us to engage with change from a holistic viewpoint and with an open mind, for the scope of these cultural challenges is greater than our capacity to face them." Although Arab ministers agreed on these recommendations eight years ago, they have yet to be implemented. Arab officials continue to insist that scientific research forms a complement to higher education, whereas Western and newly developed countries have moved beyond this limited understanding to tie research directly to industry, trade, and services.

Source: The Arab League Educational, Cultural, and Scientific Organisation, recommendations issued at the meetings held in Abu Dhabi in November 2007 and Sana'a in December 2005. Recommendations of the Arab Economic and Social Summit, Kuwait, 19-20 January 2009.

the import and consumption of ready-made technical products.

ARAB INITIATIVES AND STRATEGIES

Despite repeated official Arab calls to bridge the gap between scientific research and development projects, these recommendations have translated only weakly into reality (see Box 5-1).

National scientific research centres have often relinquished, or been distanced from, their responsibility to develop a national research vision and have left creation of their strategic work plans to the political leaders of their countries. In several Arab countries, however, this orientation began to change at the beginning of the decade, and a number of research centres have now laid out a national research vision tied to development issues. This has occurred in Lebanon (see Box 5-2), Saudi Arabia, Jordan, Tunisia, Morocco, Algeria, Qatar, and the UAE. Yet these efforts remain in their early stages, and their outcomes and impact are difficult to assess at present.

A review of the most prominent strategies prioritizing scientific and technical research in some Arab countries (The Arab League Educational, Cultural, and Scientific Organisation, 2005, in Arabic) leads us to conclude that most have adopted orientations that respond to the needs of food and water security, sustainable development, and technological development. These strategies aim to support innovation and improve competitiveness in sectors such as the petrochemical, communications, information, and renewable energy industries, public health, the medical sciences, and epidemic control, and the social sciences. These orientations reveal a real understanding of the priorities demanded by Arab circumstances, as well as close review by Arab scientists of new fields and specialisations in the arena of science and innovation.

Progress in strengthening research and development policies requires a commitment from the state to establish agencies and institutions dedicated to devising science and technology strategies. National polices must be built, in the first place, upon the state's social and economic development plans in such a way as to achieve the greatest possible degree of partnership between research and development centres on the one hand, and government and private sectors that benefit from their findings on the other. Research and development experience in Saudi Arabia, Lebanon, Jordan, and Morocco has shown that the best policies are those that are built upon collective forecasting and forms of collaboration that are based on solid information.

BOX 5-2

A Policy for Science, Technology, and Innovation in Lebanon

The Science, Technology, and Innovation Policy (STIP) plan in Lebanon is the outcome of three years of work by numerous Lebanese scientists and professionals, and international experts. The documents they produced are marked by both an objective local vision and regional and international ambitions for the future of technological and research development.

Experts analysed the strong and weak points of Lebanon's economic and social forces, as well as the challenges facing them and the opportunities available to them. This allowed the experts to determine the needs of Lebanese society and to formulate recommendations for the priorities of scientific research programmes to be included in the plan. The reports of specialised work groups were integrated into the final plan, which calls for a fundamental shift in the work of relevant parties in the private and public sectors and in universities. The plan seeks to present a holistic vision that ties community, economic, and social needs to the country's human capacities that are capable of creating solutions. It focuses on partnership and consultation among all concerned parties of Lebanese society in both planning and implementation.

The plan recommends specific initiatives in a number of scientific fields that have a direct impact on various economic and production sectors, including a noticeable increase in the material and human resources allocated for research and the upgrade and development of infrastructure. In the mid-range, this approach will lead to obvious economic results. It will drive the Lebanese economy to become knowledge-based and possessed of clear competitive advantages on the regional and international levels through the use made of the youthful human capital that forms Lebanon's primary natural wealth.

Source: Science, Technology, and Innovation Policy Plan, the National Council for Scientific Research, Lebanon, 2006.

National scientific research centres have been distanced from their responsibility to develop a national research vision and have left creation of their strategic work plans to the political leaders of their countries

THE PRODUCTION AND DISSEMINATION OF SCIENTIFIC KNOWLEDGE

In the context of a growing awareness of economic and development challenges, the three Arab Summits held since 2006 have,

for the first time, approved important resolutions in the area of the production and dissemination of scientific knowledge. These resolutions urge Arab countries to "cooperate in the field of scientific research, increase expenditure on scientific research to 2.5 per cent of Gross Domestic Product (GDP) within the next ten years, encourage government-private partnerships, and establish scientific centres of excellence in socially and economically significant fields such as water, desertification, nutrition, the environment, information technology, agriculture, renewable energy, disease, poverty, and peaceful uses of nuclear energy."[4] These resolutions were included in the ten-year plan for scientific research and development approved by the 2007 Arab Summit held in Saudi Arabia.

It has become clear that the wager on technology transfer, so common in the last century, has ended in failure

The Arabs have an opportunity to join the mainstream of scientific research and innovation, which moves according to its own laws and mechanisms and does not tarry for those who make no effort. It has become clear that the wager on technology transfer, so common in the last century, has ended in failure. The production of knowledge and the mechanisms for its assimilation depend on, in addition to transfer, an environment that supports the researcher's quest for new ideas, and the economic and social applications that they are guaranteed to produce.

Constraints on scientific research in Arab countries are not limited to the absence or weakness of institutional structures or their lack of staff. They also include the weakness of relevant administrative arrangements and legal frameworks

PARTNERSHIP WITH THE PRIVATE SECTOR

Partnership between the state, the private sector, and civil society is necessary for the development of scientific research and innovation in any society. Attention must be given to the role of the state as a primary partner in the production and exploitation of local innovation, as experiences in a number of developed countries and in China and Malaysia have proven. This partnership can take the form of either of two intersecting and complementary models. The first comprises active partnership between research and development institutions and institutions of higher education, so that universities provide research institutions with human resources and then research findings are incorporated into educational curricula. The second model is that of active partnership between industry (economic and social service and production sectors) on the one hand, and research and development institutions and institutions of higher education on the other. Such a partnership works toward defining social needs and research priorities, and translates research findings into useful applications.

Military research in Western and Asian countries forms an important sub-field to both research and development and the marketplace. Important data on this area is sometimes made available on expenditure, levels of technological development, and the significance of commercial returns, as well as the role of technological developments in the adjustment of global military and political balances. Yet Arab indices, like international ones, lack precise data on the extent and orientation of research conducted for security, military, and defence purposes. According to the scarce information available in this field, this research is limited to improving military performance and to developing advanced applications of information technology and genetic research with the aim of upholding security, combating crime and terrorism, and maintaining the regime. Some countries, such as Egypt, Saudi Arabia, Syria, Iraq, Algeria, and Morocco, have at various periods established military industries locally by building upon imported technologies.

THE REALITY OF ARAB RESEARCH CENTRES

Constraints on scientific research in Arab countries are not limited to the absence or weakness of institutional structures or their lack of staff. They also include the weakness of relevant administrative arrangements and legal frameworks, and this impacts on the efficiency and effectiveness of these institutions.

FIGURE 5-4

Arab-international cooperation in scientific dissemination, 2004

Source: Estime Programme, 2007

Although Arab countries have public and private scientific research institutions and centres, they are heavily informed by the notion of technology transfer and do not work to indigenise existing knowledge so as to allow for innovation and local knowledge production. As a result, these institutions have not succeeded in determining societal needs and setting research priorities, and this in turn has lowered their actual impact on higher and technical educational curricula. In the context of these structural problems, the complaint is increasingly heard that most researchers fail to show interest in publishing and disseminating their results and thus increasing their benefit to society. Others complain about the weakness of electronic communications with global scientific research networks, with a resulting falling behind by institutions and researchers in following and benefiting from global developments.

Yet the picture is not all that bleak. Strong points do exist, as do initiatives that merit attention and a little hope, if not also a great deal of concern. Arab research centres are diverse and endow qualified individuals with an appropriate education and a considerable accumulation of contemporary experience. These individuals may become prominent heralds of science and innovation if provided with material and moral support.

Arab research centres at first focussed on the basic sciences but subsequently diversified their programmes to include medical and agricultural sciences among other applied specialisations. During the last two decades, human, social, and environmental sciences have been added. There is a focus on locally significant specialisations in some centres, such as

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BOX 5-3

Expenditure on Research and Development

The fourth annual analysis of expenditure on research and development conducted by the consulting firm Booz and Company showed that the world's largest companies spent 492 billion USD on research and development in 2007, a noticeable increase of 6.7 per cent of compound annual growth rate since 1999. These companies spent an average of 45 per cent of their research and development expenditure in their home countries, and invested the rest in other countries in order to benefit from the latter's experience and skills and their proximity to growing markets. The companies that invested more than 60 per cent of their funds allocated for research and development outside of their home countries recorded a better performance with regard to returns to shareholders, operating margins, and market share.

Source: Barry Jaruzelski and Kevin Dehofff, 2008. "Beyond Borders: The Global Innovation 1000," on the website http://www.strategy-business.com/media/file/sb53_08405.pdf, on 17 December 2008.

Joint research projects among Arab scientific research institutions working in similar fields remain extremely rare even within the same country

palm tree research in a number of Gulf countries, agricultural research in Egypt, Syria, Morocco, and Sudan, and linguistic research in the Maghreb. Surprisingly, joint research projects among Arab scientific research institutions working in similar fields remain extremely rare even within the same country. The joint projects currently being implemented focus on partnerships with Western industrial states (Figure 5-4) and the exchange of scientific visits and training, especially when funding is available. This situation results in persistently weak impact.

The largest and most significant proportion of funding for most Arab research centres comes from the state

With regard to the structure of Arab research and development centres, they function through ministries of higher education and scientific research (eight countries), ministries of education (three countries), and a ministry of planning (one country), in addition to some specialised ministries (agriculture, health, industry). Five Arab countries (Lebanon, Kuwait, Bahrain, the UAE, and Qatar) show an exception to this trend, having assigned the task of research and development to relatively independent councils and academies (Nabil 'Abd al-Majid Salih, 2008, in Arabic). Egypt currently has the largest number of research centres (fourteen specialised government research centres, 219 research centres under the auspices of ministries, and 114 centres at universities). In Tunisia, there are thirty-three research centres comprising 139 laboratories and 643 branch research units. Technological research cities are few and are limited to Egypt, Saudi Arabia, and Tunisia (UNECA, 2008, in French). Other serious attempts exist in the Arab region, such as the Science and Technology Oasis that functions under the umbrella of the Qatar Foundation and sponsors numerous scientific and developmental studies.

The obstacles to funding and the lack of incentive-driven work opportunities for researchers are among the reasons for most Arab countries' weakness in research. This is compounded by a dearth of research, and the scarcity of support offered by public and private industry

The largest and most significant proportion of funding for most Arab research centres comes from the state. In Morocco, Tunisia, and Algeria, for example, research institutions enjoy close relations with the public sector and the state, which in return expects from them a considerable contribution to social and economic development programmes. These institutions have recently begun to take an important step toward developing self-evaluation tools, yet they also continue to suffer from centralised decision-making and their ties to state funding, despite their increasing access to bilateral European programmes and Euromed programmes. The obstacles to funding and the lack of incentive-driven work opportunities for researchers are among the reasons for most Arab countries' weakness in research. This is compounded by a dearth of research, and the scarcity of support offered by public and private industry.

Based on the analysis of the available data on research and innovation practices and outputs, Arab countries can be classified in one of three models:[5]

Model one: Countries whose research centres are characterised by a highly centralised administration and a bureaucratic relationship with the public sector. The funding for these research centres is limited to state contributions, and they show no diversity in their financial or human resources. The missions of these research centres and their programmes are burdened with scientific services required by public utilities. As such, their contribution to the production of original research and patents are limited and they do not include all scientific specialisations (Syria, Libya, Algeria, Sudan).

Model two: Countries whose centres are characterised by flexibility in their relationship with the public sector and diversity in their funding sources and human resources. Their most significant research production, however, remains within the institutions that are able to draw international support and build partnerships with industry. The institutions within this model show promising dynamism, yet they are also characterised by the frequently brief tenure of their experts and their intensive domestic and international travel (Tunisia, Lebanon, Jordan).

Model three: Countries whose centres

are characterised by flexibility towards, and sometimes independence from, the public sector, as well as by diversity of funding sources, and the ability to attract specialists from abroad and guarantee the relative stability of national specialists. A significant percentage of their scientific production comes from universities and private centres, and they are able to benefit from international cooperation programmes and from partnerships with service and industry sectors, as well as from independent national support funds (the UAE, Qatar).

