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The Innovation Landscape in Arab Countries

A Critical Analysis

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I. BACKGROUND

Research and policy recommendations for development have long focused on technology transfer, especially for the purpose of industrialization. At the turn of the century, the focus moved towards information and communication technology (ICT): making available the benefits of new technologies, especially ICT, was a clear target of the Millennium Development Goals (MDGs, target 8F). Today, achieving a knowledge economy is a key objective for developing countries.

Recently, innovation has become a principal aspect of development. Goal 9 of the 2030 Agenda on industry, innovation and infrastructure stipulates building resilient infrastructure, promoting inclusive and sustainable industrialization, and fostering innovation. Consequently, innovation has become a core aspect of development, like infrastructure and industrialization. Research centres and international organizations have undertaken intensive activities to analyse the impact of innovation on countries' production systems and its contribution to development, so as to derive policy recommendations, especially within the context of the 2030 Agenda.

ESCWA is part of this process in the Arab region, and tackles issues related to ICT, knowledge-based economies and societies, and to science, technologies and innovation (STI). It has clearly identified the opportunities that ICT, knowledge and innovation bring to development. In a 2013 report,[1] ESCWA identifies several challenges facing Arab counties, including limited funding for university research from internal and external sources, and a lack of post-doctoral fellowships and grants even at top universities. Consequently, Arab countries lose tremendous research potential at the university level.

ESCWA has organized a number of meetings to discuss innovation in the Arab region. The 2015 regional meeting[2] recommended a thorough assessment of national innovation systems, focusing on how effectively they facilitate innovation and on practical measures to improve their operations. It also proposed that supply- and demand-side innovation policies should be developed and periodically reviewed. Such efforts will be supported by ESCWA, and the STI policy reviews provided by UNCTAD and other international organizations. The meeting also requested the establishment of a regional network of innovation policy institutions.

The need to shift from ICT and knowledge policies towards comprehensive innovation policies is a result of weaknesses in Arab countries' paths towards a knowledge economy. The World Bank Knowledge Economy Index[3] shows that most Arab countries are below world averages (figure 1).

UNCTAD has noted the "modest performance" of the national innovation systems in the region,[4] stressing that innovation is central to economic development in today's world. Thus, national development policies in Arab countries should include innovation policies that stress the following three key aspects: (a) the importance of taking into account global knowledge and technology in national competencies and when drawing inspiration from local culture and identity; (b) the importance of political leadership that inspires all economic sectors; (c) the need for innovation that targets sustainable development. The experiences of successful countries,[5] such as South Korea, show how development is strongly linked to industrial policies, transforming an economy from factor-driven to investment- and innovation-driven.

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[1] ESCWA Technology Centre, 2014.

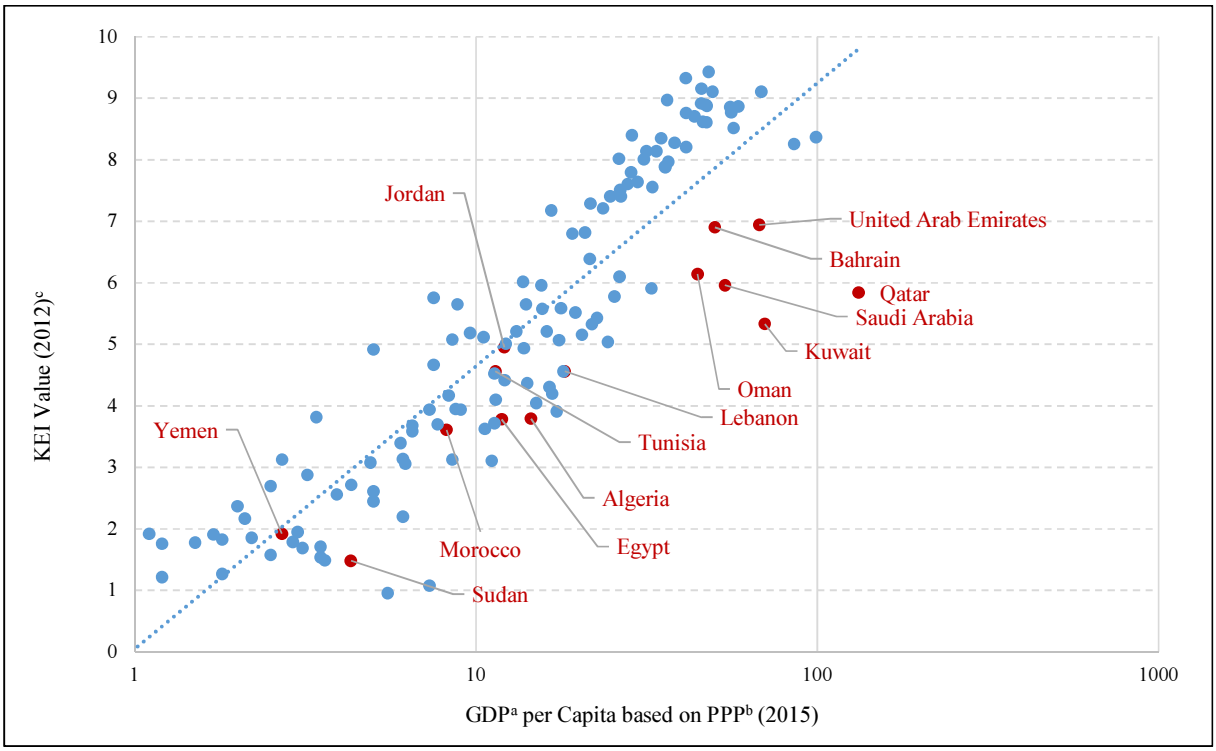
[2] ESCWA, 2015a.

[3] The Knowledge Economy Index – an aggregate index – represents the preparedness of a country or region to compete in the knowledge economy. The Index is the average of four sub-indexes, namely the Economic Incentive and Institutional Regime, Innovation and Technological Adoption, Education and Training, and Information and Communications Technologies. For more information, see https://knoema.com/atlas/topics/World-Rankings/Knowledge-Economy-Index/Knowledge-Economy-Index.

[4] Gonzalez-Sanz, 2015.

[5] Mrayati, 2015.

Figure 1. The knowledge economy



Sources: World Bank, 2012; World Bank, 2017.

Notes: [a] In thousands of United States Dollars.

[b] PPP = Purchasing Power Parity.

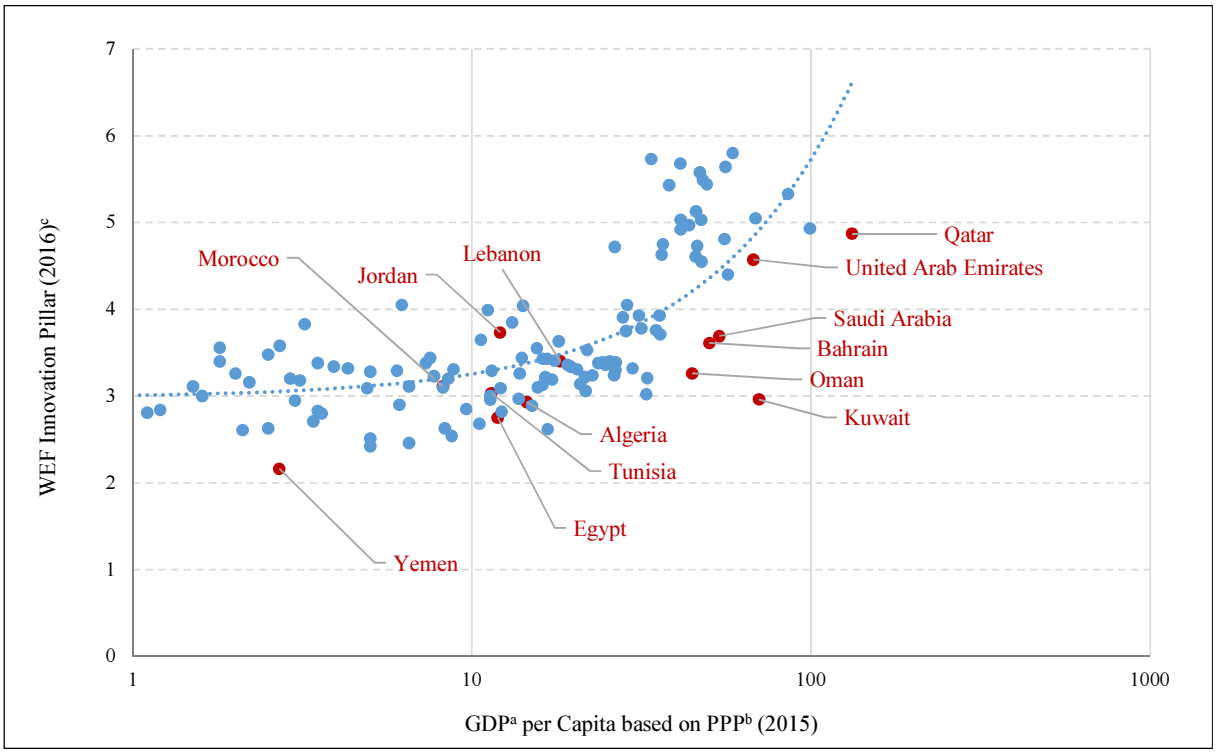
[c] The KEI value is the simple average of the scores of the four knowledge economy sub-indexes. The KEI was last updated in 2012.

At the global level, there are a number of indexes for innovation measurement, including the Global Competitiveness Index (figure 2) and the Global Innovation Index, which will be used in the present report to assess the innovation landscape in the Arab region.

The World Economic Forum considers Bahrain, Qatar and the United Arab Emirates as stage 3 economies, i.e. innovation driven; Egypt, Jordan, Morocco and Tunisia as stage 2 economies, i.e. efficiency driven; and Lebanon, Oman and Saudi Arabia as in transition from stage 2 to 3. Mauritania and Yemen are in stage 1, i.e. factor driven; while Algeria and Kuwait are transitioning from stage 1 to 2.

ESCWA has recognized the need to work on a specific set of indicators for Arab countries, and to assess their innovation landscape through a comprehensive framework, focusing on innovation policies as vital for inclusive and sustainable development.

Figure 2. Innovation and the economy



Source: World Bank, 2017; World Economic Forum, 2016.

Notes: [a] In thousands of United States Dollars.
[b] PPP = Purchasing Power Parity.
[c] Average for a series of indicators scored between 1 and 7 (best).

II. THE INNOVATION LANDSCAPE AND SOCIOECONOMIC DEVELOPMENT

There are many schemes to explore the elements of a national innovation system. For example, UNCTAD[6] and OECD[7] have developed models that countries can implement to enhance their national innovation landscape. The difference between these schemes lies in whether the innovation system's "core engine" is based on the productive sectors or on the Government.

In 2016, ESCWA produced a comprehensive report on innovation policies. The ESCWA innovation policy framework is tailored to the needs and priorities of the Arab region and is built around two major components: the innovation vision, and the national innovation system. It also identifies the various stakeholders involved in actualizing innovation. Overall, it places innovation in the context of inclusive sustainable development, ensuring that policies consider Arab countries' development goals on economic, social and environmental issues in every component of national innovation systems.[8]

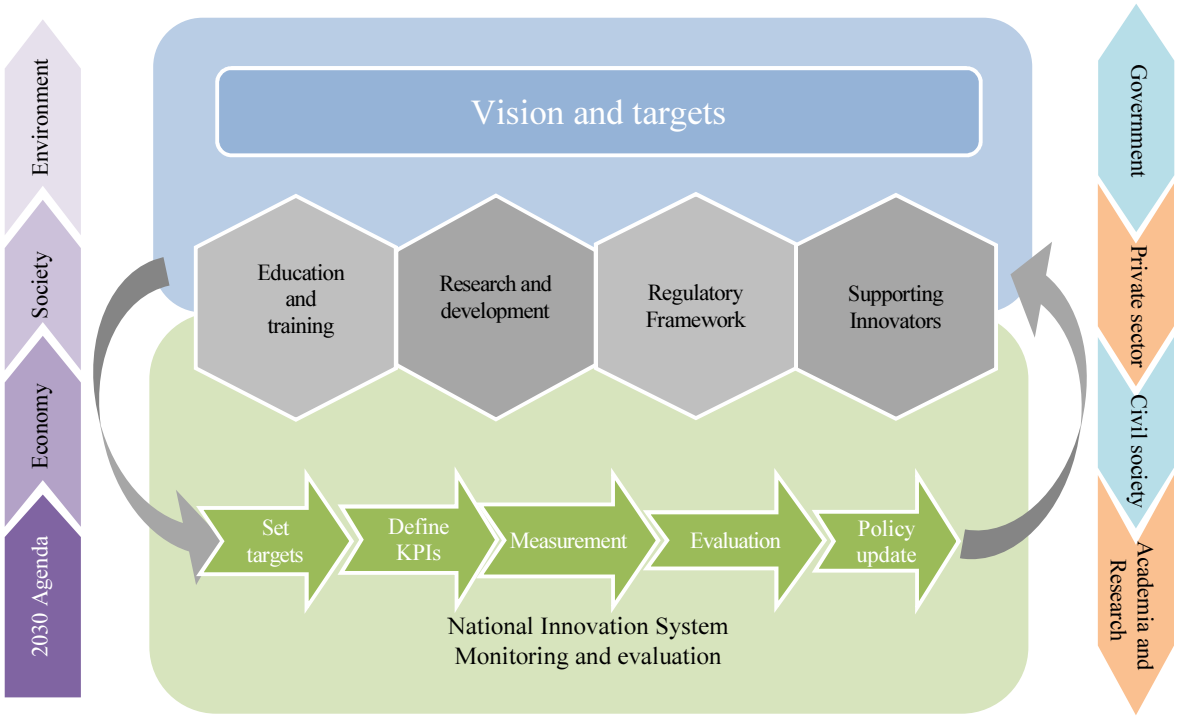
To determine the innovation landscape, it is necessary to understand the issues that fuel its various interpretations, such as the complexity of innovation issues, the role of Government, and the impact on socioeconomic development.