THE CAPACITY OF RESEARCH CENTRES FOR INNOVATION

Due to the lack of detailed and reliable data, it is difficult to conduct a comprehensive evaluation of the capacity of scientific research institutions for innovation, both for the Arab countries in general and on an individual country basis. The reports of the World Economic Forum (World Economic Forum, 2008-2009) list a number of composite indicators that provide a preliminary ranking of Arab countries on the basis of the quality of their research centres' production and the assimilation of information technology into their activities (Tables 5-1 and 5-2).

Tables 5-1 and 5-2 above rank fourteen Arab countries that contain more than three-quarters of the Arab region's population; Malaysia and Turkey are added for comparison. The most conspicuous facts reflected by the data are the following:

- Qatar obtained a relatively acceptable ranking on the global level and first place among the Arab countries (rank, thirty), while four Arab countries (Tunisia, Jordan, Saudi Arabia, and Kuwait) attained middling ranks (forty-second, fifty-first, fifty-second, and fifty-fourth respectively) with regard to the quality of their research institutions. The remaining Arab countries covered by the report placed lower on the list. Malaysian research centres, known for

TABLE 5-1

The quality of Arab research institutions[6]

Country	The quality of Arab research institutions	
	Rank among 134 countries	Rank among Arab countries
Qatar	30	1
Tunisia	42	2
Jordan	51	3
Saudi Arabia	52	4
Kuwait	54	5
Oman	59	6
UAE	74	7
Syria	89	8
Morocco	94	9
Egypt	96	10
Bahrain	100	11
Algeria	108	12
Turkey	52	..
Malaysia	20	..

Source: The World Economic Forum, 2008b

TABLE 5-2

Ranking of Arab countries in the Assimilation of Technology index[7] **(out of 134 countries)**

Country	Technology assimilation at the institutional level	Networked readiness
UAE	14	27
Qatar	40	29
Tunisia	34	38
Bahrain	36	37
Oman	95	50
Kuwait	28	57
Jordan	35	44
Egypt	63	76
Morocco	70	86
Syria	87	94
Libya	97	101
Algeria	128	108
Mauritania	79	109
Saudi Arabia	44	40
Malaysia	21	28
Turkey	48	61

Sources: World Economic Forum website http://www.weforum.org/pdf/gitr/2009/rankings/pdf on 12 June 2009.

their quality, ranked twentieth globally.

- The UAE obtained a relatively high ranking (fourteen) among the thirty top nations heading the institutional technology assimilation list, outperforming the comparison countries (Malaysia and Turkey). Kuwait came twenty-eighth, surpassing the second comparison country (Turkey). Some other Arab countries (Tunisia, Jordan, and Bahrain) were close behind, coming in at thirty-fourth, thirty-fifth, and thirty-sixth respectively, while the rest of the Arab countries lagged behind. UAE and Qatar also recorded relatively high ranking technology preparedness indicator at the global level, occupying twenty-seventh and twenty-ninth place respectively and higher than the remaining Arab countries.
- Most of the Arab countries occupied medium ranks (from thirtieth to one hundredth) for all indicators, with noticeable improvement in the indicators of technology assimilation and technological preparedness in the Arab Gulf countries (Kuwait, UAE, Qatar, Bahrain, Oman). This points to the presence of a number of special factors in these countries, including financial prosperity and the role of global oil and gas companies in introducing modern technologies to the oil-producing Arab countries.

Theoretically, the more researchers there are, the higher the quality and quantity of research. Yet this correlation between the number of researchers and the yields of scientific research does not hold true of the Arab region

TABLE 5-3

The number of researchers in the Arab region[9]

Country	Researchers per million inhabitants		Availability of researchers (out of 134 countries), World Economic Forum 2008-2009
	ESTIME 2007	COMSTECH 1998-2007	
Tunisia	492	1013	10
Algeria	170	..	41
Egypt	..	..	47
Morocco	166	782	68
Jordan	280	1927	39
Kuwait	..	69	62
Libya	..	361	44
Syria	..	29	40
Saudi Arabia	..	..	43
Qatar	..	1236	53
UAE	..	..	75
Oman	..	..	95
Bahrain	..	..	94
Iraq	..	..	..
Lebanon	200	..	..
Sudan	..	263	..
Occupied Palestinian Territories	..	..	..

World Economic Forum, in English, 2008b
World Bank Database, Knowledge Assessment Methodology (KAM), on 10 June 2009
ESTIME, in English 2007
COMSTECH, 2007

THE PERFORMANCE OF ARAB RESEARCHERS

Theoretically, the more researchers there are, the higher the quality and quantity of research. Yet this correlation between the number of researchers and the yields of scientific research does not hold true of the Arab region, partly due to the difficulty in defining the role of the researcher there, even within a single country. The concept and specifications of the researcher's mission vary in the Arab region, just as international descriptions vary for the full-time researcher and the research professor. Countries need to produce comparable and analysable indicators for these kinds of issues.

Teaching staff at Arab universities, who constitute the majority of researchers in the Arab region, are burdened with teaching duties of twice the scope of those of their colleagues in Western universities. It is rare for the actual research activity of teaching staff in government and most private universities to exceed 5 to 10 per cent of their total academic duties, whereas it forms 35-50 per cent of academic duties in European and American universities, which consider this high percentage a marker of the practical value of higher education and of the effective role played by university professors.[8] The lack of clear guidelines and incentives for full-time scientific research and development as a profession may explain why most

researchers prefer to remain in universities, turn to other professions that realise higher returns, or join the caravan of migration from the Arab region.

The data available on the Arab countries demonstrates clearly that the relationship between the quality of research centres and the number of researchers is not always positive; Tunisia is an exception. Tunisia, Qatar, and Morocco are distinguished by their relatively high numbers of scientific researchers, as shown in Table 5-3.

According to World Economic Forum statistics, Tunisia holds the highest rank for the number of researchers, both among Arab countries and globally, ranking ninth among 134 countries. Jordan, Algeria, Libya, and Saudi Arabia hold acceptable ranks (less than forty-fifth), while the remaining countries hold lower ranks. A recent study that relies primarily on government data from ten Arab countries (Nabil 'Abd al-Majid Salih, 2008, in Arabic) shows Egypt as having the highest number of full-time researchers (13,941 at universities and research centres) and that these researchers show the greatest diversity of research interests (agriculture, materials sciences, manufacturing, metals, oil, water, energy, and medicine). In this study, Egypt was followed by Algeria (5,943), Tunisia (5,625), Morocco (4,699), and Jordan (2,223), while the number of full-time researchers was less than 1,000 in each of Qatar (789), Kuwait (634), Oman (548), Yemen (486), and Mauritania (411). On the basis of a survey of nine Arab countries, women accounted for 40 per cent of researchers in Egypt and Kuwait, 30 per cent in Algeria and Qatar, and 20 per cent in Morocco and Jordan. Their numbers fell to as low as between 14 and 4 per cent in Oman, Yemen, and Mauritania.

Despite the low percentage of women among scientific researchers, female Arab researchers have excelled globally in numerous fields. Among them are Algerian Asya Jabbar, elected to the French Academy, Jordanian Huda al-Zughbi, elected to the

BOX 5-4

Pioneering Arab Innovators in Genetic Science

Lihaz al-Ghazali, who works in the paediatrics department of the medical school at Al-Ain University in the UAE, helped establish the first Arab medical centre for clinical genetics in Dubai and the Arab Centre for Genome Studies, which is dedicated to studying genetic composition from the biological and medical perspectives. Her regional academic and medical experience is apparent in her research, which has uncovered the natural history of many of the genetic syndromes found in the Arab region. The international medical journal Lancet devoted its biographical page on famous doctors to her in its 25 March 2006 issue, and she was awarded the 2008 UNESCO-L'OREAL award for the Arab region. The statement accompanying this award praised the team she supervised for its identification of fifteen regressive genes and the mapping of seven genes. It stressed the need to know what genes are and the effect on society of genetic diseases such as haemoglobin disorder, birth defects resulting from regressive genes, and metabolic disorders, and their relation to the high percentage of consanguineous marriages in the Arab world.

The lack of clear guidelines and incentives for full-time scientific research may explain why most researchers prefer to remain in universities, turn to other professions that realise higher returns, or join the caravan of migration from the Arab region

BOX 5-5

The Ten Commandments for Researchers in Low-income States

Scientific research shares common academic characteristics around the world. These include the capacity to study the natural world, a commitment to the concerns of society, acceptance of criticism, productivity, and transparent teamwork based on solid scientific methodology. In a number of Arab countries, success in the profession requires that scientific researchers additionally meet a number of other specifications that can be summarised by the following Ten Commandments:

- Fully understand the conditions of the country and society.
- Focus on beneficial scientific research, and do not become preoccupied with trivial matters.
- Carefully select research projects and methodologies.
- Improve communication skills in foreign languages (English is a must).
- Build local and regional/international networks of cooperation.
- Commit to involving young researchers in research projects, and also to training them.
- Write highly competitive research proposals, and submit them in requests for support from international institutions.
- Publish in respected international journals.
- Persistently pursue self-education.
- Believe in and be proud of the scientific research profession.

This text draws on Moreno and Gutiérrez, 2008.

Despite the low percentage of women among scientific researchers, female Arab researchers have excelled globally in numerous fields

American Academy of Sciences, Lebanese Rabab Karidiya, elected to the Canadian Academy of Science, and Iraqi Zuha' Hadid, who has won global awards. The performance of female Arab researchers has also been distinctive in medical and public health research, with females appearing in higher numbers than males in Egypt, Jordan, Morocco, and Oman. These indicators are significant in that they reflect the development of the role of Arab women in building the field of research and innovation, as well as their direct participation in the development of social sectors, particularly by eradicating some forms of discrimination and securing equal employment opportunities in a field that requires many years of effort and persistence.

Average expenditure on scientific research does not exceed 0.3 per cent of the GDP in most Arab countries

It is clear from the above that the number of Arab countries that have invested human resources in full-time scientific research remains limited, and they score lower on the basis of this criterion than similar countries around the world. Yet the failure of these statistics to include Arab countries with extensive research experience and the lack of a unified instrument for surveying researchers may have led to an underestimation of the critical scientific mass that is capable of directing future research and development.

SCIENCE RESEARCH FUNDING IN THE ARAB WORLD

The annual share per Arab citizen of expenditure on scientific research does not exceed $10, compared, for instance, to the Malaysian citizen's annual share of $33

Average Arab expenditure on scientific research does not exceed 0.3 per cent of Gross Domestic Product (GDP) in most Arab countries, exceptions being Tunisia, Morocco, and Libya, whose spending rates are in excess of 0.7 per cent.[10] However, averages reach 3.8 per cent in Sweden, 2.68 per cent in the USA, 3.51 per cent in Finland, and 3.18 per cent in Japan. Rarely is average expenditure on scientific research lower than 1.8 per cent of the GDP in the European or the young Asian countries.[11] Yet added to this funding crisis for government and private research institutions in the Arab world are complications created by the administrative and financial systems that most of them deal with and which make them captive to bureaucratic routines in approving expenditures, equipment procurement, salaries, and bonuses. Some countries have additionally placed new restrictions on science-related expenditure such as appropriating a percentage of foreign aid allocated for scientific research projects and imposing taxes on science-related purchases similar to those imposed on commercial or consumer goods. In Egypt and Lebanon, for example, tariff laws and statutes do not distinguish between consumer goods and research materials. Such modest funding cannot help to improve Arab performance in innovation and research. What Arab research institutions need most are financial resources to fund the infrastructure of research and development.

In contrast to advanced industrial states, funding of scientific research in Arab countries depends on a single source—the government. This amounts to approximately 97 per cent of the funding available for scientific research in the region (Sasson, 2007). In contrast, government funding does not exceed 40 per cent in Canada, 30 per cent in the USA, and is less than 20 per cent in Japan.[12]

To get an idea of the status of Arab countries in comparison to developed states with regard to the extent of government spending on research and development, we provide data that shows that spending by the private sector in developed states (Britain, France, Germany, and the USA) is nearly twice that by the public sector. In Arab countries, the situation is not merely reversed; the private sector contribution amounts to barely 5 per cent, even though total spending on research amounted to a meagre 0.2 per cent of GDP in 2002 (Adib Kulu, 2006, in Arabic). In the Arab world, support for research and development programmes is generally concentrated in direct government funding and in official university programmes. There is a clear inability to attract substantial funding from foreign programmes or the private sector.