[6] UNCTAD, 2011.

[7] OECD, 2014.

[8] ESCWA, 2016.

Figure 3. Innovation policy framework for inclusive sustainable development



Source: ESCWA, 2016.

Innovation issues are complex and innovation policy is broad in its scope. It is not only concerned with the strengthening the supply side of knowledge and technology, but also needs to consider the demand side (the use that firms, farms and public sector entities make of knowledge and technology in the production of goods and services), as well as interactions between the two sides and the development of enabling framework conditions.[9]

However, countries differ greatly in their interpretation of the role of Government in innovation. Its complexity and rapid evolution require strong "management", although this is not a role traditionally practised by the State. New ways should emerge for Government and industry to work together, while avoiding undue influence from vested interests, with Governments supporting general purpose technologies so as not to impede downstream competition or infringe State aid rules in international treaties.[10] This support is also increasingly challenge-focused, as Governments seek to redirect technological change from path-dependent trajectories towards more socially and environmentally beneficial technologies. Moreover, this change presents Governments with new challenges in managing innovation rents at a time when there is a fiscal crisis, a confidence crisis in Governments, and growing significance of non-State actors.

A strong Government role is vital to facing threats posed by globalization, environmental changes, exclusion and disruption caused by innovations and new technologies at the social, economic and political levels. Some innovations and new technologies can lead to the failure of major industrial sectors,[11] or can create rent-

[9] UNCTAD, 2011.

[10] Warwick, 2013.

[11] Christensen, 1997; Christensen and Raynor, 2003.

seeking monopolies, as in the case of mobile phones and Internet provision. Government regulation across the world has been challenged by disruptive innovation,[12] as demonstrated by Uber, Amazon and Google.

Today, the socioeconomic environment is an integral part of an innovation system. Technological innovation is a main source of employment dynamics, particularly in the creation and destruction of jobs, both in developed and developing countries.[13] Some observations show that innovative firms tend to create more jobs than non-innovative firms. However, other measurements contradict such results, and show that process innovation leads to direct laboursaving.[14]

In developed countries, there is strong awareness that, despite the opportunities from digital jobs and the wider use of digital tools, technology also brings risks.[15] Some jobs might be digitized to varying extents, with some workers or part of their functions being replaced by technology. The ability to take advantage of opportunities will also vary among individuals: workers with higher level skills are more likely to benefit, while those with weaker skills are more exposed to lower job quality or job loss.

Concern about the link between innovation and employment is greater in developing countries,[16] including Arab countries, which have substantial informal economies. Informality dominates non-farm and non-public sector employment, and constitutes the main dynamic of employment and thus of the social and political crises that Arab countries have been experiencing since 2011 because of the "youth tsunami".[17]

The World Intellectual Property Organization (WIPO) is assessing and measuring innovation in the informal economy to derive related policies.[18] WIPO is an international network actively defending the rights of informal workers, especially women, which helped change the International Labour Organization's (ILO) vision on informality. Such effort tackle disregard for intellectual property rights in the informal sector, where innovations, such as mobile banking, have spread rapidly.[19]

These issues are significant for determining and properly assessing the innovation landscape in Arab countries at the national and the regional levels. The innovation landscape should therefore be investigated based on the following two concepts and their components:

- An innovation vision, expressed at the highest political level, spelling out 'what for', 'by which means' and 'by whom'. The vision is essential to prioritising policies and embedding them within a country's development targets, including the Sustainable Development Goals (SDGs);
- A national innovation system, which entails interaction between the Government, the private sector, civil society, academia and research centres, to develop, protect, finance and/or regulate new science and technology.[20]

[12] Vanoverschelde and others, 2015.

[13] Alonso-Borrego and Collado, 2002.

[14] Vivarelli, 2015.

[15] World Bank, 2015.

[16] Kraemer-Mbula and Wunsch-Vincent, 2016.

[17] Aita, 2015.

[18] Charmes and others, 2016.

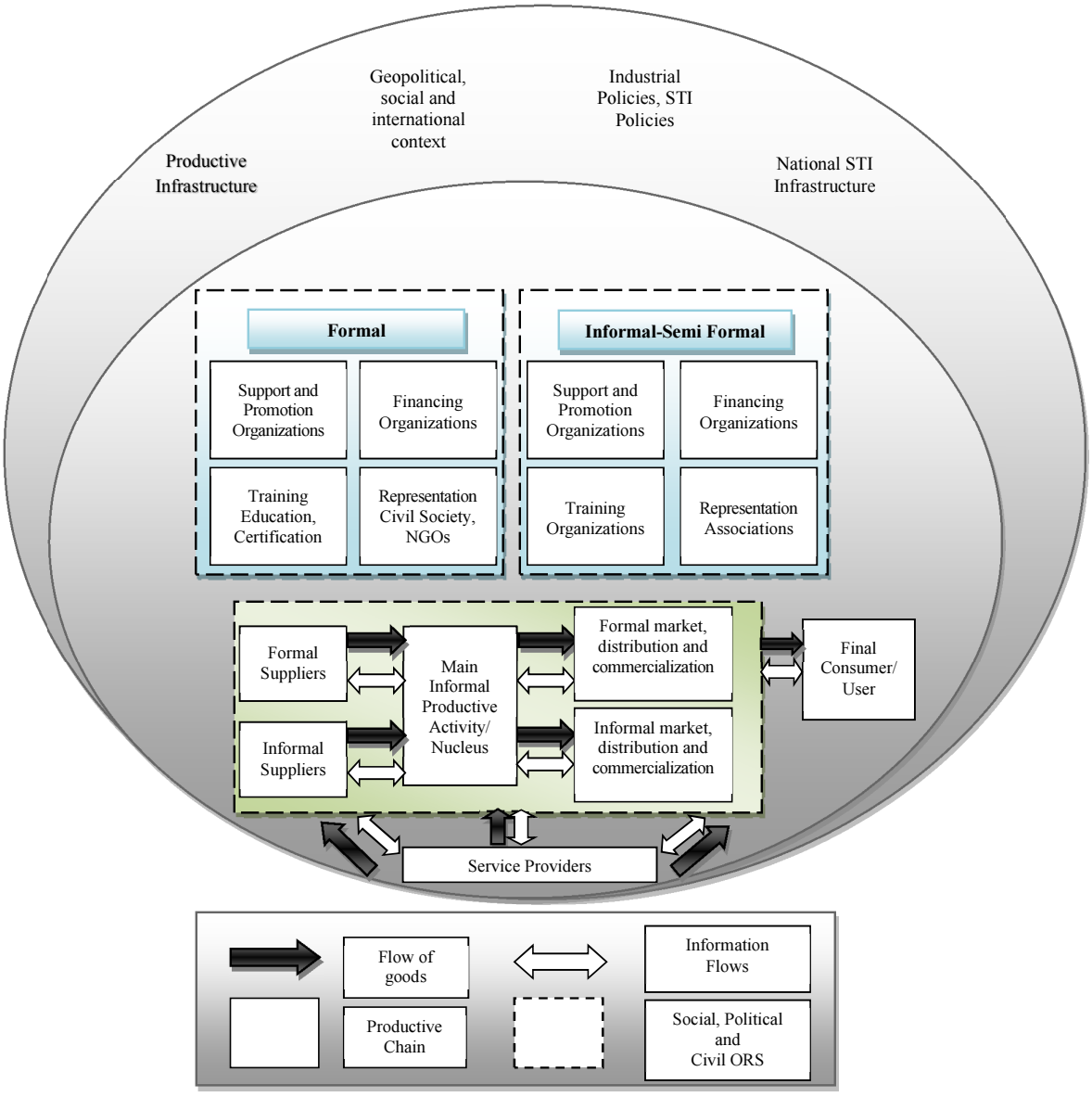
[19] Bill and Melinda Gates Foundation, 2016.

[20] UNCTAD, 2011.

Informal economy in African innovation frameworks

A framework has been developed placing the informal economy within the innovation framework of African countries (figure below).[a] An African Observatory of Science, Technology and Innovation has also been created for innovation policy analyses on the continent. It has assessed both national production of innovation and cooperation between African countries, and showed that South Africa is the leader in scientific collaboration between African Union members, followed by Egypt, Tunisia and Nigeria.[b] It interacts with Agenda 2063, for which the New Partnership for Africa's Development (NEPAD) was created.

The informal economy in the innovation framework



Source: De Beer and others, 2013.

Notes: [a] De Beer and others, 2013.
[b] Vroh, 2015.

To fully understand the innovation landscape, the national innovation system should be broken down into the following micro-level components:

- A core engine linking education, research centres and the productive system of a country; this core engine is where technology and knowledge transfers take place to develop products and services for the market;
- An innovation framework that builds on an institutional and regulatory environment;
- Innovation infrastructures, including ICT, energy, and transportation;
- An economic environment for innovation, involving markets, financial systems, foreign direct investments, government incentives and taxation;
- A socioeconomic environment for innovation;
- A measurement and policy monitoring system.

III. GLOBAL INNOVATION INDEX AND THE INNOVATION LANDSCAPE IN THE ARAB REGION

A. GLOBAL INNOVATION INDEX

One of the most comprehensive databases to compare the innovation landscapes of countries is the Global Innovation Index (GII), developed by Cornell University, the European Institute of Business Administration and WIPO. It is a composite index with two sub-indexes, one focussing on innovation input and another on innovation output. There are seven innovation pillars, namely institutions, human capital and research, infrastructure, market sophistication, business sophistication, knowledge and technology output, and creative output, divided into sub-pillars with individual indicators. This framework is revised annually. In 2016, there were 82 indicators from 30 resources used to analyse innovation in 128 national economies.[21]

Table 1. Innovation landscape and GII pillars

Innovation landscape / GII Pillar	Vision	Core engine	Framework	Infrastructure	Economic environment	Socio-economic
1. Institutions			■			
2. Human capital and research		■				
3. Infrastructure				■		
4. Market sophistication					■	
5. Business sophistication		■				
6. Knowledge and technology outputs		■			▒	
7. Creative outputs		▒				■

Source: Compiled by author.

[21] See https://www.globalinnovationindex.org/.

The Index and its sub-indicators address the broad nature of issues in an innovation landscape, except socioeconomic aspects. However, the database is limited and cannot assess the innovation vision at top government levels, but it does include the various elements of national innovation systems and allows comparison between countries regionally and globally.

To analyse the innovation landscape based on GII indicators, it is necessary to map the elements of the innovation landscape to the GII framework. Table 1 provides the required mapping, with the landscape components that correspond to one or more pillars in black, and those that relate partially to the sub-elements of a pillar in grey.

B. Overall performance of Arab countries

GII scores vary significantly between countries, and are linked to the level of development and to citizens' revenue and wealth. Comparison between countries will therefore be made based on gross domestic product (GDP) per capita purchasing power parity (PPP) in United States dollars for the year 2015, where data are available.[22]

The 2016 scores (figure 4) show a general trend, where the Index value increases rapidly after a certain level of GDP/capita, with moderate deviations between countries. Arab countries[23] (in red) are divided into three groups: low, middle and high income. Medium income Arab countries perform at the global average, while low and high income Arab countries rank well below other countries with similar GDP/capita.

The 2016 GII report states that resource-rich Arab countries could rank higher. They exhibit relative shortcomings in important areas, such as institutions, market sophistication and business sophistication. This phenomenon is reminiscent of what has been called the "resource-curse" or the "paradox of plenty". Such countries are uniquely positioned to do better in the years to come.[24]

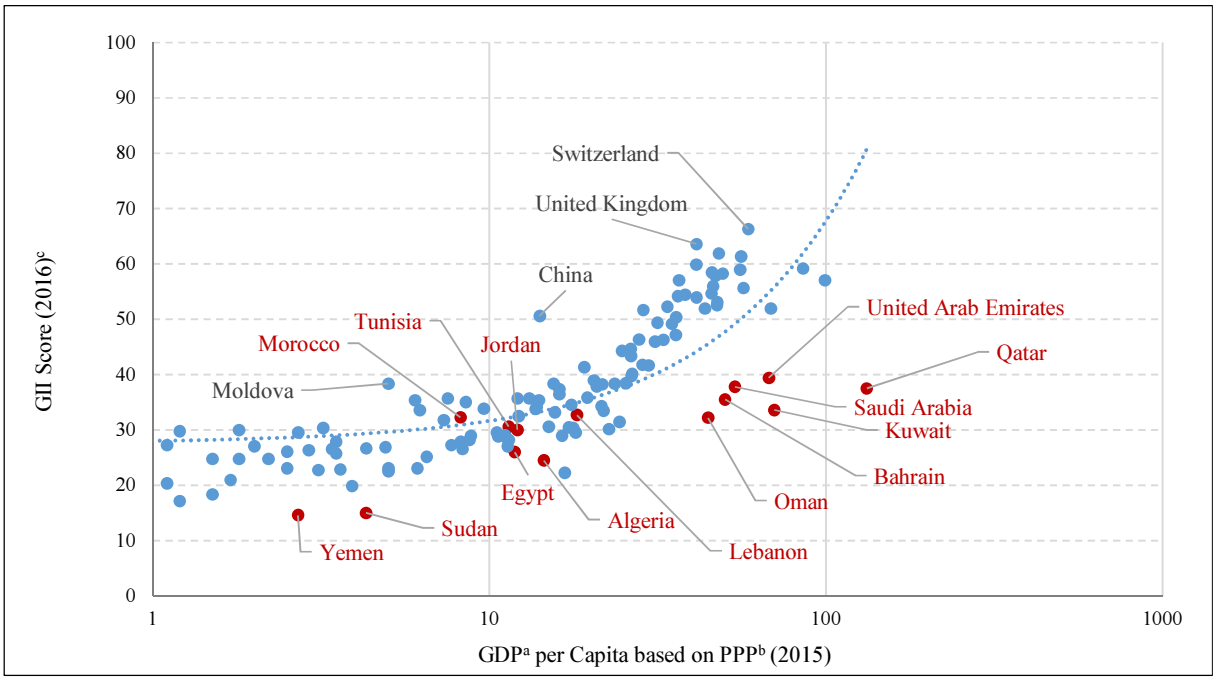
No champion in innovation emerges among Arab countries. The 2016 GII report's key findings note that improvements in the pillars of institutions, business sophistication, and knowledge and technology output have allowed sub-Saharan Africa to catch up with Central and Southern Asia in these pillars, and to overtake North Africa and Western Asia (i.e. Arab countries).