Arab countries can be ranked in terms of expenditure on scientific research using the data shown in Table 5-4 below, which demonstrates the following:

- Tunisia holds first place among Arab countries, with spending on research and development exceeding 1.3 per cent of GDP. Morocco follows, with 0.75 per cent spent on research and development thanks to the allocation of a significant portion of mobile phone revenue and that of some agricultural and industrial production sectors to this end.
- The private sector makes a relatively active contribution to funding research in Oman, Tunisia, Qatar, and Saudi Arabia, with an indicator ranging from 3.5 to 3.9 (with 1 being the lowest and 7 the highest.)
- In the same context, Qatar, Tunisia, Saudi Arabia, and Oman held first place among Arab countries, followed immediately by the UAE. The rest of the Arab countries placed below fiftieth (out of 134 countries).

It is worth pointing out the exceptional Arab initiative approved by Qatar in mid-September 2008 that calls for the allocation of 2.8 per cent of the general budget to support scientific research (Law Number 24 of 2008 regarding support and regulation of scientific research).

When the average per capita share of total expenditure on scientific research is calculated as a measure of a state's scientific and technological advancement, the results for the Arab region are disappointing overall, despite the significant differences between countries. The annual share per Arab citizen of expenditure on scientific research does not exceed $10, compared to the Malaysian citizen's annual share of $33. Record levels are spent in small European countries such as Ireland and Finland, where annual expenditures on scientific research per capita reach $575 and $1,304 respectively.[13]

The availability of only modest government funding may lead to the consideration of alternative sources and

TABLE 5-4

Expenditure on research in the Arab region

Country	Government spending as a percentage of 2006 GDP[1]	Private sector spending (scale of 1-7)[1]	Corporate spending on research (out of 134 states)[2]
Oman	..	3.9	44
Tunisia	1.3	3.8	38
Qatar	..	3.6	35
Saudi Arabia	..	3.5	43
UAE	..	3.3	50
Morocco	0.75	3.2	69
Egypt	0.2*	3.1	57
Kuwait	0.18	3.1	93
Jordan	0.34	3.1	79
Algeria	..	2.8	116
Syria	..	2.7	115
Bahrain	..	2.6	82
Libya	0.7*	..	124
Lebanon[3]	0.2	..	..
Sudan	0.3	..	..

Sources:
[1] World Bank Database, Knowledge Assessment Methodology (KAM), on 10 June 2008
[2] The World Economic Forum, 2008b
[3] The National Council for Scientific Research, Lebanon
*COMSTECH, 2007

TABLE 5-5

Expenditure on research and development and percentage contributions from private and public sectors in comparison countries

Country	Spending on research and development (percentage of GDP)	Percentage private sector contributions (percentage of GDP)	Percentage public sector contributions (percentage of GDP)
Sweden	3.73	2.79	0.94
Japan	3.39	2.62	0.77
Finland	3.37	2.46	0.91
United States	2.61	1.84	0.77
Germany	2.53	1.77	0.76
France	2.09	1.34	0.75
European Union (27 states)	1.84	1.11	0.73
China	1.42	1.01	0.41
Spain	1.20	0.67	0.53
Italy	1.09	0.54	0.55

Source: The Organisation for Economic Co-operation and Development (OECD); the European Statistical Service Groups; UNESCO; the National Institute of Scientific Research (Quebec); Science and Technology Observatory, 2007.

BOX 5-6

Jordan's "A Professor in Every Factory"

This pioneering project aims to benefit from the wealth of knowledge among academics and to strengthen the experience of researchers by solving practical problems in the industrial sector, creating opportunities for the formulation of development projects, and strengthening the competitive skills of small and medium-sized industrial companies. The project selects industrial institutions and then organises visits to them by a university professor or researcher, after which a preliminary report is produced on the technical and administrative problems faced by the institutions. The project secures the presence of a researcher in each factory throughout the academic summer vacation for at least 10 hours each week. The Supreme Council of Science and Technology covers 80 per cent of the researchers' costs, and the industrial institutions cover the other 20 per cent. The fields currently covered include engineering, business administration, agriculture, science, and information technology, though the project is open to any other fields in which the production sectors may need assistance and will provide them with relevant local experience. Among the most significant indicators of this project's success is the continued participation of supporting agencies since its launch in 2003. Supporting agencies, convinced of the project's role in developing the academic and industrial sectors, have increased in number from four to eleven, while the value of support has increased tenfold.

Source: Jordan University of Science and Technology http://www.just.edu.jo/fff/intro.htm

Production and service sectors of Arab countries typically rely on imported, ready-made technology, on the basis of turn-key agreements

invigorate the contributions of the private sector, whose contributions to scientific research have in fact increased recently. However, this increase remains modest, and includes that spent on research and development within companies. The primary reason for this may be that production and service sectors typically rely on imported, ready-made technology, on the basis of turn-key agreements.

While the World Trade Organisation has placed tight restrictions on state support for production sectors, spending on research and development is exempted from these restrictions.As such, most advanced states have approved the allocation of large budgets for research and development, and have granted a clear priority to research projects that include effective partners in the production and service sectors. Within this context, most industrial states consider spending by production and service sectors on research and development to be tax exempt, which creates an additional incentive for companies to spend in this field and thus maintain their competitive strength in international markets.

Foreign funding may lead to distancing researchers and their teams from research that is tied to national policies and priorities

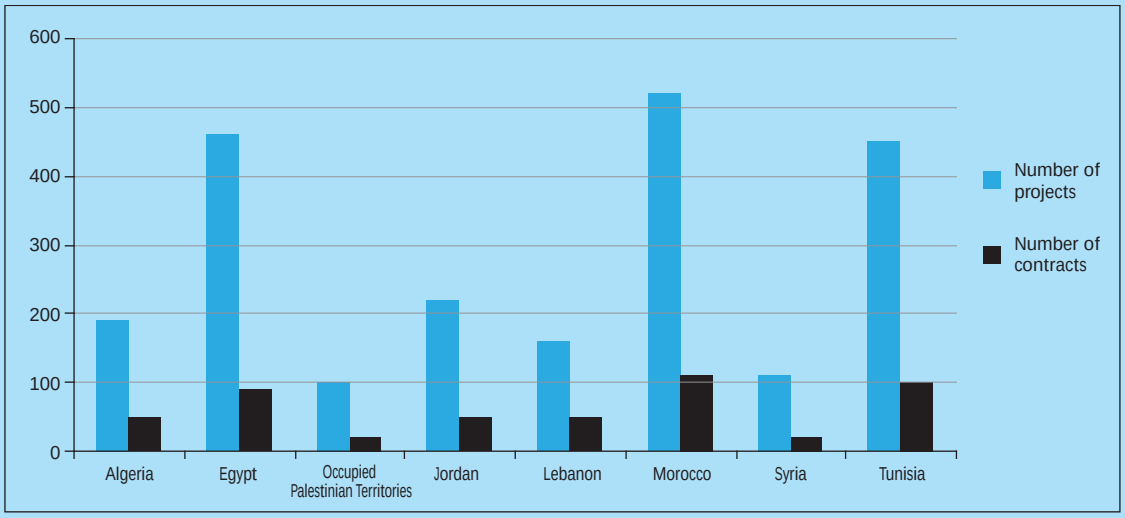
The reliance of scientific research centres on internal resources requires that they make efforts–with no guarantee of their results–to market their scientific and technological services and to offer their experience in helping to solve problems faced by the industrial, agricultural, and service sectors in return for financial compensation. The few research centres around the world that have been successful in this approach have not been able to cover more than a small amount of their annual expenditure. Thus researchers in Arab countries strive to obtain foreign funding for their projects and fail when their research falls outside the priorities of international programmes. Typically the targets set by such programmes are limited to cooperation and the establishment of research networks among states in the global North and South.

There is growing interest among most Mediterranean Arab countries in benefiting from the significant support offered by Europe as part of the programmes launched through the Barcelona Process. Morocco, Egypt, and Tunisia submitted the largest number of research proposals to the call of the European Union's Sixth Framework Programme for Research and Technological Development (2002-2006) for proposals and received the highest number of acceptances. Yet European-Arab scientific partnership remains slow-moving in Palestine, Syria, Lebanon, Jordan, and Algeria (Figure 5-5).

Bilateral international support is often offered to fund research centres on the basis of the political relations between

FIGURE 5-5

Arab participation in the European Union's Sixth Framework Programme (2002-2006)[14]



Source: European Union, Sixth Framework Programme, 2007, www.ec.europa.eu/research/fp6

the countries involved. Foreign funding may lead to distancing researchers and their teams from research that is tied to national policies and priorities. This often affects the most competent of researchers because these are best able to attract foreign support. Thus the ability of the Arab world to benefit from the experience and efforts of its most competent scientists is decreasing. Open-competition programmes of international support prioritise limited social, developmental, and scientific goals, leading some Arab researchers to avoid them, particularly when they address sensitive issues such as the manifestations of religious

The ability of the Arab world to benefit from the experience and efforts of its most competent scientists is decreasing

BOX 5-7

The European Growth Strategy

In early 2008, Europe decided that the greatest challenge facing its twenty-seven states lay in its ability to transform itself into the most competitive and dynamic knowledge economy in the world by 2010. Following a technology setback at the beginning of the new millennium as a result of the gap imposed by the development of internet systems and the economic ramifications of the USD exchange rate, the European Union bounced back and drew up strategies for competitive growth based on innovation and supported by competent human resources. For two decades, Europe had striven for economic, environmental, and social achievement, while goals accumulated, interests clashed, and the necessary financial resources remained unsecured. Since early 2005, policies have focussed on growth and employment opportunities, and each state has committed to socially acceptable reform programmes. Intense efforts have been exerted in scientific research and higher education.

The most significant outcomes of this approach are represented in the European Union's Seventh Framework Programme for Research and Technological Development (for 2007-2013, with a budget of 53.2 billion euro), the European Research Council (2006), and the establishment of the European Institute of Innovation and Technology. Investment in research and higher education is one of the primary entrance points for growth in the knowledge economy, and is fundamental to the unified European budget planned for 2012. Among other approved initiatives is the facilitation of the movement of researchers between European states (the ERA-NETS Programme), the funding of transnational research projects, the establishment of major centres of excellence, and a focus on research that directly reflects social needs, such as containing climate change, population ageing, and incurable diseases.

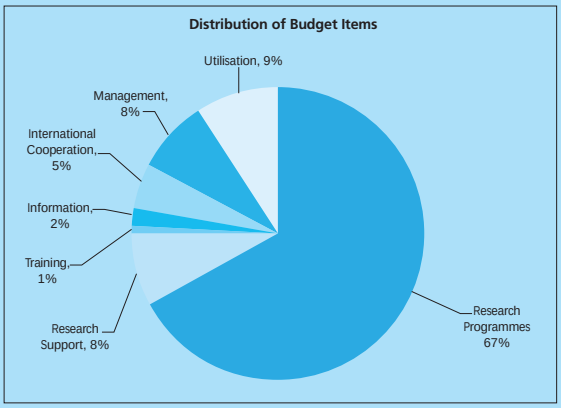
Source: European Commission, Sixth and Seventh Framework Programmes, http://cordis.europa.eu/fp6/dc/index.cfm?fuseaction=UserSite.FP6HomePage, http://cordis.europa.eu/fp7/cooperation/home_en.html

BOX 5-8

ICARDA

For the last three decades, the International Center for Agricultural Research in the Dry Areas, ICARDA, (Aleppo) has been committed to issues such as agricultural research development, open exchange of germ plasma and data for use in research, protection of intellectual property rights including the local knowledge of farmers, development of human resources, sustainable use of natural resources, and lessening the burden of poverty in dry areas all over the developing world (Western Asia, North Africa, Central Asia, the Arabian Gulf, and the Horn of Africa). ICARDA receives most of its private budget from the Consultative Group on International Agricultural Research, CGIAR, and a large number of international and Arab funds (totaling forty-one in 2007), in addition to direct support for private projects. ICARDA is run by an independent board of trustees that includes a number of prominent figures from developing and newly developed countries in addition to a director general. The centre is distinctive in its balancing of resources and spending and in its annual development, as well as in its high percentage of allocations to research projects and its ability to draw support as an international authority in dry region research the world over.

Source: The International Center for Agricultural Research in the Dry Areas (ICARDA), http://www.icarda.cgiar.org/AboutICARDA.htm



Source: ICARDA Annual Report, 2007, http://www.icarda.cgiar.org/Publications/AnnualReport/ICARDA_AR2007.pdf

fundamentalism, issues related to minorities, and the development of democracy.

In light of the above, researchers are—rightly—asking for increased funding for their research, while the public sector, pro-active funding agencies, and private institutions are—again rightly— stipulating greater impact and more creative and dependable returns. There is no solution to this problematic other than building clear, programmatic partnerships between knowledge-producing institutions and researchers on the one hand and those who benefit from their research on the other.