[22] Purchasing power parity: the number of units of currency of a country enabling the purchase of a quantity of goods or services, expressed in United States dollars. The database of GDP per capita PPP is extracted from http://siteresources.worldbank.org/ICPEXT/Resources/ICP_2011.html and http://knoema.fr/sijweyg/gdp-per-capita-ranking-2016-data-and-charts.

[23] GII institutions have collected no data on Libya and the Syrian Arab Republic since conflict began. Data are partially lacking for most Arab countries.

[24] Cornell University and others, 2016, p. 42.

Figure 4. Global Innovation Index 2016

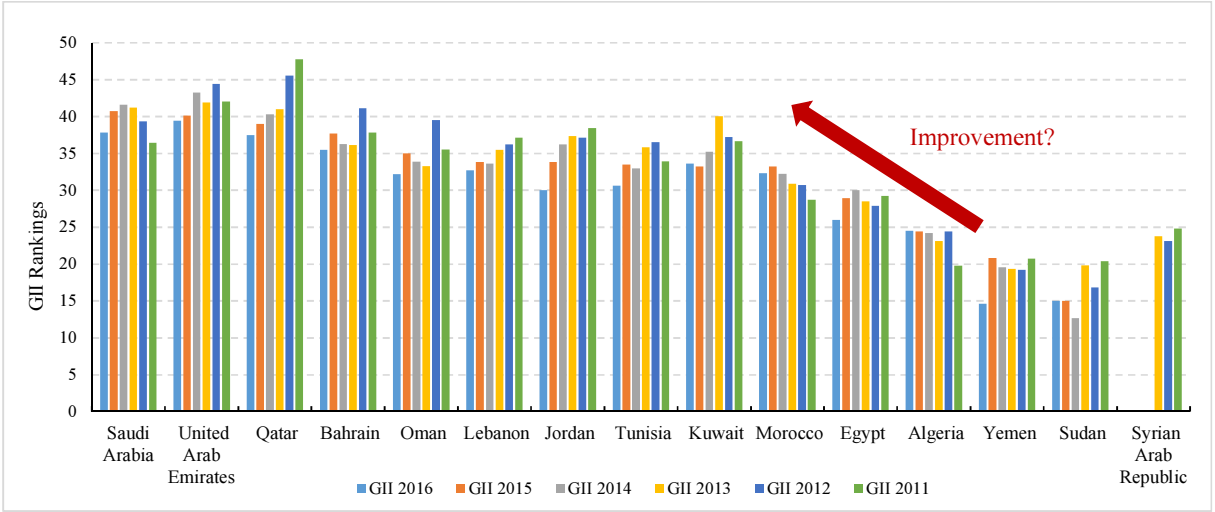


Sources: Cornell University and others, 2016; World Bank, 2017.

Notes: [a] In thousands of United States Dollars.
[b] PPP = Purchasing Power Parity.
[c] Each country is scored from 0 to 100 for every pillar in the Global Innovation Index.

In the overall Index, Western Asia and North Africa[25] ranked fourth after North America; Europe; South East Asia, East Asia and Oceania. Moreover, they have shown downward tendencies in the Global Innovation Index since 2011, except for Algeria and Morocco (figure 5).

Figure 5. Global Innovation Index evolution of Arab countries, 2011-2016



Source: Cornell University and others, 2016.

[25] Including Armenia and Israel.

C. CORE ENGINE OF A NATIONAL INNOVATION SYSTEM

The core engine of a national innovation system comprises high education institutions, research centres and production enterprises. It is covered in pillars 2, 5 and 6 of the Global Innovation Index, and partly by components of pillar 7.

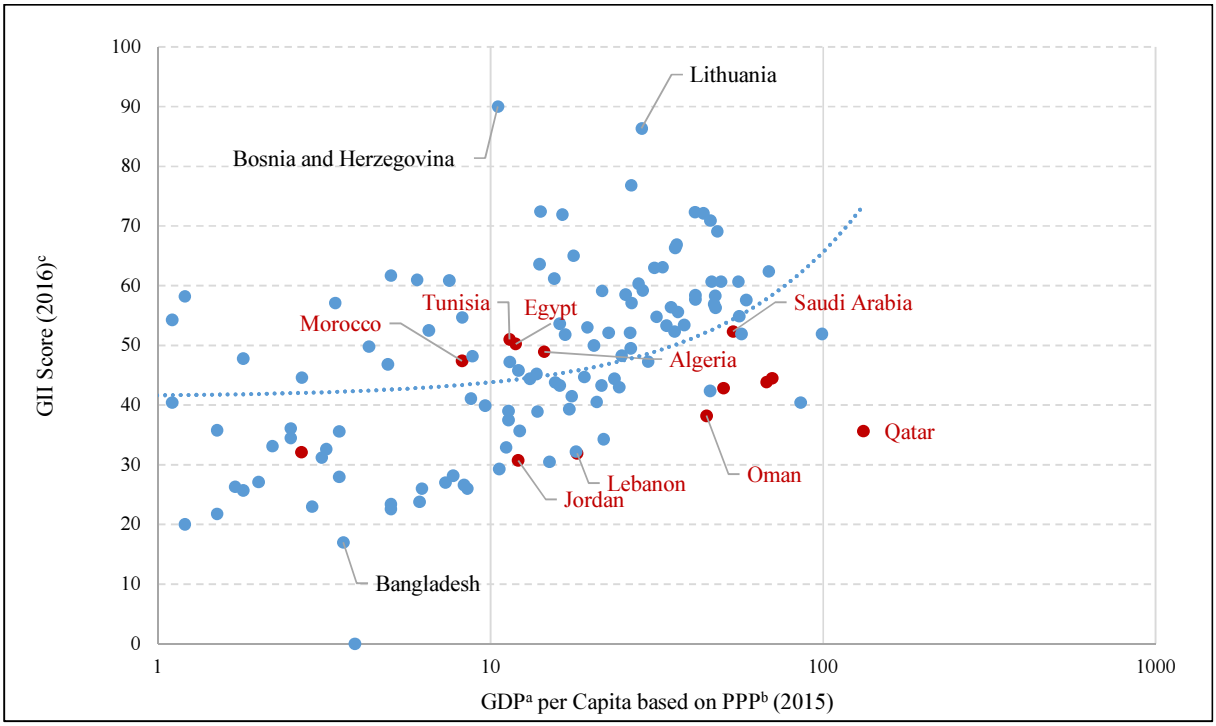
1. *Pillar 2: Human capital and research*

The second pillar of the Global Innovation Index combines data on base education (expenditure on education, Government expenditure on education, school life expectancy, assessment of reading, mathematics and science, pupil teacher ratio in secondary education), tertiary education (tertiary enrolment, graduates in sciences and engineering, tertiary inbound mobility), and research and development activities (researchers, gross domestic expenditure on research and development (GERD), global research and development expenditure of the top three companies, Quacquarelli Symonds ranking of top three universities). Most components are simple to measure and assess; however, many Arab countries have missing data on several issues.

World data on base education show a wide scattering, with weak links to wealth (figure 6). Some low and middle income countries challenge the pre-tertiary education index of developed countries.

The results for Arab countries follow this trend, where several middle-income countries (Algeria, Egypt, Morocco and Tunisia) surpass those with higher income. However, the education indexes for Jordan and Lebanon are lower than expected. This is due to the low ranking of both countries in terms of expenditure on education as a percentage of GDP and government expenditure on secondary education per pupil as a percentage of GDP per capita.

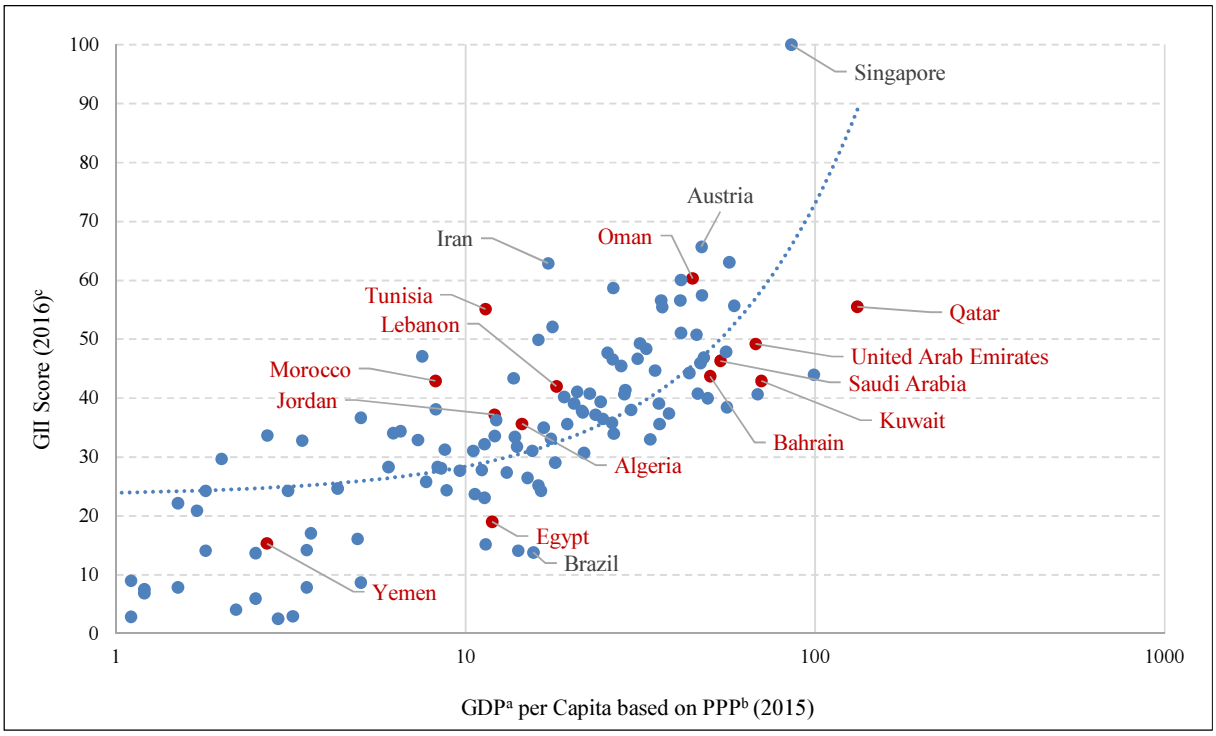
Figure 6. Pre-tertiary education, 2016



Sources: Cornell University and others, 2016; World Bank, 2017.

Notes: [a] In thousands of United States Dollars.
[b] PPP = Purchasing Power Parity.
[c] Each country is scored from 0 to 100 for every pillar in the Global Innovation Index.

Figure 7. Tertiary education, 2016



Sources: Cornell University and others, 2016; World Bank, 2017.

Notes: [a] In thousands of United States Dollars.
[b] PPP = Purchasing Power Parity.
[c] Each country is scored from 0 to 100 for every pillar in the Global Innovation Index.

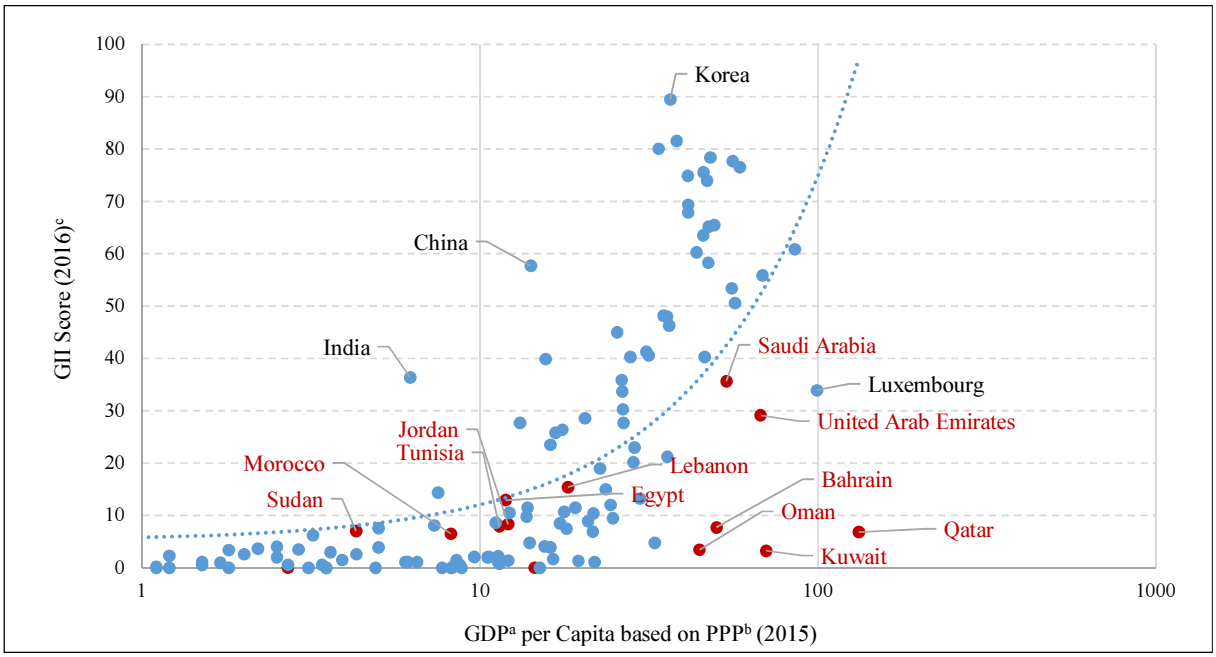
The tertiary education index (figure 7) follows different global trends, and the scores are less scattered. Most Arab countries rank well, except for Egypt and Qatar. Qatar ranks ninety-seventh because of weak tertiary enrolment at 15.8 per cent. Egypt ranks ninety-sixth because of low numbers of graduates in science and engineering as a percentage of total tertiary graduates (11.8 per cent).

For research and development (figure 8), global comparisons show that a GDP per capita threshold must be reached before a country's research and development index becomes significant.

Among Arab countries, Saudi Arabia ranks well. Although gross expenditure on research and development as a percentage of GDP is low (0.1 per cent, ranking the country 106th), Saudi Arabia is ranked thirtieth in terms of global research and development companies (average expenditure on research and development of the three top globally listed companies, in millions of United States dollars) and twenty-fifth in terms of the Quacquarelli Symonds university ranking average score of the top three universities. It also ranks well in terms of graduates in science and technology as a percentage of total tertiary graduates.

Combining the above indexes, Morocco and Tunisia rank highly in the index for human capital and research (figure 9). Tunisia ranks third worldwide in terms of graduates in science and engineering at 44.1 per cent, and Morocco ranks fourth at 34.9 per cent. Tunisia ranks twenty-third and Morocco tenth in terms of government expenditure on secondary education per pupil as a percentage of GDP per capita. However, both show weaknesses in global research and development companies and in the Quacquarelli Symonds university ranking.

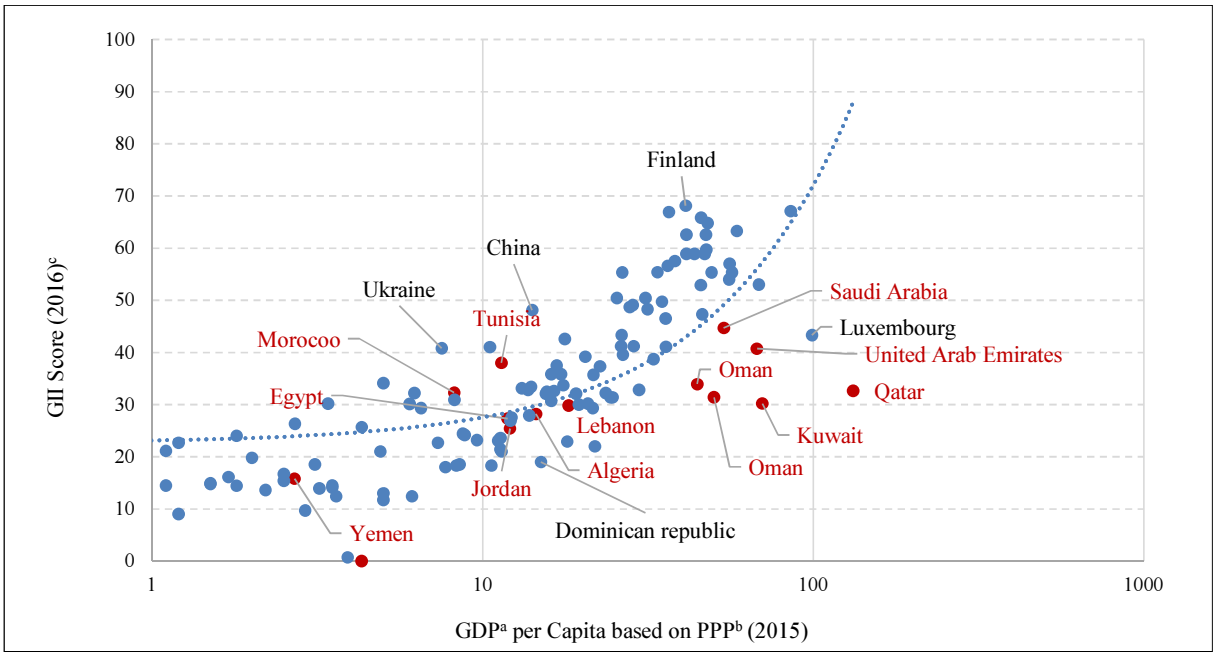
Figure 8. Research and development, 2016



Sources: Cornell University and others, 2016; World Bank, 2017.

Notes: [a] In thousands of United States Dollars.
[b] PPP = Purchasing Power Parity.
[c] Each country is scored from 0 to 100 for every pillar in the Global Innovation Index.

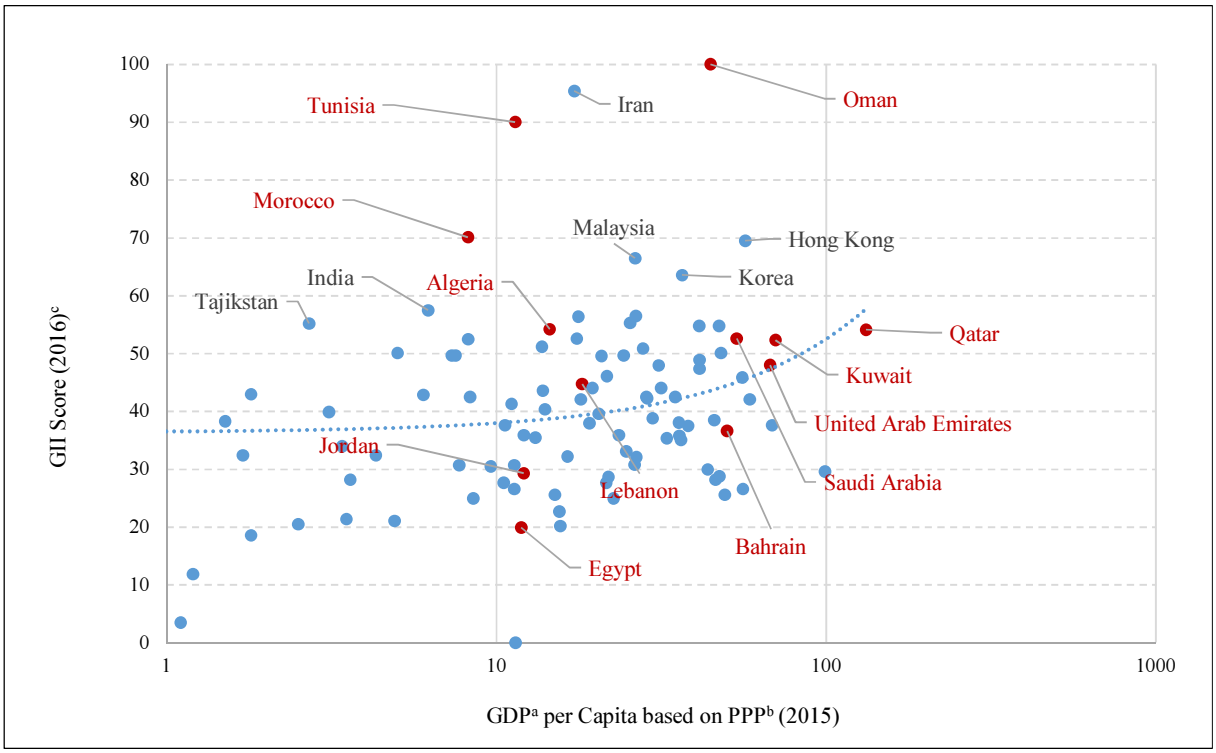
Figure 9. Human capital and research, 2016



Sources: Cornell University and others, 2016; World Bank, 2017.

Notes: [a] In thousands of United States Dollars.
[b] PPP = Purchasing Power Parity.
[c] Each country is scored from 0 to 100 for every pillar in the Global Innovation Index.

Figure 10. Science and engineering graduates, 2016



Sources: Cornell University and others, 2016; World Bank, 2017.

Notes: [a] In thousands of United States Dollars.
[b] PPP = Purchasing Power Parity.
[c] Each country is scored from 0 to 100 for every pillar in the Global Innovation Index.

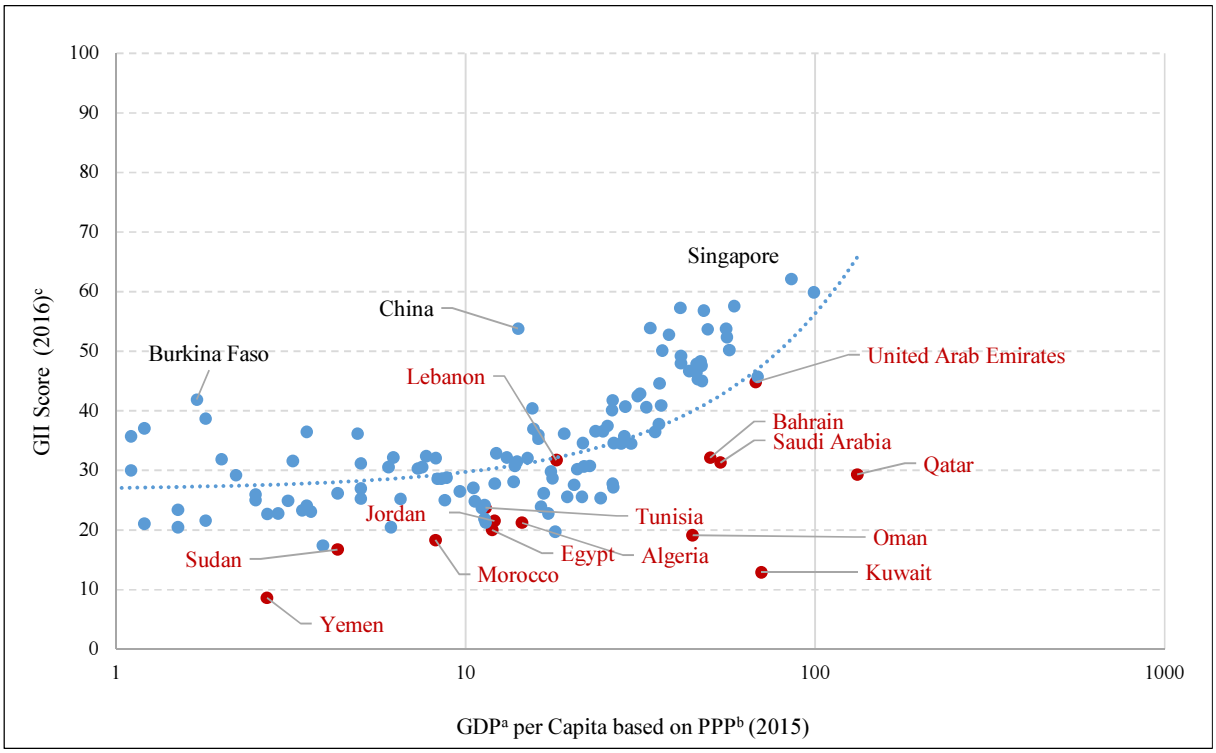
Many Arab countries have high rankings in terms of graduates in science and engineering. Oman ranks first worldwide, Tunisia comes third, Morocco is fourth, Algeria is fifteenth, Qatar is sixteenth, Saudi Arabia is eighteenth, Kuwait is twentieth, Lebanon is thirty-fourth and the United Arab Emirates is fifty-first (figure 10). Consequently, the challenge in Arab countries is not a lack of engineers and scientists, but rather the proper functioning of the core engine: cooperation between research and production.

2. *Pillar 5: Business sophistication*

The fifth pillar of the Global Innovation Index analyses the functioning of the core engine by assessing how firms enable innovation activities. It combines data on knowledge workers (percentage of knowledge intensive employment, percentage of firms offering formal training, GERD by businesses as a percentage of the GDP, GERD financed by businesses, women employees with advanced degrees), innovation linkages (university-industry research collaboration, state of cluster development, GERD financed from abroad, joint venture-strategic alliance deals, patent families), and knowledge absorption (intellectual property payments, high tech imports less re-imports, ICT services imports, foreign direct investment net inflows, research talent).

Comparisons (figure 11) show that most Arab countries are far below the global average and trends, except Lebanon and the United Arab Emirates. Most Arab countries display weaknesses in the majority of the pillar's components, especially university-industry research collaboration. Consequently, the main difficulty with the core engine of innovation in Arab countries lies in the weak capacity of Arab firms to absorb technologies, and in the link between research and businesses.

Figure 11. Business sophistication, 2016



Sources: Cornell University and others, 2016; World Bank, 2017.

Notes: [a] In thousands of United States Dollars.
[b] PPP = Purchasing Power Parity.
[c] Each country is scored from 0 to 100 for every pillar in the Global Innovation Index.