The achievements of Arab institutions are considered meagre both by international standards and by their own self-evaluation and that of their societies

The achievements of Arab institutions are considered meagre both by international standards and by their own self-evaluation and that of their societies. It can be argued that this weakness substantiates the claim that while financial support comprises a primary component of scientific research, it does not guarantee its quality or usefulness. If the funding of research and the capacity to attract additional funding are part of the basic enterprise constituting scientific knowledge and inventiveness, they are tied ultimately, at the institutional and human resources levels, to the assured presence of the following:

- Scientific research institutions that are credible and transparent in their administration and enjoy good relationships with the higher education system and the economic and social sectors. These institutions must be actively involved in solving development problems.
- The institutions should be administrated by decentralised bodies that include experts and figures drawn from various sectors of society and known for their distinction and credibility.
- Flexible financial systems must be approved and must be subject to close monitoring by independent agencies. This is in addition to systems for accountability, oversight, and on-going evaluation.
- The institutions should have the ability to take initiative and to represent the scientific community at national and international events through innovative programmes and projects that have positive, short-term local impact in the context of regional and global scientific concerns.

THE OUTPUTS OF ARAB SCIENTIFIC RESEARCH

While the outputs of research and innovation are numerous, peer-reviewed publications and patents are the most common and expressive indicators of scientific activity. Among the many global databases on the quantity and type of scientific articles published in peer-reviewed journals the most prominent are France's Pascal (CNRS-INIST) database and the Science Citation Index (SCI) database published by the Thomson

Institute in the USA. By analysing the quantitative indicators for Arab scientific publications contained in these databases, as well as those in the World Bank's KAM 2008 indicators and the studies of the Standing Committee on Scientific and Technical Cooperation (COMSTECH), a number of significant facts can be gleaned on what the Arab world has and has not accomplished. The most significant of these is that Egypt, Saudi Arabia, Tunisia, and Morocco lead the Arab countries in scientific publishing.

The total number of scientific articles published in sixteen Arab countries in 2005 was 4,859.[15] Egypt held first place with 34 per cent of the total number of publications, followed by Saudi Arabia and Tunisia with 11.8 per cent, while the percentages held by Morocco, Algeria, Jordan, Lebanon, Kuwait, and the UAE ranged from 4.7 to 9 per cent. As such, and following a lengthy Arab absence from scientific publishing that has only recently come to an end, Arabs now account for 1.1 per cent of global scientific publishing (TWAS, 2005).

Since the mid-1990s, Arab scientific publishing has recorded a clearly rising trend in Egypt and the Maghreb, and to lesser degrees in the Mashreq (eastern) and the Arabian Gulf countriesstates (Figure

TABLE 5-6

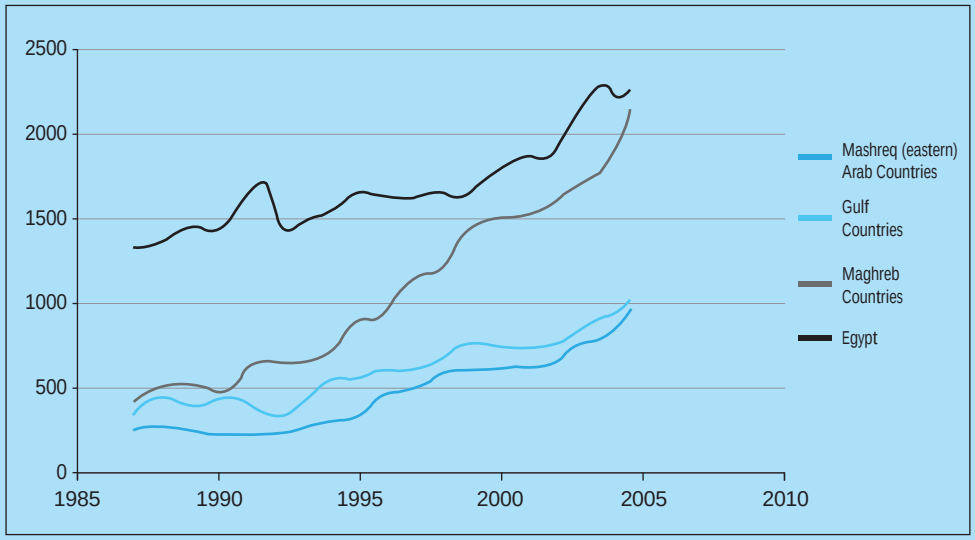
Number of scientific publications in selected Arab Countries[16]

Country	Number of scientific publications, 2005[1]	Scientific publications per 1,000 global publications[2]
Egypt	1658	2.83
Saudi Arabia	575	..
Tunisia	571	0.80
Morocco	443	0.87
Algeria	350	0.49
Jordan	275	0.55
Lebanon	234	0.35
Kuwait	233	..
UAE	229	..
Oman	111	..
Syria	77	0.11
Sudan	43	..
Bahrain	29	..
Qatar	19	..
Yemen	10	..
Mauritania	2	..

Sources:
[1] The World Bank, Knowledge Assessment Methodology, KAM, 2008
[2] Thompson Reuters, Scientific Citation Index, http://scientific.thompson.com/products/co. on 30 August 2008

FIGURE 5-6

Number of scientific papers published in the Arab region

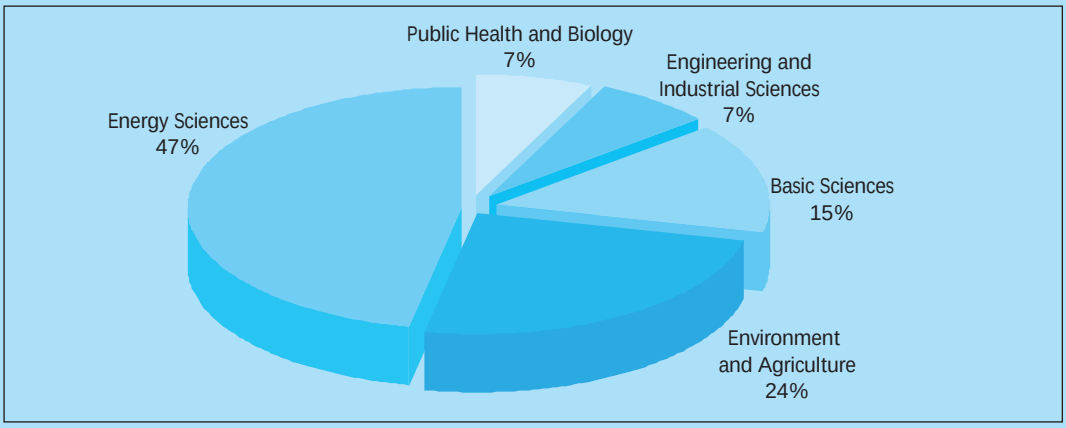


Source: UNESCO, 2008b

Arabs now account for 1.1 per cent of global scientific publishing

FIGURE 5-7

Published scientific articles according to specialisation (1998-2007), based on Table 5-7



Source: COMSTECH, 2007

TABLE 5-7

Number of scientific articles published in the Arab world, 1998-2007

Country	Number of scientific articles published from 1998-2007						Number of articles per one million inhabitants (2005)
	Environment and agriculture	Public health and biology	Basic sciences	Energy Sciences	Engineering and Industrial Sciences	Total	
Egypt	827	205	720	2276	245	4273	50.9
Jordan	474	113	202	523	113	1425	177.3
Morocco	366	78	317	614	69	1444	39.1
Saudi Arabia	352	111	183	846	182	1674	72.3
Tunisia	264	95	179	622	56	1216	146.2
Kuwait	240	56	70	216	81	663	267.2
Algeria	206	20	190	737	67	1220	27.1
Syria	183	30	25	92	9	339	12.8
Lebanon	160	158	83	201	53	655	347.3
Oman	145	20	52	152	39	408	117.2
Sudan	62	29	3	32	4	130	4.4
Libya	31	8	10	39	9	97	14.7
United Arab Emirates	29	6	5	39	8	87	66.3
Bahrain	26	7	7	54	16	110	189.7
Iraq	26	3	8	57	13	107	3.8
Qatar	24	7	16	50	6	103	226.2
Yemen	18	6	2	24	7	57	2.7
Mauritania	18	6	2	6	..	32	7.5
Occupied Palestinian Territories	12	2	4	13	4	35	17.3
Comoros	4	..	..	..	..	4	8.2
Djibouti	2	..	..	..	..	2	6.3
Somalia	1	..	..	..	..	1	0.3
Total	3470	960	2078	6593	981	14082	..

Source: COMSTECH, 2007

5-6). A tabulation of all the Arab peer-reviewed scientific publications in forty-seven scientific and technical specialisations published over the last ten years (1998-2007) reveals a total of 14,000 articles (Figure 5-7 and Table 5-7), while Turkey alone published 9,800 studies during the same period. Close inspection of the content of these scientific publications allows us to categorise it into five research foci. Energy studies comprise a high percentage of these publications, followed by the agricultural and environmental sciences and then the basic sciences. Engineering and industrial science publications are on a par numerically with those of public health and biology.

TABLE 5-8

Arab-international cooperation in scientific publishing

Rank	Tunisia Country	%	Egypt Country	%	Lebanon Country	%
1	France	77.0	United States	27.9	France	37.0
2	United States	5.7	Germany	14.9	United States	32.3
3	Germany	4.1	Saudi Arabia	12.4	United Kingdom	10.1
4	Italy	3.7	Japan	10.3	Canada	6.9
5	Belgium	3.6	United Kingdom	8.6	Bahrain	4.5
6	Canada	3.6	Canada	5.3	Italy	3.8
7	United Kingdom	3.1	Italy	4.1	Saudi Arabia	3.2
8	Morocco	2.2	Belgium	3.1	Germany	..
9	Spain	2.1	France	2.9	Australia	..
10	Algeria	1.5	Spain	2.2	Egypt	..

Source: Thomson Reuters and the Science and Technology Observatory (Observatoire des Sciences et Technologie - OST, Quebec, Canada), 2007

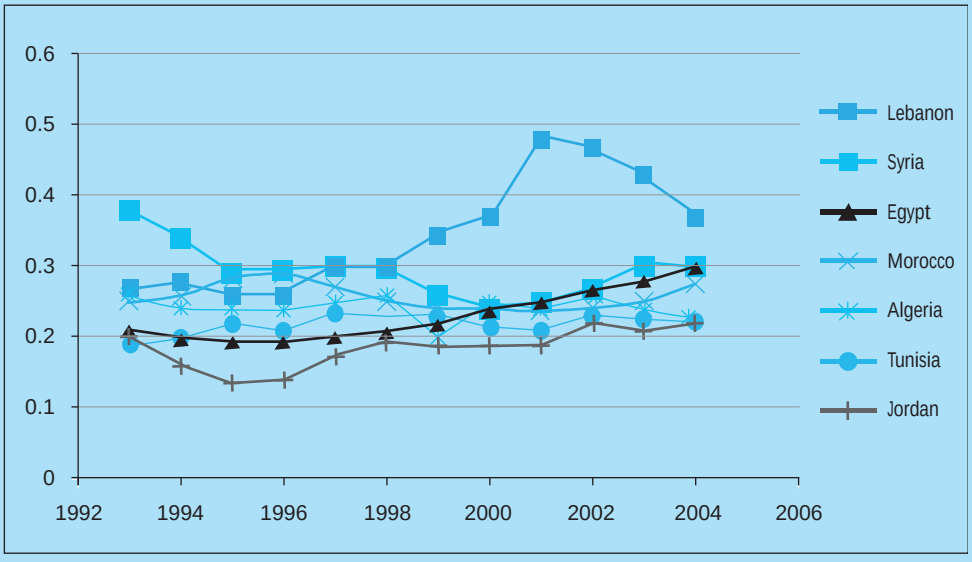
GLOBAL ENGAGEMENT

In contrast to the above, there are also positive signs that attract attention, the most striking of which is the increase in joint publications between Arab researchers and their peers in European countries and North America. A study of three Arab countries known for their ability to cooperate with foreign programmes (Table 5-8) shows that France is Tunisia's primary scientific partner. Egypt has a conspicuous scientific partnership with the USA, and shows reasonable degrees of scientific partnership with Germany, Saudi Arabia, Japan, and Britain. The percentages of Lebanon's research partnerships with France and the USA are similar. These partnerships can perhaps be interpreted as

There are positive signs in the area of Arab scientific research, the most striking of which is the increase in joint publications between Arab researchers and their peers in European countries and North America

FIGURE 5-8

Scientific impact of Arab publications[17]



Source: Thomson Reuters, Science Citation Index, 2007, and ESTIME Programme, 2008

an outcome of the historical and cultural relations between Lebanon and the Maghreb on the one hand and France on the other, in addition to Lebanon's recent economic relations with the USA. Arab-Arab relationships are noticeably weak with the exception of a few successful partnerships such as those between Egypt and Lebanon on the one hand and Saudi Arabia on the other, as a well as to a lesser degree between countries in the Maghreb.