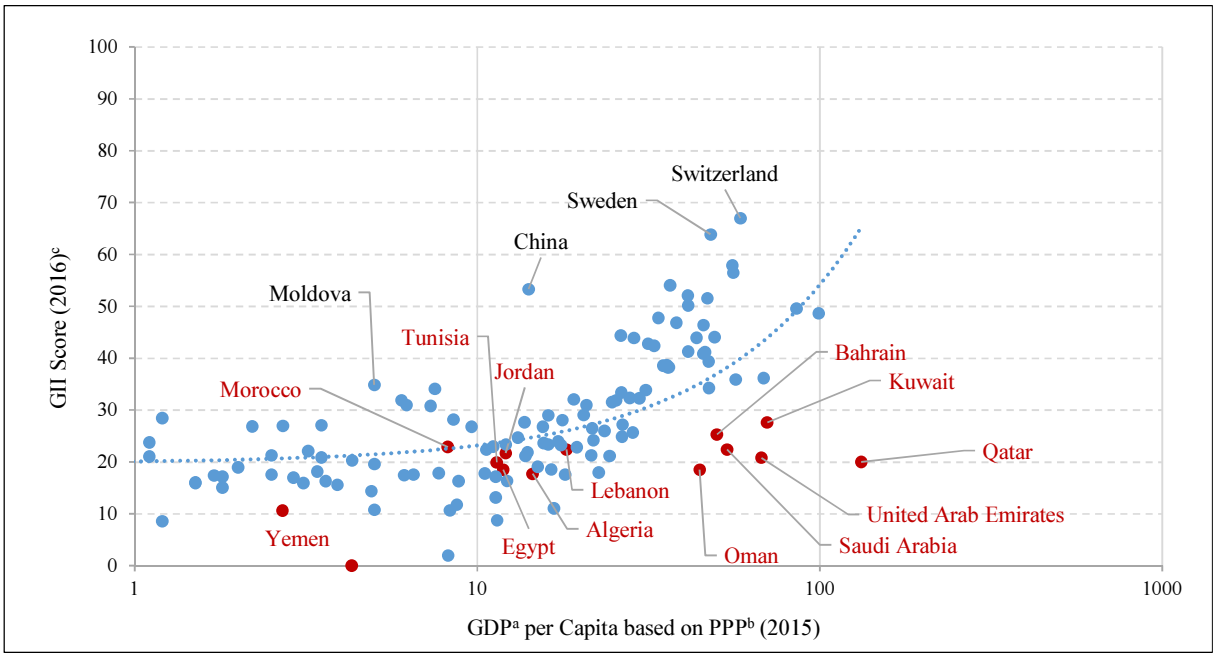
3. *Pillar 6: Knowledge and technology output*

This sixth pillar concerns the fruits of invention and innovation. It measures the output of the proper functioning of the core engine of a national innovation system. It comprises data on knowledge creation (patent applications, Patent Cooperation Treaty applications, utility models, scientific and technical articles, citable documents in h-index), knowledge impact (growth rate of PPP$ GDP/worker, new business density, computer software spending, ISO 9001 certificates, high and medium high-tech manufactures), and knowledge diffusion (intellectual property receipts, high-tech exports less re-exports, ICT services exports, foreign direct investment net outflows).

International comparisons (figure 12) show a higher than expected output for middle-income Arab countries, and a lower than expected output for high-income countries. The strength of the United Arab Emirates in terms of business sophistication is not reflected in terms of output. The weakness of Morocco in business sophistication is compensated by strengths in ICT service exports and in the growth rate of PPP$ GDP per worker.

This indicator also establishes a correlation between the core engine of innovation and employment, thus partially addressing the socioeconomic environment of innovation. It consists on the ratio of GDP PPP converted to 1990 USD values, divided by total employment in the economy. It is by nature a measure of productivity. International comparisons show higher values for low-income countries, and a tendency for the index to decrease with country wealth (figure 13), with a large scattering between countries. This correlation seems counter-intuitive; however, it takes into consideration that labour force participation is generally weak in low-income countries. The measure of total employment in the economy includes both formal and informal employment.

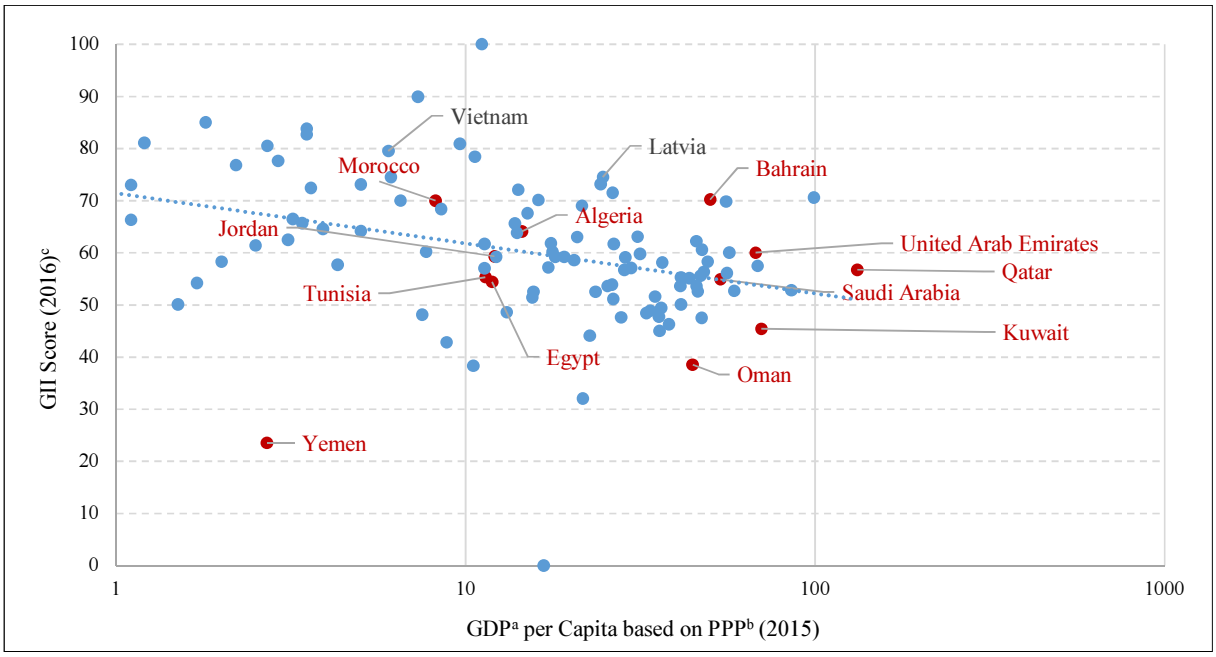
Figure 12. Knowledge and technology output, 2016



Sources: Cornell University and others, 2016; World Bank, 2017.

Notes: [a] In thousands of United States Dollars.
[b] PPP = Purchasing Power Parity.
[c] Each country is scored from 0 to 100 for every pillar in the Global Innovation Index.

Figure 13. Index on growth rate of GDP per person engaged, 2016



Sources: Cornell University and others, 2016; World Bank, 2017.

Notes: [a] In thousands of United States Dollars.
[b] PPP = Purchasing Power Parity.
[c] Each country is scored from 0 to 100 for every pillar in the Global Innovation Index.

Interactions between Arab countries are also important in this context. Many researchers from low and middle income Arab countries tend to migrate to high income countries, in search of better opportunities and living standards. Nevertheless, some ICT and high-tech products can be produced in low and medium income Arab countries, specifically for companies in high income Arab countries.

D. INSTITUTIONAL FRAMEWORK OF NATIONAL INNOVATION SYSTEMS

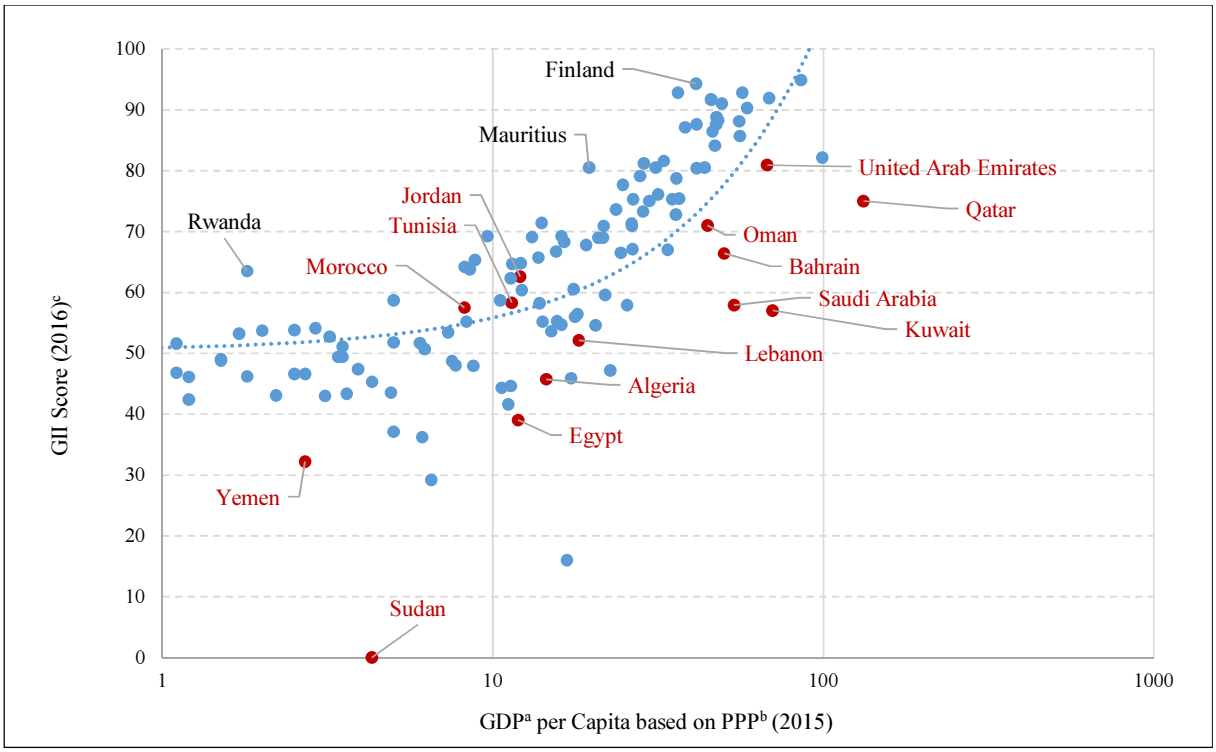
1. *Pillar 1: Institutions*

Pillar 1 on institutions has a significant impact on the Global Innovation Index (figure 15). It includes an assessment of the political environment (political stability, government effectiveness), the regulatory environment (regulatory quality, rule of law, cost of redundancy dismissal), and the business environment (ease of starting businesses, resolving insolvency, and paying taxes).

Figure 14 shows global scores for pillar 1, based mostly on subjective surveys. Several Arab countries perform better than the mean world curve (Jordan, Morocco and Tunisia), or close to it (Oman and the United Arab Emirates). However, all other Arab countries rank far below their international counterparts.

However, the situation of Arab countries under pillar 1 has significantly deteriorated since 2011. The index dropped from 67.5 in 2011 to 57.9 in 2016 for Saudi Arabia; and from 61.7 to 39 over the same period for Egypt, which has experienced major social and political events. The drop for Egypt concerns all three sub-pillars: political environment (41.0 to 19.9), regulatory environment (58.8 to 36.6), and business environment (85.3 to 61.2).

Figure 14. Institutions, 2016



Sources: Cornell University and others, 2016; World Bank, 2017.

Notes: [a] In thousands of United States Dollars.
[b] PPP = Purchasing Power Parity.
[c] Each country is scored from 0 to 100 for every pillar in the Global Innovation Index.

The innovation landscape depends strongly on the existence of country institutional frameworks. However, pillar 1 assesses the overall institutional environment rather than innovation per se. There is therefore a need to develop other ways to assess and measure more precisely institutional frameworks in a country's innovation landscapes, so as to analyse how innovation policies and the innovation institutional framework are implemented in practice.

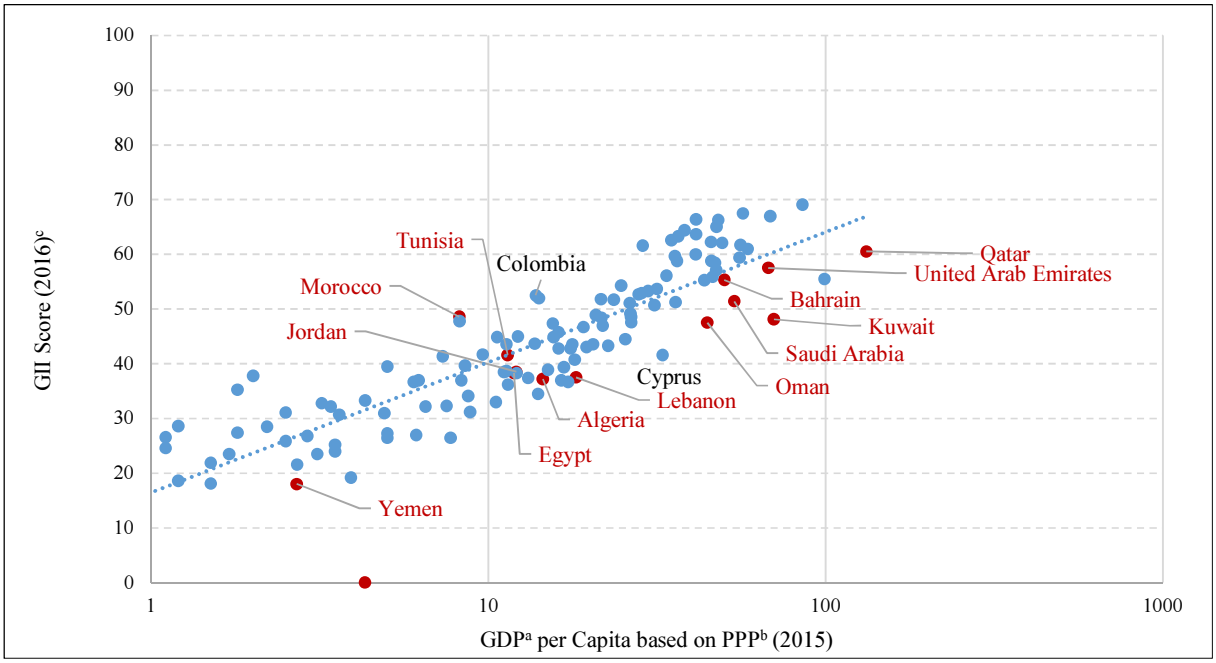
2. *Pillar 3: Infrastructure*

Pillar 3 on the infrastructure of a national innovation system is also an easy index to measure, as it includes data on ICT (ICT access, ICT use, government online services, e-participation), on the general infrastructure (electricity output, logistics performance, gross capital formation), and on ecological sustainability (GDP per unit of energy use, environmental performance, ISO 14001 environmental certificates).

Most Arab countries compare well in infrastructure (figure 15). However, major differences exist on several issues. A first example is the GDP (PPP $) per unit of energy use (oil equivalent), also known as energy intensity. International comparisons show large variations in energy consumption used to produce added value, with greater efficiency in some high-income countries (figure 16). However, other analyses found that, on average, Arab countries tend to have an energy intensity – two to three times that of the global average – which has increased over the last two decades. Oil-producing Arab countries (high income) experienced the largest waste in energy.