To clarify further the scientific value and importance of Arab scientific publications, the Science Citation Index (SCI) lists only a relatively limited number of citations for studies by Arab researchers in comparison to those published from other regions of the world. Whereas the average citation of a single paper from the USA is 3.82, and from South Korea 1.51, the average number of citations from the Arab region ranges from 0.99 for Lebanon and 0.60 for Egypt, and goes as low as 0.01 for other Arab countries.

Similarly, the indicator of the scientific impact of articles published by Arab researchers has also brought low results since the early 1990s, approaching 0.5 only in rare cases, most notably in Lebanon, which has shown some distinction in this regard since 2000. The global average for the indicator, in comparison, is between 0.8 and 1.0 (Figure 5-8).

Arab science periodicals not included in international databases number no more than 500, about a third of which are published by Egyptian universities and research centres and the rest of which are distributed among Morocco, Jordan, and Iraq.[18] Arab science journals suffer from fundamental problems such as irregular publishing, lack of objective peer review of the articles accepted for publication, and resort to the unedited publication of the proceedings of conferences and seminars. Additionally, some of these periodicals are not regarded as credible for academic promotion purposes, which makes many researchers and academics prefer to publish in international, peer-reviewed journals.

The situation is similar with patents, which are another vital indicator of innovative performance and one that more accurately reflects the capacity of scientific research to produce innovative outcomes than does the status of Arab scientific publishing. The number of patents registered with national institutions is minimal, but in any case national institutions do not have the jurisdiction to protect rights internationally. Although comprehensive statistics are not available, a recent study (Nabil 'Abd al-Majid Salih, 2008, in Arabic) notes that Egypt and Morocco lead the Arab countries in this regard, with a total of 500 registered patents per year, whereas the six other countries covered by the study produce less than fifty patents annually. Numbers are available for the patents registered with the United States Patent and Trademark Office (USPTO) during 2005 and 2006 for only seven countries (Figure 5-9). Saudi Arabia stands out among these countries with thirty-seven patents, followed by the UAE, Egypt, and Kuwait (around ten patents each).[19]

A review of the period from 2002 to 2006 shows that, out of thirteen Arab countries, Saudi Arabia had the highest average number of patents issued, at 14.8 per year, followed by Kuwait and Egypt, and then the UAE, Lebanon, and Jordan

A review of the period from 2002 to 2006 shows that, out of thirteen Arab countries, Saudi Arabia had the highest average number of patents issued, at 14.8 per year, followed by Kuwait and Egypt, and then the UAE, Lebanon, and Jordan. The rest of the Arab countries averaged less than one patent per year. For comparison, the annual average of patents issued during the same period in Turkey was 18.6, in Malaysia it was 74.4, in Ireland 170.8, and in Finland 854.8.[20]

In the same context, the utility patents indicator does not differentiate the achievements of oil-producing from those of other Arab countries, with Kuwait, Saudi Arabia, Jordan, and Egypt at the forefront. In contrast, the ranking of the other eight countries fell to seventy and below out of 134 countries. Most Arab researchers are challenged by the exorbitant costs associated with registering patents with American and European institutions, and are forced to seek out fictitious

In order to register and protect their patents in preparation for marketing them to production sectors and turning them into high-quality products, goods, or services, Arab researchers are forced to seek out fictitious partnerships with foreign scientific institutions

partnerships with foreign scientific institutions in order to register and protect their patents in preparation for marketing them to production sectors and turning them into high-quality products, goods, or services.

Analysis of the outcomes of Arab scientific research shows weak yields for most indicators in comparison to other regions of the world. Despite the relatively high GNPs of some countries of the Arab region, Arab innovative, scientific, and research performance is not faring well in comparison to that taking place in the rest of the world. The picture grows more negative still when attention is turned to the output of scientific research in terms of publications and patents, as well as with regard to the number of researchers working to produce it and the estimated value of Arab spending on research and development.

For example, it is clear that no positive correlation exists between the number of researchers in the Arab region and the number of scientific publications produced there. The number of scientific papers published per 100 researchers each year was only two in four countries, was six and thirty-eight in two further countries, and was around 100 in Kuwait. If the total number of Arab university teaching staff is calculated at 180,000 doctorate-holding university professors, and if we add around 30,000 researchers working full-time in specialised centres, then the academic-scientific corps working in Arab research and development is estimated at 210,000 researchers. Yet this corps produces only 5,000 academic papers per year, equalling twenty-four scientific papers per 1,000 university professors and full-time researchers.[21]

Data related to national income of seventeen Arab countries show that Arab GDP was $1,042 billion in 2006, and yet annual gross expenditure on scientific research did not exceed two billion USD, an average of 0.2 per cent. This expenditure produced only 38 invention patents and 5,000 scientific papers, meaning that the cost of one scientific paper came to around $400,000. This estimated cost for the production of a scientific paper or patent is clearly exorbitant, and weakens the trust of society and its production sectors in Arab research programmes and their researchers. In comparison, Malaysia spends on research and development 22.5 per cent of gross Arab expenditure, while Finland spends 1.75 times as much as the Arab region and registers 855 invention patents at the cost of $4.1 million each, equalling 8 per cent of the cost of one patented Arab invention.

TABLE 5-9

Patents registration with the USPTO by seven Arab countries

State	Number of patents (2005-2006)[1]	Average annual number of patents (2002-2006)[2]	Utility patents (out of 134 countries)[3]
Saudi Arabia	37	14.8	51
UAE	11	4.6	132
Egypt	11	5.6	70
Kuwait	10	5.6	37
Syria	3	0.8	80
Oman	1	0.2	121
Jordan	1	1.4	63
Bahrain	0	0	90
Qatar	..	0.4	124
Algeria	..	0.4	89
Tunisia	..	0.6	130
Morocco	..	0.8	82
Lebanon	..	2.8	..

Source: [1] USPTO, http://www.uspto.gov, on 29 August 2008; [2] World Bank Database, Knowledge Assessment Methodology (KAM), 2008, on 10 June 2009; [3] The World Economic Forum, 2008b

SOCIAL SCIENCE POLICIES AND ARTISTIC INNOVATION

Here we shall attempt to broaden the significations generally given the concept of the knowledge society, based on the requirements for the development of knowledge in the Arab nation. It would, after all, be unreasonable for indicators, many of which do not encapsulate the

No positive correlation exists between the number of researchers in the Arab region and the number of scientific publications produced there

various dimensions of the Arab knowledge society, to remain the unchanging foundation for such development, or for quantitative criteria to be the sole deciding factor for all knowledge and all societies. The significance of this attempt will be obvious from the fact that efforts aimed at analysing the conditions of Arab knowledge performance and identifying its gaps require that we pay close attention to the existing vestiges of its earlier forms, despite the methodological quandaries and other issues that this poses.

This section brings research in the human and social sciences together with everything that is generally classified in the broadest sense as culture, including the products of what we have grown accustomed to calling artistic innovation (novels, the fine arts, cinema, and so forth). This combined perspective, we believe, allows us to view knowledge from an angle commensurate with the nature of the output in circulation in contemporary Arab knowledge circles. It also will allow us to examine at close quarters the limited nature of existing innovation and the legitimacy of the aspiration to discover means of knowledge production that correspond to the various forms of symbolic production and epistemological activity currently present in society and which express its aspirations. It will also allow us an opportunity to consider ways of raising this vital knowledge component to a higher plane.

Social science research holds a special significance in the Arab research and innovation scene because it addresses local issues that directly touch on the concerns and realities of Arab citizens

Despite the proliferation of colleges of social and human sciences, as well as public and private research centres, social science remains the "poor cousin" of Arab research and is not paid sufficient attention in knowledge reports on the Arab nation

SOCIAL SCIENCE RESEARCH

Social science research holds a special significance in the Arab research and innovation scene because it addresses local issues that directly touch on the concerns and realities of Arab citizens. Yet despite the proliferation of colleges of social and human sciences, as well as public and private research centres, social science remains the "poor cousin" of Arab research and is not paid sufficient attention in knowledge reports on the Arab nation. This stems in part from the difficulty in determining the scope of social and human science research in the Arab region. Yet the available data suggest a weakness in production and dissemination, and in quantity and in quality, compared to research in basic and applied sciences. Maghreb countries show the highest output of social and human sciences research, whereas Egypt and the Mashreq (eastern) Arab countries are characterised by relative stagnation in this field (El Kenz, 2005, in French). Taking the total number of projects supported in all fields in Lebanon, for example, we find that support for projects in human and social science research did not exceed 9 per cent at the American University in Beirut and 5 per cent at the National Council for Scientific Research.[22] The situation is comparable in most Arab countries. The reason for this may not lie in a lack of financial or human resources, or in the absence of research priorities tied to the daily concerns of members of society, but in weak academic incentives for researchers and university professors especially in the fields of the human and social sciences.

Researchers in the social sciences prefer to conduct their research outside the frameworks usually relied upon by researchers in basic and applied sciences, and outside of government institutions. This may allow for productive research in thorny social issues. Although universities continue to play a primary role in social science research in the Maghreb, Syria, Libya, and Lebanon, more than 80 per cent of social science research is produced through research centres or consultative agencies outside of universities, especially in Palestine, Jordan, and Egypt, and to some degree in the countries of the Gulf.

The interests of researchers in the social and human sciences focus mostly on literature, law, and history, followed by sociology and then economics and political science. The ranking of the human sciences in published studies supported by Western funding agencies has changed, in that publications in political science, economics, history, and Islamic studies have increased, but those in sociology

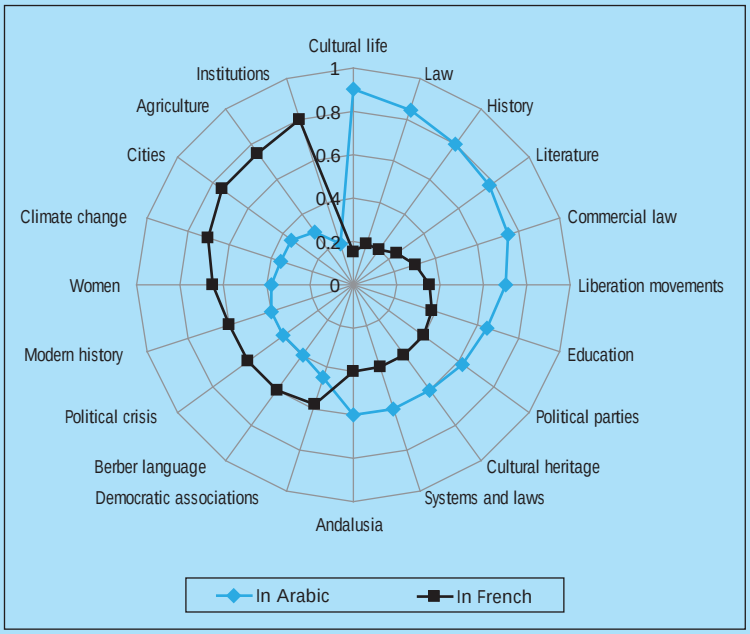
and anthropology have decreased (Hanafi, 2008). The topics addressed in the social and human sciences in the Arab region include development, democracy, social transformations, migration, governance, gender, violence, and Islamic movements. These studies have replaced studies of social class and the problematics of human society.

THE ARABIC LANGUAGE AND INNOVATION

One of the most important signs of development in Arab social and human science research is that the number of Arabic-language publications in the Maghreb increased by 60 per cent between 1980 and 2007, while French-language publications formed only 30 per cent. This improvement did not include basic and applied science research, which continued to rely upon foreign languages (Figure 5-9). Among 34,000 papers published by researchers in the Maghreb during the last decade, French was the most commonly used language, out-ranking Arabic (Figure 5-10). As for the Mashreq (eastern) Arab countries, with the exception of Lebanon and Palestine, the overwhelming majority of research papers in the human sciences were published in Arabic, which explains the dearth of Arab social science

FIGURE 5-9

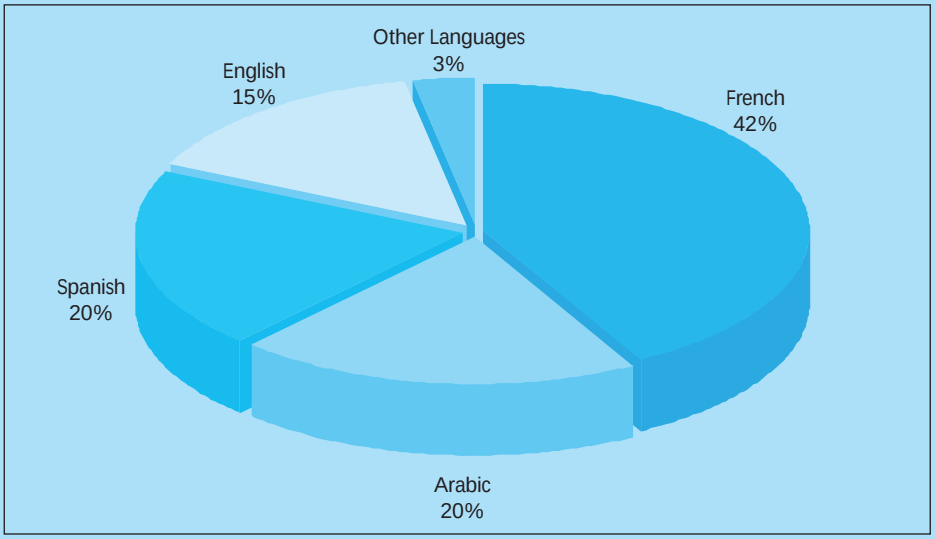
Percentage of Arabic language-use in research papers published in the Maghreb, 1980-2007



Source: Waast et al., 2007, in French.