Another example is the environmental performance index, which assesses high-priority environmental issues in two areas: protection of human health, and protection of ecosystems (figure 17). Only Morocco and Tunisia show good performance, while high-income countries are underperforming on an issue where innovation is key for achieving sustainable development.

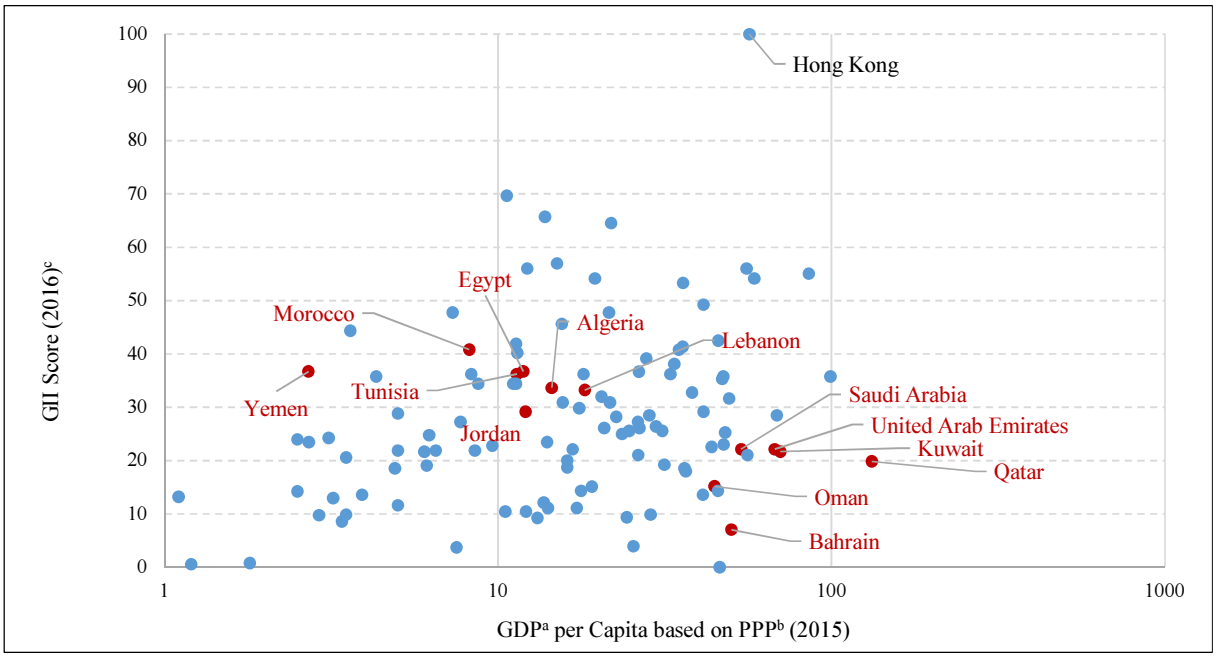
Figure 15. Infrastructure, 2016



Sources: Cornell University and others, 2016; World Bank, 2017.

Notes: [a] In thousands of United States Dollars.
[b] PPP = Purchasing Power Parity.
[c] Each country is scored from 0 to 100 for every pillar in the Global Innovation Index.

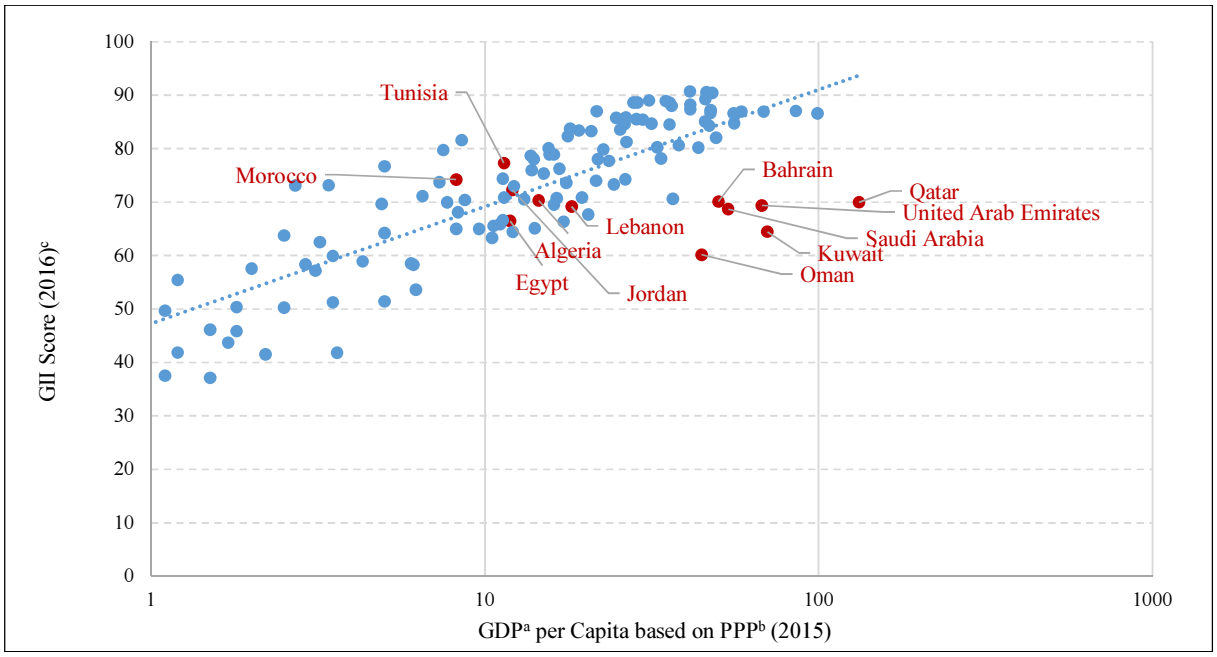
Figure 16. GDP per unit of energy use, 2016



Sources: Cornell University and others, 2016; World Bank, 2017.

Notes: [a] In thousands of United States Dollars.
[b] PPP = Purchasing Power Parity.
[c] Each country is scored from 0 to 100 for every pillar in the Global Innovation Index.

Figure 17. Environmental performance, 2016



Sources: Cornell University and others, 2016; World Bank, 2017.

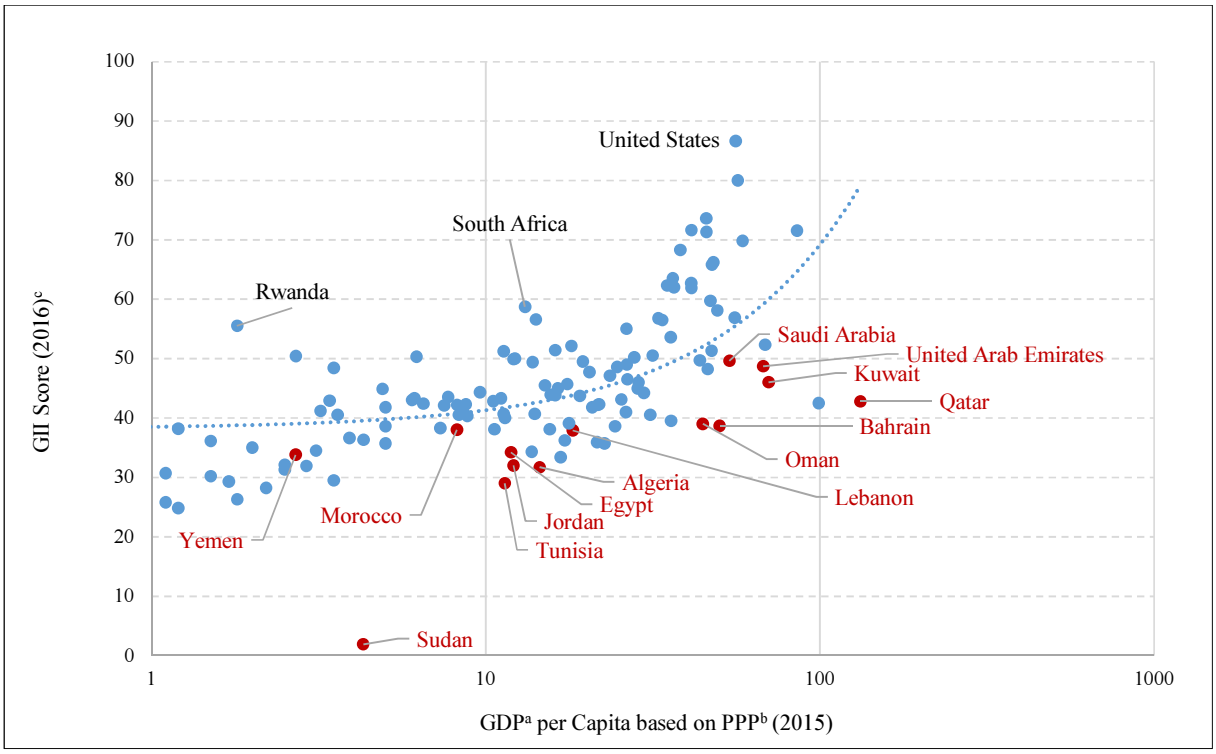
Notes: [a] In thousands of United States Dollars.
[b] PPP = Purchasing Power Parity.
[c] Each country is scored from 0 to 100 for every pillar in the Global Innovation Index.

3. *Pillar 4: Market sophistication*

The fourth pillar of the Global Innovation Index on market sophistication best represents the economic environment of a national innovation system. This pillar includes credit (ease of getting credit, domestic credit to the private sector as a percentage of GDP, microfinance gross loans as a percentage of GDP), investment (ease of protecting minority investors, market capitalization as a percentage of GDP, total value of stocks traded as a percentage of GDP, venture capital deals) and the scale of trade, competition and markets (applied tariff rate, intensity of local competition, domestic market scale).

International comparisons (figure 18) show all Arab countries below the global average. Most rank low or very low in terms of ease of getting credit,[26] including high-income countries. However, the level of domestic credit to the private sector as a percentage of the GDP[27] compares well with other countries. This inconsistency could be the result of concentrating bank credit on large firms and non-performing loans. The Arab region is also one of the weakest in micro-financing, with little effort to help new small businesses or support the formalization of informal enterprises.[28]

Figure 18. Market sophistication, 2016



Sources: Cornell University and others, 2016; World Bank, 2017.

Notes: [a] In thousands of United States Dollars.
[b] PPP = Purchasing Power Parity.
[c] Each country is scored from 0 to 100 for every pillar in the Global Innovation Index.

[26] See http://www.doingbusiness.org/~/media/WBG/DoingBusiness/Documents/Annual-Reports/English/DB16-Full-Report.pdf.

[27] See http://data.worldbank.org/data-catalog/world-development-indicators.

[28] See https://www.sanabelnetwork.org/home/.

Except for Kuwait and the United Arab Emirates, the Arab countries rank also low in terms of ease of protecting minority investors,[29] although many rank high in terms of market capitalization as a percentage of GDP[30] (Kuwait, Qatar, Jordan, Bahrain, Saudi Arabia, United Arab Emirates, Morocco, Oman and Egypt) and total value of stocks traded as a percentage of GDP. Only Lebanon, Jordan, the United Arab Emirates, Tunisia and Morocco rank well on venture capital deals. On average, Arab capital market activities are concentrated in large firms, mostly financial, real estate and telecommunications companies.

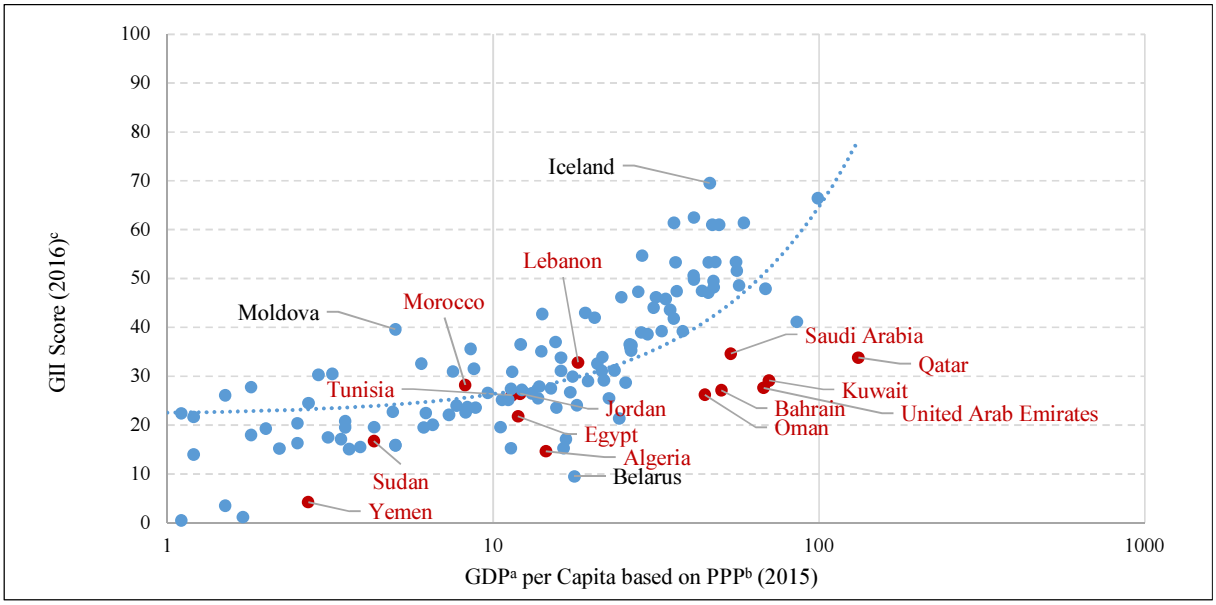
Arab countries also rank low on applied tariff rates, although most of them experience an intensity of local competition comparable to their international counterparts,[31] and some have large domestic markets scales (Saudi Arabia, Egypt, the United Arab Emirates and Algeria).