FIGURE 5-10

Languages used in human and social science research publications in the Maghreb, 2007



Source: ESTIME Programme, 2007

Among 34,000 papers published by researchers in the Maghreb during the last decade, French was the most commonly used language, out-ranking Arabic

publications in global databases. A survey of twenty-two journals published during 2007 in the USA, Canada, and Europe, four of which were specialised in the Arab region, showed that only two studies were published by Arab researchers residing in Arab countries. Yet most Arabic-language periodicals in the social sciences are of extremely poor quality by global standards, are highly local in nature, and do not adhere to neutral peer-review methods (Hanafi, 2008).

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In summary, the development of the human and social sciences in the Arab world remains dependent on the fostering of an enabling environment for knowledge that guarantees the freedom of expression and the flow of information and strengthens the political participation of both citizens and researchers. While it is true that some Arab countries have seen promising activity in human and social science research, it is also true that this improvement remains much weaker than the development of research in the basic sciences and technology. It is also ironic that while Western agencies show increased interest in social sciences in the Arab world and offer direct and generous funding for it, such interest is absent among Arab governments and institutions. Thus the increasing marginalisation of social science research drives serious researchers towards increasing dependence on foreign programmes and funding.

LITERARY AND ARTISTIC INNOVATION

Artistic and literary production occupies a knowledge space that is intimately linked to reality. It constitutes theoretical activity based on the employment of the imagination to create symbolic worlds imbued with open-ended and creative resonance. It reformulates an imaginary reality that may not bow to digital systems or positivist logic, but which rather constructs additional spaces that enrich the mind and the soul. The knowledge society for which we aim must go beyond quantifiable scientific knowledge to embrace creative knowledge in all its literary, artistic, and cultural forms. Unlike the sciences and technology, artistic innovation contributes to enriching the symbolic existence of humankind. Despite differences in definitions, concepts, processes, and results, creative knowledge forms a primary component of contemporary human knowledge and an element of regeneration for its concepts and tools. While the effect of a painting, piece of music, novel, poem, or play cannot be quantitatively measured, a statistical measure of the number of literary writers, musicians, and theatre professionals provides a general idea of the scope of cultural activity, although it fails to capture the human and aesthetic dimensions of creative production. Contemporary studies of how concepts are passed on within widely separated fields of knowledge have shown that concepts significantly increase in value as they are transferred from one field of knowledge to another.

Arab cultural production faces numerous challenges related to the climate of freedom and stability, the need for sustained institutional and financial support, and the need to raise the awareness of the public (see Chapter 2). Among its most prominent challenges are the limited publication of books in proportion to the Arabic-reading population and the weak quality of these books, and, more significantly, the extremely limited base of actual readers among the Arabic-reading population. On average, the individual Arab reads very little annually. The first Arab Report on Cultural Development, published by the Arab Thought Foundation, states that "if we distributed all the books published every year among the population, for every 11,950 Arab citizens there would be one book, whereas there would be one book for every 491 British citizens and every 713 Spanish citizens. This means that the Arab citizen's share in published books equals 4 per cent of the British citizen's share and 5 per cent of the Spanish citizen's" (Mu'assasat al-Fikr al-'Arabi, 2008, in

If we distributed all the books published every year among the population, for every 11,950 Arab citizens there would be one book, whereas there would be one book for every 491 British citizens and every 713 Spanish citizens

Arabic). Aversion to reading is connected to a high illiteracy rate, low purchasing power, low quality of education, and the lack of cultural development plans, all of which facilitate the spread of easier, simpler, and less costly commercial media whose knowledge content becomes central to mainstream culture.

As for Arab architecture, it faces the problem of the relationship between local architectural heritage and contemporary architectural concepts and technologies. And yet the experiences of innovative architects have been a success when they have been able to strengthen the relationship between heritage and the production, industry, and technology markets. In contrast, certain attempts to transfer or copy architectural models that do not take Arab particularities into consideration have failed.

In contrast, the cinema scene is both lively and full of variety. Arab cinema has a lengthy history that began in the early twentieth century in Egypt, which still remains the leader of Arab cinematic production today. Arab interest in cinema has expanded since then, however, to include Morocco, Lebanon, and some Gulf countries, which now have advanced cinema production studios. Arab cinematic productions participate in international festivals even as some Arab countries continue to ban public movie theatres.

A telling sign that cultural and artistic innovation is opening up in the Arab world is the growing number of cinema screens and audiences. Data on cinema audiences shows that Egypt, Bahrain, and Morocco take the lead with regard to the seven Arab countries for which detailed data is available in both the number of viewers and their ratio to the number of cinemas (Figure 5-10). In so far as film-making is a

TABLE 5-10

Sizes of cinema audiences and numbers of cinema screens, 2004-2005

Country	Size of audience (in millions)	Cinema screens	Number of cinema goers (in thousands) per cinema screen
Egypt	26.8	250	107.2
Bahrain	1.3	26	48.1
Morocco	3.8	115	33.2
United Arab Emirates	6.3	202	31.4
Lebanon	2.1	87	24.1
Tunisia	0.3	29	10.3
Algeria	0.7	69	10.1

Source: The European Audiovisual Observatory, www.obs.coe.int, 15 December 2008

A telling sign that cultural and artistic innovation is opening up in the Arab world is the growing number of cinema screens and audiences

BOX 5-9

Arab Innovators in Architecture and Music

As set forth in his book *Building with the People,*[23] Hasan Fathi's view of the relation between architecture and the human led him to establish an alternative form of architecture that rejects the copying of Western buildings. In Egyptian rural architecture he found artistic, technical, and environmental solutions for facilitating daily life and maintaining a relationship with the land.

The works of Rif'at Chadirji are characterised by a deep theoretical and practical assimilation of local roots of expression and their translation into the technical terms of modernity. Chadirji has also made theoretical and critical contributions through his writings that address debates in the field of architecture and has established an annual award for pioneering Arab architects.

Fairuz and the Rahbani brothers

The second half of the twentieth century is marked by the pioneering experience of the late Rahbani brothers, Asi and Mansur, which culminated in their collaboration with the enchanting voice of Fairuz, imprinted in the imagination of successive generations as an accompaniment to their joys, sorrows, rituals, and longings. The Rahbani school has had a radical impact on Lebanese art in its reliance on short songs, subtle vocal expression, and high-level orchestral and theatrical performance, as well as inspiring poetic images and a revival of Lebanese rural heritage in compositions that vary from the romantic and traditional to the modern. After performing hundreds of their songs and scores of musical plays every year, and after exploring new vocal horizons with her son Ziyad, Fairuz remains an innovator today. She shines in the hearts of her public, remaining at the heart of public taste, despite the shifts in generations, technologies, and artistic preferences.

mass art, the flourishing of a commercial, consumer-oriented cinema sets the pattern for public taste, and it is a pattern that, in this case, makes no contribution to the development of the cinema as an art form. Films recorded on video and compact disc in violation of intellectual property laws have contributed significantly to the decreasing percentage of the public that attend Arab cinemas.

Arab societies are filled with examples of distinguished literary and artistic expression of the highest standards, but these continue to be disproportionately small in comparison to the size of the Arab world and the range of its natural and human capacities

The issue of freedom of expression arises more often in the fields of cultural and artistic innovation than it does in the pure sciences, due to the latter's direct connection to political issues, to the public, and to people of all social and cultural levels, as well as to the ease and speed of its dissemination and the possibility of its transmission through the modern media. The danger lies in the possibility of innovators adapting to the intellectual limits placed upon them by modern media, and in persecution. "Exile" literature and music flourish as a result because innovators are drawn abroad; they migrate to the broad spaces of freedom in order to express their innovation honestly, daringly, and distinctively. Although Arab societies are filled with examples of distinguished literary and artistic expression of the highest standards, these continue to be disproportionately small in comparison to the size of the Arab world and the range of its natural and human capacities. The delivery of creative products to the people and their dissemination throughout the Arab world remain restricted by the limited nature of its freedoms and the meagreness of its opening up to and communicativeness with both inside and outside.

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THE INNOVATION GAP AND ITS INDICATORS IN THE CURRENT STATE OF ARAB KNOWLEDGE

THE INNOVATION GAP

Awareness of and interest in investment in research and innovation as pillars of knowledge have increased in Arab countries since the early 1980s. Arab scientific research centres have made consistent and noticeable progress in all specialisations, and whereas in the mid-twentieth century only Egypt, Iraq, Morocco, and Lebanon had research centres and institutions, now most Arab countries have them. When Arabs were once entirely absent from the global arena of scientific publishing, their publications now constitute up to 1.1 per cent of the world's total (TWAS, 2005). This presence, even though modest, is a step in the right direction. Most peer-reviewed scientific publications come from a small number of Arab countries, Egypt at their head, and a significant portion of it consists of joint scientific publications between Arab researchers and researchers from Europe and the USA.

According to UNESCO's definition, "scientific research and development includes all innovative activities carried out according to a methodology and systematic procedures with the aim of enriching the store of human knowledge, which embraces knowledge of man, of nature, of culture, and of society, and makes use of this store of knowledge in pioneering applications to serve holistic human development." It is now widely accepted that the concept of science encompasses the natural sciences, engineering, agriculture, medicine, technology, the social and human sciences, and a society's cultural heritage (UNESCO, 2005, in Arabic).

The primary mission of the sciences is to find solutions to problems faced by humankind. Advanced technologies meanwhile drive the process of change, while innovation is the true indicator of a shift to the stage of effective impact in the areas of social action and production. Policies in many countries have mandated scientific research as a means of producing innovation and developing the production, service, environment, and public health sectors. Yet innovation is not to be measured only in terms of the outcomes of research, for it is an active process characterised by dynamism and openness, and its sustainability depends on its ability

to attract a number of invested partners at all stages.

Available data show a large increase in the number of universities, colleges, and institutes, as well as scientific research centres and institutions of various specialisations and capacities. These data also show a growing number of researchers, technicians, engineers, and architects working in scientific endeavours, as well as a slight increase in spending on scientific research in countries such as Qatar, Tunisia, Morocco, and some of the Gulf Cooperation Council countries that have begun to invest greater interest in the knowledge sector. Yet despite the positive developments made on the research and innovation pillar index in some Arab countries over recent years, especially in quantitative terms, performance remains the weakest point in current Arab knowledge, and the scientific research and innovation gap between the Arab region and the rest of the advanced world remains the clearest, deepest, and most dangerous.

The Arab world's spending on scientific research in relation to Arab GNP is the global lowest, and its research and development institutions have weak ties to production cycles. The development impact of Arab scientific research is out of proportion in its weakness to the annual Arab expenditure of two billion USD, which from 2002 to 2006 produced only about 38 invention patents, 14.8 of which were from Saudi Arabia, and 5,000 scientific papers.[24] Expenditure in the Arab world on scientific research hovered at around 0.2 per cent of GDP and was limited almost entirely to the government sector; the private sector played almost no role in this regard, for its view of scientific research remains limited to its potential economic significance. In developed states in contrast, the matter is entirely different, with an average spending of 2.5 per cent of GDP on research and development, and with 80 per cent of funding coming from the private sector (Al-Mu'assasa al-'Arabiyya lil-'Ulum Wal-Tiknulujya, 2008, in Arabic).

Rates of Arab human capital flight and migration of skills are among the highest worldwide. A total of 45 per cent of Arab students who study abroad do not return to their home countries after obtaining their university degrees because of the Arab political and intellectual environment that repels innovation and creative individuals. The irony is that Arab countries celebrate the achievements of successful Arab migrants more than they do success stories at home.

These facts on Arab innovative performance confirm that it is impossible to remain silent over the need to change these circumstances if our goal is to improve Arab knowledge performance and develop a positive connection to the global knowledge arena. The greatest challenges facing the Arab countries with regard to knowledge include the following:

- Modernising the environment and structures of innovation.
- Possession of scientific knowledge and production of advanced technology, cultural knowledge, and knowledge in the area of the human sciences through more generous investment in research and development and through setting policies for the indigenisation of science and the creation of an atmosphere conducive to innovation and innovators.
- Realisation of partnerships between government, private research centres, and institutions that benefit from the outcomes of innovation, with the goal of improving scientific research and employing its applications in ways that support production and development cycles.

Despite the positive developments made on the research and innovation pillar index in some Arab countries, "innovation" remains the weakest point in current Arab knowledge status

A total of 45 per cent of Arab students who study abroad do not return to their home countries after obtaining their university degrees because of the Arab political and intellectual environment that repels innovation and creative individuals

FLIGHT OF HUMAN CAPITAL

The flight of human capital forms an important component of the flow of knowledge in the age of globalisation, and is affected by both the push and the pull elements of its enabling environments. The attitudes of countries toward human

capital flight has changed over time, for the need for skills, experience, and human resources has grown considerably during the last ten years all over the world, including in Europe and the USA, which are no longer capable of generating sufficient skills locally and thus have begun to search for them elsewhere, and particularly in developing countries. These global orientations strengthen the notion of "stealing" human capital, including those Arab human intellectual assets that are prepared to migrate to countries of the North.

Human capital is among Arab countries' major exports, possibly equalling oil and gas in value

The Arab region is considered one of the most active in terms of the export of highly qualified human capital equipped with university degrees. Indeed, human capital is among its major exports, possibly equalling oil and gas in value. The little data available on this indicates that 45 per cent of Arab students who study abroad do not return to their home countries, that 34 per cent of skilled doctors in Britain are Arabs, and that the Arab world has contributed 31 per cent of the skilled migration from developing states to the West, including 50 per cent of doctors, 23 per cent of engineers, and 15 per cent of scientists (Zahlan, 2004).[25]

The data in Table 5-11 differentiates two groupings of Arab countries on the basis of their ability to attract or repel national skills and talents.[26] According to the official indictor for measuring human capital flight, the first group, which scored between 3.5 and 7 points and includes six oil-producing Gulf countries and Tunisia, are the countries capable of holding on to innovative national human capital. The second group includes six Arab countries, including Algeria and Egypt, that are incapable of persuading human scientific capital to remain in its home country. Five Arab countries that are not included in the table suffer from chronic human capital flight due to their political and security crises and the deterioration of their living conditions. These are Lebanon, Sudan, Iraq, Yemen, and Palestine.

Opinions concerning the desirability of human capital flight from the Arab region vary; some consider it a curse, others a blessing. Human capital flight offers employment opportunities to university graduates whom domestic markets cannot absorb, and secures important financial resources that range between 5 and 10 per cent of the GDP of some Arab countries. The financial remittances sent by Arab migrants are considered among the most important factors contributing to development and the provision of foreign currency in a large number of impoverished Arab countries. The total sum of financial remittances sent to the Arab region in 2006 was over 25 billion USD.[27]

Finally, attention must be drawn to the movement of Arab skills and human capital within the Arab world. This phenomenon is new to Arab intellectual life and can be viewed in the context of inter-Arab cooperation, allowing us to speak of a circulation of human capital rather than human capital flight. The financial incentives and stable political

BOX 5-10

Knowledge Transfer via Migrant Scientists

Arab human capital flight creates an opportunity not only to obtain financial resources, but also to transfer knowledge via migrants. This is the goal of the TOKTEN programme launched by the UNDP in 1977, in an attempt to turn "brain drain" into "brain gain." The TOKTEN programme began by surveying Arab human capital found abroad, developing a database of information on these professionals' academic and practical experience, establishing a network of direct relations between them and their home countries, and supporting the costs of their travel home for limited periods. TOKTEN is an arm of international technical cooperation relations that aims to lessen the negative effects of human capital flight. It is characterised by an open attitude to home societies and relies on the ties of shared language and tradition, the feelings that migrants hold for their homelands, and their desire to return favours to them, especially since most of these migrants were raised in their homelands and completed their education in them. The number of experts who have served their countries through the programme over the last decade is over 4,000; they have also offered consultative services to government agencies and the private sector, and some of them have returned to live in their home countries. Lebanon and Palestine are the Arab countries that have benefited most from this programme.

Other networks like TOKTEN exist that connect scientific and intellectual communities abroad with their home countries, some of which were established by Arab scientific and academic communities abroad, such as the network of Maghreb researchers living in France (Migration et Recherche) and the Arab Scientists and Technologists Abroad network. With UNDP-support, the Palestinian Ministry of Planning and International Cooperation launched in the 1990s the Palestinian Scientists and Technologists Abroad (PALESTA) network, and this has developed a database on 1,200 Palestinian diaspora scientists.

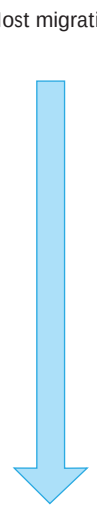
Source: Muhammad 'Arif, background paper for the Report, in Arabic

and security conditions offered by oil-producing Arab countries have become a pull factor for Arab and global human capital that competes with the attractions of Western states. Moreover, these oil-producing countries are in close geographic proximity to a number of Arab countries that are incapable of holding on to their human capital. The circulation of Arab human capital has in recent years helped to develop Gulf universities and knowledge-based and research institutions that in turn have helped to improve Arab knowledge performance. The circulation of Arab human capital is an alternative in the field of knowledge to the flight of human capital from the Arab region. For the sake of objectivity, it must be acknowledged that the movement of scientists within the Arab world is, overall, a positive phenomenon: it does not deplete the store of Arab knowledge but maintains it and contributes to its circulation and development.

TABLE 5-11

Human capital flight index[28]

Country	Human capital flight (scale of 1-7)
Syria	2.3
Egypt	2.3
Mauritania	2.4
Algeria	2.4
Jordan	2.8
Morocco	3.1
Oman	3.9
Tunisia	3.9
Saudi Arabia	4.6
Bahrain	4.7
Kuwait	5.4
UAE	5.6
Qatar	5.7



Source: World Bank, Knowledge Assessment Methodology (KAM), 2008

THE SOCIAL AND ECONOMIC IMPACT OF INNOVATION

Production in the fields of knowledge, science, and technology is not sufficient to guarantee the application of that production to the relevant economic sectors. The transfer of knowledge from an innovator to a beneficiary consists of many complicated stages. These include the assimilation of new developments and their positioning within frameworks that

The movement of scientists within the Arab world is, overall, a positive phenomenon: it does not deplete the store of Arab knowledge but maintains it and contributes to its circulation and development

BOX 5-11

Corporate Funding of Research and Development

Among the Arab examples of successful cooperation between scientists and the industrial sector in Arab Gulf countries are the partnerships between King Abdul Aziz City for Science and Technology (KACST) and pharmaceutical companies, and between Aramco and Saudi academic institutions and universities (120 projects in 2002), as well as the cooperation between Sultan Qaboos University and the Muscat Knowledge Oasis, between the Kuwait Institute for Scientific Research (KISR) and the Kuwaiti oil company, among Zayed University, IBM corporation, and the Innovation Centre in the Dubai Internet City (Smart Square), and among UAE University and several petroleum companies and aluminium factories.

As part of its cooperation with the Arab Science and Technology Foundation in al-Shariqa, Abdul Latif Jamil Limited, a Saudi Arabian company, has offered since 2005 competitive funding for projects proposed by Arab researchers working in technological research and development. The value of support offered annually to each project is $50,000, totalling a sum of a million dollars of funding a year for research in the medical sciences, engineering, and other related applied sciences. Intellectual property rights and patents ensuing from this research follow specific programme regulations. To date, funding has been provided for fifty-three projects, and cooperation between the institute and the company has been ongoing for four years. In addition, a third of the Abdul Latif grants are to be allocated for research proposals that put forth solutions to problems faced by the poor, which supports the idea adopted by this report, that knowledge should be used for development.

Source: The Arab Science and Technology Foundation/the Abdul Latif Jamil Grant for Funding Scientific Research and Innovation in Technology in the Arab World, http://www.astf.net/site/arabic/zone/zone.asp?ogzid=10195; King Abdel Aziz City for Science and Technology, http://www.kacst.edu.sa/ar/default_ar.aspx; Kuwait Institute for Scientific Research, http://www.kisr.edu.kw/default.aspx?pageId=104.

TABLE 5-12

Trade in technological products

Country	Supply chain presence (scale of 1-7),[1] 2007	Hi-tech exports as a percentage of all manufactured exports, 2005[1]	Total trade in manufactured goods (percentage of GDP),[1] 2005	Venture capital availability (scale of 1-7)[2]
Saudi Arabia	4.3	1.3	20.8	3.7
Kuwait	3.4	1.0	19.0	3.8
UAE	3.9	10.2	74.7	4.3
Qatar	3.9	1.2	25.5	4.1
Bahrain	3.5	2.0	25.5	4.0
Oman	4.4	2.2	..	4.1
Algeria	2.6	1.0	15.6	2.2
Egypt	3.9	0.6	14.7	3.4
Tunisia	4.4	4.9	63.2	3.8
Morocco	3.8	10.1	37.7	3.0
Syria	3.9	1.0	22.2	2.5
Lebanon	..	2.4	32.9	..
Jordan	3.9	5.2	72.0	3.4
Mauritania	2.8	..	18.9	2.2
Malaysia	5.0	54.7	151.0	4.2
Turkey	4.3	1.5	38.6	2.5

Sources: [1] World Bank, Knowledge Assessment Methodology (KAM), 2008, on 10 June 2008; [2] The World Economic Forum, 2008b.

During the last two decades, the Arab world invested approximately $4,000 billion in gross fixed capital formation and more than $1,000 billion in human resources, without these major investments leading to growth at the same rates in the GNP

facilitate their adjustment and application to new innovative fields that ultimately form the practical measure of the social and economic impact of acquired knowledge.

The ability of countries to earn economic and social returns on knowledge in general is measured by the Competitive Industrial Performance index, which focuses, according to the United Nations Industrial Development Organisation (UNIDO) on four indicators: manufacturing value added per capita; manufacturing exports per capita; share of medium- and high-tech activities in manufacturing value added; and the share of medium- and high-tech products in manufactured exports (UNIDO, 2003).

One Arab expert estimates that, during the last two decades, the Arab world invested approximately $4,000 billion in gross fixed capital formation and more than $1,000 billion in human resources, without these major investments leading to growth at the same rates in the GNP (Zahlan, 2004).

Reviewing the Arab World Competitiveness Report 2007 and the 2008 World Bank indices, we see noticeable improvement by Gulf countries on the global competitiveness index. The Arab World Competitiveness Report placed the Arab countries within three groups, the third of which comprised forty states worldwide with innovation-driven economies that are in the third stage of development and which included four Arab countries (UAE, Qatar, Kuwait, and Bahrain). The second group, comprising countries with efficiency-driven economies, included five Arab countries (Tunisia, Oman, Jordan, Libya, and Algeria), with Egypt, Syria, Morocco, and Mauritania holding various ranks in the first group, which comprises countries with factor-

driven economies that are in the first stage of development (World Economic Forum, 2007, in Arabic).

The readiness of Arab production and service institutions for innovation is measured by a number of indicators (Table 5-12) that can be analysed as follows.

- The percentage of GDP made up of manufactured exports is declining in most Arab countries when compared with otherwise similar countries, with the exception of the UAE, where such exports account for 75 per cent of all trade, and Jordan and Tunisia, where it comprises 72 per cent and 63 per cent respectively. Perhaps the reasons for the success of these countries is the increased number of free industrial zones and preferential trade partnership agreements with European Union countries, the USA, and some Asian emerging economies .
- According to World Bank statistics, the UAE rated highest for hi-tech exports as a percentage of all manufactured exports (10.2 per cent), followed by Morocco (10.1 per cent) and Jordan (5.2 per cent).
- Most Arab countries score positive yet average rankings with regard to their supply chain presence via their engagement with the post-extraction stages of materials or their production, including the design and marketing of products and the provision of post-sale services. This is due to the growing conviction in the private sector that the competency of production institutions in assimilating new technologies must improve in order to maintain competitive positions in local and global markets.
- The position of most Arab countries hovers around the mid-point on the "venture capital availability" index,[29] with positive exceptions in the UAE, Qatar, Bahrain, and Oman. This mid-point ranking indicates the persistence of cautious policies among investors in Arab countries and their hesitancy to invest in new, innovative projects. Some signs of change are, however, beginning to appear, as manifested in initiatives sponsored by newly developed Gulf countries to bring together innovative Arab researchers and venture capitalists in the region to fund the shift from innovative projects to production.