Economic environment, market sophistication, and institutions are the most critical aspects of a national innovation system.

4. *Pillar 7: Creative outputs*

The seventh pillar of the Global Innovation Index on creative outputs provides some insight into the socioeconomic environment of innovation. This pillar deals with intangible assets (trademark applications (per billion PPP$ GDP, industrial designs, ICT and business model creation, ICT and organizational model creation), creative goods and services (cultural creative service exports as a percentage of total trade, national feature films produced per million working age population, global entertainment and media market per working age population, printing and publishing output, creative goods exports), and online creativity (generic top level domains, country code top level domains, Wikipedia monthly edits, video uploads on YouTube).

Figure 19. Creative outputs, 2016



Sources: Cornell University and others, 2016; World Bank, 2017.

Notes: [a] In thousands of United States Dollars.
[b] PPP = Purchasing Power Parity.
[c] Each country is scored from 0 to 100 for every pillar in the Global Innovation Index.

[29] See www.doingbusiness.org/~/media/WBG/DoingBusiness/Documents/Annual-Reports/English/DB16-Full-Report.pdf.

[30] See http://data.worldbank.org/data-catalog/world-development-indicators.

[31] See http://reports.weforum.org/global-risks-2015/executive-opinion-survey-2014/.

Lebanon ranks high in creative goods and services, and Morocco and Qatar in intangible assets (figure 19). These indicators shed light on the socioeconomic environment, but only measure the cultural impact of new technologies although this impact goes far beyond the cultural and entertainment aspects. No GII indicator targets inclusiveness, or employment generation, or inequalities and disparities, for example. There is therefore a need to develop more detailed indicators to assess the impact of innovation and new technologies on the socioeconomic environment, as well as the manner in which the socioeconomic environment encourages innovation.

IV. REVIEW OF THE INNOVATION LANDSCAPE IN SELECTED ARAB COUNTRIES

Researchers have pointed out that the weaknesses of innovation in Arab countries mainly result from poor systems and a lack of sound policy instruments.[32] Systems are hampered by weak institutions, inadequate human and financial resources, a lack of appropriate economic structure owing to the prevalence of natural resources (rentier economies), labour market deficiencies, poor social development indicators, and a lack of incentives. Moreover, the weakness of public spending on research and development and innovation is cause for concern.

Such an assessment should be verified and documented, not only through the comparative GII indicators, which are largely insufficient as shown above, but also through a consistent analysis of the innovation landscape in Arab countries.

A. INNOVATION VISION

It is necessary to formulate clear innovation visions and strategies in Arab countries, and ensure their support by the highest authorities so as to ensure structural changes in the innovation system and redesign policy instruments.

A regional vision

No innovation strategy exists at the regional level (the League of Arab States, for example) similar to the one adopted by the European Commission in the European 2020 strategy.[33] The European Union recognizes that it is facing an "innovation emergency": it spends less on research and development than Japan and the United States; and its best researchers and innovators have moved to other countries. Under the new strategy, a European Research Council has been created with the following seven flagship initiatives:

- Innovation Union Initiative;[34]
- Youth on the Move;
- A Digital Agenda for Europe;
- Resource Efficient Europe;
- An Industrial Policy for the Globalization Era;
- An Agenda for New Skills and Jobs;
- The European Platform against Poverty.

[32] Nour, 2016.

[33] European Commission, 2010.

[34] See http://ec.europa.eu/research/innovation-union/index_en.cfm.

The Innovation Union Initiative sets out 30 action points, which periodically check and measure progress,[35] grouped under the following themes:

- Promoting excellence in education and skills development;
- Delivering the European Research Area;
- Focusing European Union funding instruments on Innovation Union priorities;
- Promoting the European Institute of Innovation and Technology as a model of innovation governance in Europe;
- Enhancing access to finance for innovative companies;
- Creating a single innovation market;
- Promoting openness and capitalizing on Europe's creative potential;
- Spreading the benefits of innovation across the European Union;
- Increasing social benefits;
- Pooling forces to achieve breakthroughs: European Innovation Partnerships;
- Leveraging policies externally;
- Reforming research and innovation systems;
- Measuring progress.

The priorities defined by the European Commission have been placed under the slogan "Open innovation, open science, open to the world",[36] with three pillars of action (figure 20). The following are institutional priorities:[37]

(a) Smart fiscal consolidation, taking into account the risk of cuts in research and development and innovation funding owing to financial and fiscal pressures;

(b) Improved framework conditions, with a focus on developing a European venture capital market, intellectual property rights, pools of excellence in areas of societal concerns, European standards, and the role of public procurement;

(c) Steering and monitoring at the European Union level with a key role for the European Council, implementing a 3 per cent research and development target, and completing the European Research area;

(d) A future oriented European Union budget. The European Commission also requests member countries to reform their innovation systems accordingly.

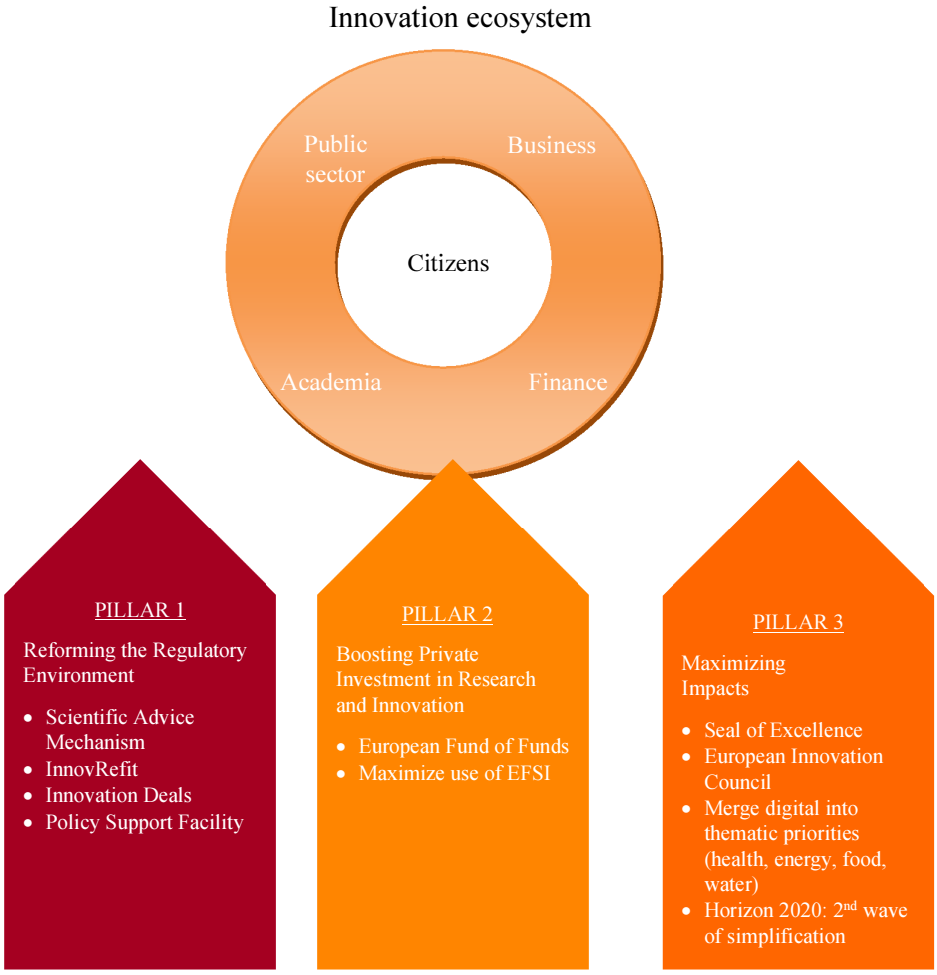
Similarly, there is a need to formulate a regional innovation vision for Arab countries, recognizing weaknesses and priorities. In addition, it is necessary to imbed innovation within partnerships and free trade agreements between Arab countries, the European Union and other major economies. For example, innovation aspects, including partnerships in research projects and the mobility of researchers, must be included in the European Neighbourhood Policy and in the Deep and Comprehensive Free Trade Agreement negotiated between the European Union and the Arab Mediterranean countries.

[35] European Commission, 2014.

[36] European Commission, 2016.

[37] Barros, 2011.

Figure 20. Three innovation pillars of action



Source: European Commission, 2016.

B. NATIONAL VISIONS AND STRATEGIES

Some Arab countries have developed strategies related to innovation, namely Egypt, Jordan, Lebanon, Morocco, Saudi Arabia and the United Arab Emirates.

1. *Egypt*

In 2015, the Ministry of Higher Education and Scientific Research of Egypt issued the National Strategy for Science, Technology and Innovation 2015-2030.[38] The Ministry of Communications issued Egypt's ICT 2030 Strategy.[39] The Sustainable Development Strategy: Egypt Vision 2030[40] was then developed by the Ministry of Planning, Monitoring and Administrative Reform.

[38] See www.bu.edu.eg/portal/uploads/NewsPDF/Scientific_Research_Innovation_5_01112015.pdf (in Arabic).

[39] See www.mcit.gov.eg/ICT_Strategy.

[40] See http://sdsegypt2030.com/?lang=en, see also http://sdsegypt2030.com/wp-content/uploads/2016/10/1.-Introduction.pdf.

The issue of scientific research has even been addressed in article 23 of the 2014 Egyptian constitution:[41] "*The State grants the freedom of scientific research and encourages its institutions as a means to achieve national sovereignty, and build a knowledge economy. The State shall sponsor researchers and inventors, and allocate a percentage of government expenditures that is no less than 1 per cent of the Gross National Product*[42] *to scientific research*".

Knowledge, innovation and scientific research, economic development, energy and transparency, and efficiency of government institutions are all pillars of the economic dimension of Vision 2030. Education and training is a pillar of the social dimension. The pillar of knowledge, innovation and scientific research has the following objectives:

- Creating a stimulating environment for the localization and production of knowledge;
- Activating and developing a national innovation system;
- Linking knowledge applications and innovation outputs with priorities.[43]

A set of quantitative indicators were formulated, including that Egypt should make an effort to move on in the Global Innovation Index from its current rank of 99 to 85 in 2020, and to 60 by 2030. The following key programmes were identified as vital to reaching those objectives:

- Carrying out legal reform on knowledge and innovation;
- Developing and restructuring the knowledge and innovation system;
- Adopting a comprehensive programme to promote an innovation and knowledge culture;
- Developing a comprehensive programme to simulate innovation activities of small and medium enterprises;
- Activating public-private partnerships to support and stimulate innovation.

The objectives of the pillar on education and training stress the following:[44]

- Activating the role of research centres at higher education institutions;
- Linking graduates to employment institutions at the local, regional and international levels.

Contrary to Vision 2030, the National Strategy for Science, Technology and Innovation is limited to universities and research centres, thus excluding the core engine of the innovation landscape. The core engine also does not include the pillars on business, production sectors and the economic and socioeconomic environment. The Strategy partially answers the "what for?" question, but gives no specific targets and no detail on "by what means?" and "by whom?" the linkage between research, production and markets should be achieved. The Strategy must therefore be rapidly updated in line with the enhanced methodology, objectives and programmes of Vision 2030.

Measurements and indicators help check the effectiveness of the Egyptian innovation vision and strategy. For example, the Global Innovation Index ranked Egypt eighty-seventh in 2011, with a score of 29.2. In 2016, the country dropped to 107th place, with a score of 26 (table 2).

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41 See www.sis.gov.eg/Newvr/Dustor-en001.pdf.

42 From a level currently estimated at 0.2 per cent of GDP.

43 See http://sdsegypt2030.com/wp-content/uploads/2016/10/4.-Knowledge-Innovation-Scientific-Research-Pillar2.pdf.

44 See http://sdsegypt2030.com/wp-content/uploads/2016/10/8.-Education-Training-Pillar.pdf.

Table 2. Evolution of GII indicators for Egypt

GII pillar	2011 score	2011 rank	2016 score	2016 rank
1. Institutions	61.7	70	39.0	123
2. Human capital and research	26.4	107	27.3	82
3. Infrastructure	21.7	100	38.3	82
4. Market sophistication	35.0	83	34.2	110
5. Business sophistication	30.7	86	20.0	122
6 Knowledge and technology output	17.2	100	18.5	94
7. Creative outputs	29.5	100	21.8	97

Source: Cornell University and others, 2016.

Note: Improvements are marked in red.

2. *Jordan*

The Jordanian Higher Council for Science and Technology issued the National Innovation Strategy 2013-2017 [45] in 2013, following the 2006-2010 strategy. In 2014, the Ministry of Information and Communications Technology developed the Jordan National Information and Communications Technology Strategy 2013-2017.[46] The Office of the Prime Minister, with direct support from the King, published Jordan 2025: A National Vision and Strategy,[47] which recognizes the need "*to chart a fundamentally different course to achieve the aspirations of Jordan 2025*". However, innovation does not appear as a core pillar of Jordan 2025, and its 10-year horizon is too short to implement structural changes.

The National Innovation Strategy has an even shorter horizon of five years. It is an action plan that tackles the interactions between universities, research and production sectors. However, it recognizes that "*there are several bodies concerned with innovation and each of them has its own orientations and activities within its programmes and plans. The activities of those bodies interrelate and interact, creating the national innovation system*".[48] The Strategy sets out the following priority sectors:

- Medical services and pharmaceutical industries;
- Information technology and telecommunications;
- Education and career guidance services;
- Architecture and engineering services;
- Banking and financial services;
- Clean technologies.

However, no target measurement indicators have been set. Gaps have been identified and prioritized in each sector. The establishment of a National Centre for Innovation, under the authority of the Higher Council for Science and Technology, has been agreed with the World Bank and other international donors.[49]

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[45] See http://inform.gov.jo/Portals/0/National%20Innovation%20Strategy%2012-2013%20with%20NCI.compressed.pdf.