THE DISSEMINATION OF KNOWLEDGE AND INNOVATION

Outside of educational institutions, Arab countries have made only modest efforts to transfer knowledge to the general public or to transfer either locally produced or imported knowledge to the production and service sectors

Outside of educational institutions, Arab countries have made only modest efforts to transfer knowledge to the general public or to transfer either locally produced or imported knowledge to the production and service sectors. The mechanisms of knowledge transfer remain limited in number and type, and even more so in impact on mainstream society. Among the most prominent mechanisms that have proved their viability and positive impact for the transfer of knowledge in newly developed and industrialised states alike are the following: industrial and technological cities; joint programmes between scientific research institutions and production sectors; business incubators; business development centres; specialised centres of excellence; houses of expertise; standardisation bodies; quality assurance certificates; general and specialised scientific media and information diffusion centres; international trade points; export promotion centres; industrial subcontracting centres; and exhibitions, seminars, and conferences, in addition to well-qualified and capable chambers of commerce and industry, and professional unions.

With the exception of the UAE, the percentage of GDP made up of manufactured exports is declining in most Arab countries when compared with otherwise similar countries

There is insufficient information on these mechanisms in Arab countries to allow a study of their development over time, especially with regard to efficiency and effectiveness. Nevertheless, a number of signs demonstrate a growing interest in such things, such as the organisation of a number of global technology exhibitions, organised by production or import companies, especially in the Gulf countries or Egypt, as well as major projects for

the construction of industrial cities that focus on the establishment of industrial infrastructure. However, these do not include the required mechanisms to select, transfer, and indigenise technology.

In the Maghreb and some Gulf countries, there are signs that some national companies and institutions are becoming convinced of the importance of investing in innovation by focusing on the training of specialised human resources, transferring and indigenising technology, and relying on local expertise. Thus in recent years, some Gulf countries have established strategic partnerships with a number of the world's best universities with the aim of establishing branches in the Gulf. Examples include the King Abdullah University of Science and Technology, Education City in Qatar, and the Dubai Knowledge Village. These partnerships include the establishment of specialised departments for scientific research in advanced fields of knowledge, as well as establishing research partnerships to form a "coalition of great minds, grand ideas, and daring ambitions, as a forum for thinkers from the East and West that will allow them to overcome the limits of geography, culture, and specialisation" in scientific research. While it is still early to judge these initiatives and their impact on the production of knowledge in the region, these are truly innovative initiatives, and it is hoped that they will include specific and realistic mechanisms for guaranteeing their sustainability, transferring the knowledge produced within them to the Arab world, and indigenising this knowledge in Arab institutions and society.

It is ironic that although the Arab world contains a wealth of skilled professionals and human capital, it is incapable of deploying this wealth optimally in production and development

If a general plan to improve Arab knowledge performance is to be proposed, the starting point lies in a move from the current major dependence on natural resources and an attempt instead to build a new economy

BOOSTING ARAB RESEARCH AND INNOVATION PERFORMANCE

The innovation pillar forms a major weak point in Arab knowledge performance. It is ironic that although the Arab world contains a wealth of skilled professionals and human capital, it is incapable of deploying this wealth optimally in production and development. This irony poses questions that can no longer be ignored: How has it been possible to make a relative quantitative breakthrough in the higher education system without that reflecting positively on innovative research activities? How is it possible to conceive of innovation without accumulating knowledge through scientific research? How can policies be devised for sustainable development, social security, and increased competitiveness without building on target-oriented scientific research programmes? How can scientific knowledge be built up without linking it to Arab and global stores of knowledge? How should we think about the preceding questions in light of the gaps in data, statistics, and indicators? How is it possible to be content to benefit from information and communications technologies without contributing to their production and development? How can we think about a qualitative breakthrough in research and development without establishing an effective partnership between the public and private sectors and among the constituencies of society, both men and women?

Perhaps no convincing answers to these questions exist, but it is time that they were posed and thought given to them. If a general plan to improve Arab knowledge performance is to be proposed, the starting point lies in a move from the current major dependence on natural resources and an attempt instead to build a new economy. This would be based on knowledge and rely on the following pillars:

- A large repertoire of human and intellectual capital based on a culture of competency and quality; a critical, capable, and proactive approach to thinking, and the capacity to deal with the complicated demands of a society that is growing increasingly dependent on knowledge.
- An efficient institutional system characterised by clearly defined and innovative mechanisms that function in effective and enabling environments capable of achieving knowledge growth and sustainable social development.

- Real and deep-rooted development in Arab education and scientific research, including a sufficient store of investment to guarantee quality education, the local production of knowledge, the assimilation and indigenisation of imported knowledge, and the rise of a culture that encourages innovation and initiative.
- Planning for the gradual transfer to an economy based on knowledge. This is a long-term ambition that requires a new, innovative, initiative-taking Arab mindset based on a positive approach to dealing with information and its technologies, highly competitive skills, professionalism in labor and production, and commitment to professional ethics.

Any strategy for improving Arab innovation and research performance must follow two parallel approaches. One is the short- and mid-term rationalization approach that requires infusing key economic sectors with high-level technology, with the goal of generating added values to their outputs and absorbing imported innovations. The other is the long-term innovative approach that revolves around indigenising new and advanced technology and then partnering in its local production. This strategy must draw on the general development goals of each Arab state, be accompanied by Arab cooperation in knowledge, and form a linked extension of the global knowledge store (see Chapter 6).

If scientific research and innovation suffer from a lack of funding in the Arab region, the time has come for the Arab private sector to provide it, not only as a national duty but as a necessity if the region is to be propelled in the direction of globalism. Numerous other methods exist for the funding of innovation. For example, one of the possible means of securing additional resources for scientific and innovative activity is to impose a fee of no more than one US cent per cellular phone call to be drawn automatically by operating companies and transferred to a joint fund to support scientific research. The goal of this direct participation in funding scientific research, however modest it may be, would be to achieve an added value that would contribute to improving Arab innovative performance.

A research and innovation strategy requires the ordering of priorities in a way that addresses the concerns shared by most Arab countries and which faithfully reflects the consensus of Arab and global literature in this field. Improving innovation performance, like improving knowledge performance, requires a political decision. This must be supported by vision and will that move in the direction of an opening up to democracy, political reform, and the liberation of intellectual and academic freedoms that will raise to international levels the standard of work in centres of knowledge production and innovation, be they universities or research centres.

Improving innovation performance, like improving knowledge performance, requires a political decision supported by vision and will that move in the direction of an opening up to democracy, political reform, and the liberation of intellectual and academic freedoms

Such institutions are the engines of national growth. They are bastions of critical thought and research, and they guarantee the creation of hi-tech companies. They also guarantee the generation of the products and ideas upon which society's security and progress depend. These institutions develop human resources that are distinctive in their professionalism and leadership, and which are capable of taking wise decisions. In contrast to companies, computers, factories, airplanes, and advanced service sectors, one cannot import universities or scientific centres of excellence, for such institutions can only be developed through an accumulative and interactive process between society and its human forces, reinforced by far-reaching vision, and in an open environment of professional commitment and high ethical standards.

In the final chapter of this report we seek to develop a general vision for the knowledge society and its establishment, including measures that will help in shifting the proposed vision from the level of aspiration to that of a search for channels and procedures necessary to facilitate its achievement.

End Notes

1 UNESCO Institute for Statistics online database, http://stats.uis.unesco.org/unesco/tableviewer/document.aspx?ReportId=143, on 13 January 2009.

2 As categorised by the World Bank's KAM, one of the most widely referred to and up-to-date indices. According to KAM, the four pillars of knowledge are innovation, education, information technology, and the knowledge environment/economic incentive regime. Index values range from zero to ten and express the relative position of the country in question compared to all other countries for which the index has been calculated. A decline in the value of the index with regard to a given country does not necessarily mean a decline in the values for the indicators entered to create the index. It may simply be a product of the fact that the values of these indicators have risen to a lesser degree than those of other countries that are jockeying for their place on the scale.

3 The innovation system consists of three variables: royalty payments, patents granted by the US Patent and Trademark Office (USPTO), and number of scientific and technical journal publications.

4 Resolutions of the 2007 Arab Summit, held in Riyadh.

5 Classification and analysis by Mu'in Hamza, Report core team member.

6 "The quality of scientific research institutions" is based on the ability of researchers to publish peer-reviewed scientific articles in international journals, to transfer the results of their research to production sectors, to preserve the environment and protect public health, to establish effective partnerships with various social sectors, and to attract funding from international programmes.

7 "Technology assimilation and technology readiness": the capacity of a private or public productive establishment to make the most benefit from the outputs of research and invention. The indicator likewise reflects the presence of an atmosphere conducive to research, the availability of specialised human assets, and the material and academic incentives that lead to innovation and invention.

8 The numbers in this paragraph are the estimates of Report core team member Mu'in Hamza, and derive from university bylaws and the evaluation instruments for full-time professors in most Arab countries.

9 As mentioned earlier, discrepancies exist among different international data sets. Such discrepancies may be attributable to differences in the definition of the term "researcher."

10 Website of the Standing Committee on Scientific and Technological Cooperation (COMSTECH) of the Organisation of the Islamic Conference, http://www.comstech.org/links/posters.htm, on 10 June 2009.

11 World Bank, Knowledge Assessment Methodology (KAM) database, http://info.worldbank.org/etools/kam2/KAM_pages5.asp, on 13 February 2009.

12 Statistical Institute, UNESCO, http://stats.uis.unesco.org/unesco/TableViewer/tableView.asp on 10 June 2009.

13 Analysis and calculation by Mu'in Hamza, Report core team member, based on data from COMSTECH and KAM.

14 The Sixth Framework Programme is the European Union's programme for research and technological development. It consists of initiatives undertaken by the EU to fund and promote research.

15 These include basic and applied, but not human and social sciences.

16 A significant proportion of research published in some Arabs countries is the work of researchers from other Arab or non-Arab countries. The reason for this is either the authors' residence in these countries or the fact that the incentives and facilities they offer are superior to that offered in the authors' home countries. As such, the numbers in this chart may give an exaggerated picture of the reality in some states, including those of the Gulf, and an underestimation of other states, such as Egypt and Iraq. The publication of scientific periodicals was stopped in Iraq during the decade of economic sanctions of 1991 to 2002, forcing Iraqi researchers either not to publish or to publish outside Iraq.

17 The scientific impact indicator reflects the value of scientific articles and their social impact.

18 Estimate of Report core team member Mu'in Hamza, based on a number of sources of information on Arab scientific publications from universities, research centres, and some private agencies that are repeated in most Arab studies without mention of a specific reference due to the lack of reliable statistics.

19 The numbers for patents registered with the USPTO found in the World Bank KAM indices may differ from those found in the national databases of various countries that are used in some regional studies.

20 The World Bank, KAM, http://info.worldbank.org/etools/kam2/KAM_page5.asp, on 13 February 2009.

21 These results were calculated based on data found in various chapters of the Report.

22 The National Council for Scientific Research, http://www.cnrs.edu.lb, on 12 December 2008

23 This book was later re-published under the title Architecture for the Poor: An Experiment in Rural Egypt.

24 World Bank, KAM database, http://info.worldbank.org/etools/kam2/KAM_page5.asp on 25 December 2008.

25 Studies published by Arab research centres (the League of Arab Countries, the conferences of Arab ministers concerned with human capital and its flight, and the Gulf Centre for Strategic Studies) show that the countries that draw the most human capital are Arab Gulf countries, some European countries (France, Germany, Spain, Italy, the Netherlands, Switzerland), the USA, Canada, and Australia. Scientifically qualified Arab human capital that migrates to the USA, Britain, and Canada forms 75% of all migrants, and the annual percentage of Arab university graduates who migrate is 25%. Global estimates suggest that the Arab countries suffer annual losses

of $1.57 billion due to human capital flight.

[26] The human capital flight indicator is to be found amongst the data in the World Bank's KAM database.

[27] The figure of $25 million is taken from World Bank data and includes Arabs working in all fields including scientific research. More research is needed on the circumstances of Arabs working in the field of research and innovation and the impact of their work, including their remittances, to Arab countries versus the economic, social, and scientific costs of their education and training and the resultant real cost of Arab human capital flight.

[28] The human capital flight index scores on a scale of 1 to 7 the responses of survey participants on their opinions as to whether the human capital and talent of a given country has migrated to seek better opportunities (1) or typically stays in its home country (7).

[29] Since the indicator runs from one to seven, the mid-point is 3.5.