[46] See http://inform.gov.jo/Portals/0/Report%20PDFs/6.%20Infrastructure%20&%20Utilities/ii.%20ICT/2013-2017%20National%20ICT%20Strategy.pdf.

[47] See http://inform.gov.jo/Portals/0/Report%20PDFs/0.%20General/jo2025part1.pdf.

[48] Ibid.

[49] See www.hcst.gov.jo/?q=en/node/80.

Table 3. Evolution of GII indicators for Jordan

GII pillar	2011 score	2011 rank	2016 score	2016 rank
1. Institutions	65.8	62	62.6	63
2. Human capital and research	41.4	50	25.4	86
3. Infrastructure	22.6	96	38.5	79
4. Market sophistication	44.7	44	32.0	115
5. Business sophistication	32.3	77	21.5	116
6. Knowledge and technology output	22.1	77	21.7	79
7. Creative outputs	48.4	10	26.4	78

Source: Cornell University and others, 2016.

Note: Improvements are marked in red.

The Global Innovation Index also highlights the effectiveness of the Jordanian innovation vision and strategy. In 2011, Jordan ranked forty-first with a score of 38.4; however, by 2016, it had dropped to eight-second place with a score of 30 (table 3).

3. *Lebanon*

In 2006, the Lebanese *Conseil National de la Recherche Scientifique* developed, with the assistance of UNESCO and ESCWA, a plan for a STI policy.[50] The strategy defined the challenges that several sectors had to overcome, evaluated the status of education and research institutions, and outlined several initiatives and actions. However, its political impact remained limited and a national STI observatory was never established. In 2012, the Ministry of Education and Higher Education launched a national strategic plan on educational technology in Lebanon to address human resources issues.[51]

In 2016, an evaluation study of the Lebanese innovation system recognized that given the challenges faced by the Government and public institutions, a top-down approach promoted and enforced by the Government was not appropriate for Lebanon.[52] The study observed failures at the market, system, infrastructure, governance, capabilities and socio-cultural levels. However, it welcomed several initiatives by specific institutions, such as the Bank of Lebanon that launched the *Kafalat*[53] programme aimed at boosting start-ups and entrepreneurship through Lebanese banks.[54] The Lebanese Ministry of Economy and Trade[55] and Berytech, an incubator and business development centre, support such initiatives.[56] The World Bank has also initiated a programme to encourage equity investment.[57]

[50] See www.cnrs.edu.lb/stip/ExecutiveSummaryFr.pdf; and http://unesdoc.unesco.org/images/0018/001865/186514e.pdf.

[51] See http://www.mehe.gov.lb/Uploads/file/TLSP.pdf.

[52] See www.unescwa.org/sites/www.unescwa.org/files/page_attachments/lebanon_technology_transfer_legislative_analysis_0.pdf.

[53] See http://kafalat.com.lb/.

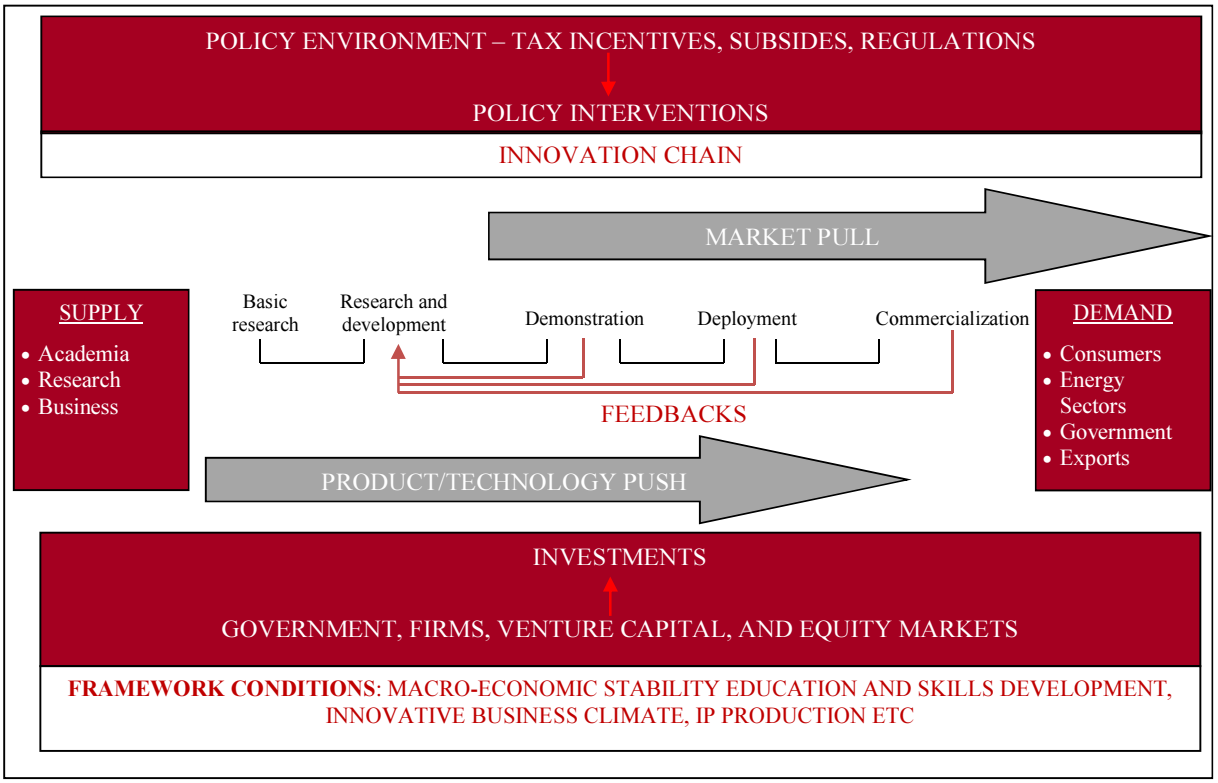
[54] See http://bdlaccelerate.com/2016/.

[55] See www.undp.org/content/dam/lebanon/docs/Governance/Publications/Lebanon-SME-Strategy_091214_2.pdf.

[56] See http://berytech.org/.

[57] See https://openknowledge.worldbank.org/bitstream/handle/10986/16133/756580BRI0QN810Box374342B00PUBLIC0.pdf?sequence=1&isAllowed=y.

Figure 21. Model of the Lebanese national innovation system



Source: ESCWA, 2016.

The Lebanese national innovation system is a market free system, with little intervention from the Government, except for the significant financial and promotional involvement of the Lebanese Central Bank (figure 21).

In 2011, Lebanon ranked forty-ninth in the Global Innovation Index with a score of 37.1, dropping to seventieth in 2016 with a score of 32.7 (table 4). The indicators for all pillars have weakened, except for creative outputs, which raises doubts about the sustainability of the Lebanese national innovation system.

Table 4. Evolution of GII indicators for Lebanon

GII pillar	2011 score	2011 rank	2016 score	2016 rank
1. Institutions	54.3	49	52.1	91
2. Human capital and research	41.0	51	29.8	76
3. Infrastructure	25.6	75	37.5	84
4. Market sophistication	39.0	67	37.9	99
5. Business sophistication	44.5	39	31.7	63
6. Knowledge and technology output	31.0	35	22.4	74
7. Creative outputs	35.7	56	32.8	51

Source: Cornell University and others, 2016.

Note: Improvements are marked in red.

4. *Morocco*

There is little evidence of any long or medium term vision document for Morocco. Instead, the High Commission for Planning has organized a series of debates with experts, the business community and civil society on the theme Morocco 2030 Prospective.[58] The Ministry of Trade, Industry and New Technologies launched the Morocco Innovation Initiative in 2009, with the following objectives:

- Make innovation a key factor of competitiveness;
- Make Morocco a technology producing country;
- Make the most of the research and development skills of Moroccan universities;
- Make Morocco an attractive destination for research and development talents and projects;
- Spread a culture of innovation and entrepreneurship.

Two simple indicators were defined to measure the initiative:

- Granting 1,000 Moroccan patents per year, starting in 2014;
- Creating 200 innovative start-ups per year, starting in 2014.

The Initiative was organized around 13 flagship projects addressing four main aspects: governance and a regulatory framework, financing and support, infrastructure development, and talent mobilization (figure 22).[59] It is owned by the Ministry of Trade, Industry and New Technologies (MCINT), the Ministry of National Education, Higher Education, Management Training and Scientific Research, and the General Confederation of Enterprises in Morocco.

The inter-ministerial committee heading the implementation of the initiative has been replaced by the National Committee for Innovation. Since 2013, the Moroccan Centre for Innovation (CMI) has acted as a governance structure and a one-stop-shop for innovation. CMI funds have financed INTILAK (up to 90 per cent for start-ups), TATWIR (up to 50 per cent of research and development projects by consortiums of firms and PTR (up to 75 per cent of diagnosis studies of small and medium enterprises).[60] Other public funds are made available by the National Agency for the Promotion of SMEs (ANPME),[61] with programmes such as RAWAJ (support for trade innovation) and the more ambitious National Plan for Industrial Emergence, which aims to create integrated industrial platforms in six strategic sectors: offshoring, automotive, aeronautics, electronic, textile, and leather and agro food.

The MCINT has also launched an industrial acceleration plan, with the following 10 measures to expedite the industrial transformation of the country:

1. Creation and animation of ecosystems;
2. Industrial compensation;
3. Moving from informal businesses to formal industries;
4. Qualification of resources;
5. Improving the competitiveness of small and medium enterprises;
6. Financial intervention tools;
7. Infrastructure for rent;
8. International integration of the country;
9. Developing a “deal making” culture for foreign direct investment;
10. Enhancing the African vocation.[62]

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[58] See www.hcp.ma/downloads/Maroc-2030_t11885.html.

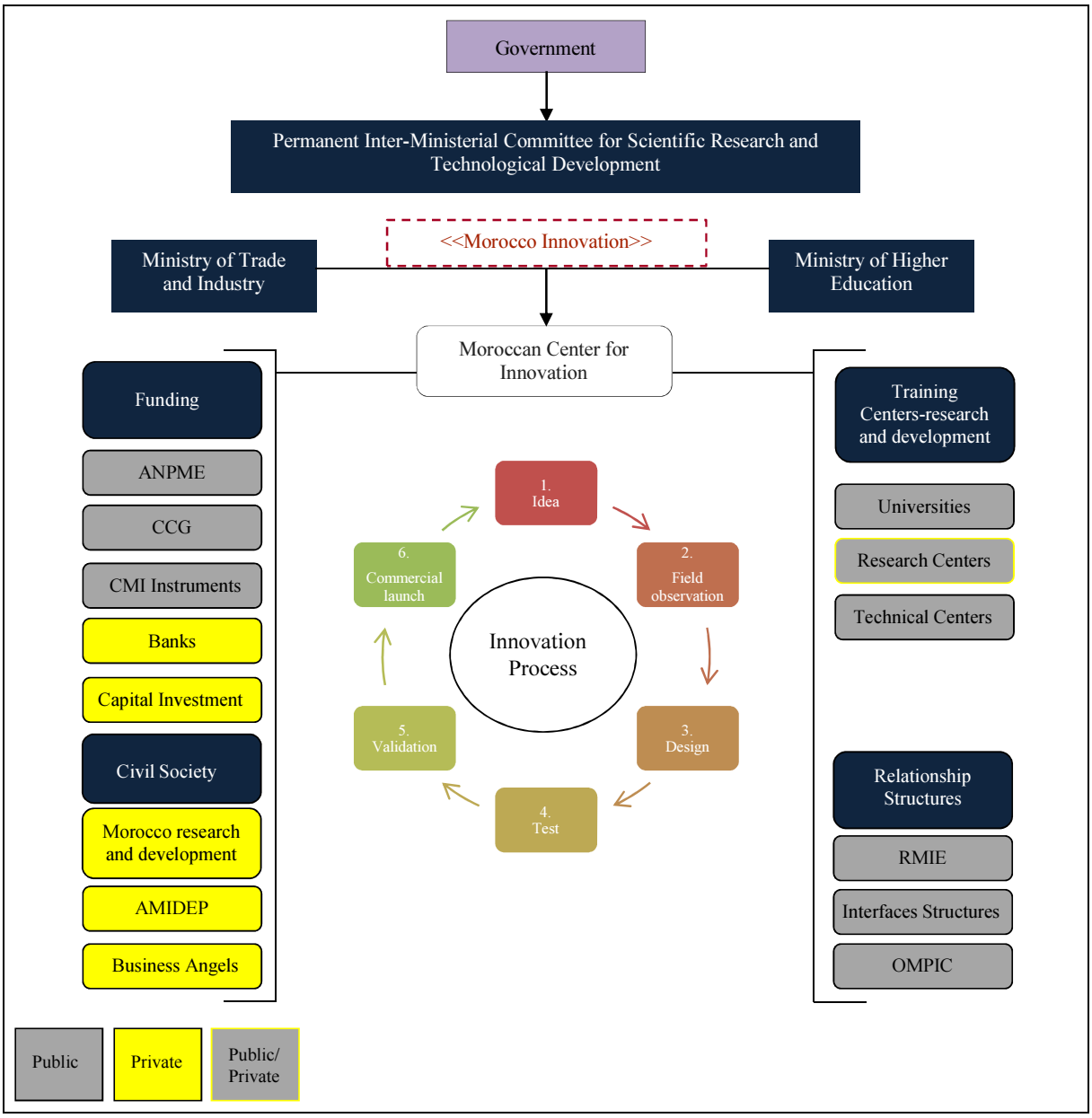
[59] AMIC, 2014; Moroccan Investment Development Agency, 2013.

[60] See http://paceim.ird.fr/wp-content/uploads/Pr%C3%A9sentation-MICIEN-rencontres-PACEIM-avril-2014.pdf.

[61] Available from http://candidature.marocpme.ma/.

[62] Morocco, Ministry of Industry, Investment, Trade and the Digital Economy, 2013.

Figure 22. National innovation system of Morocco



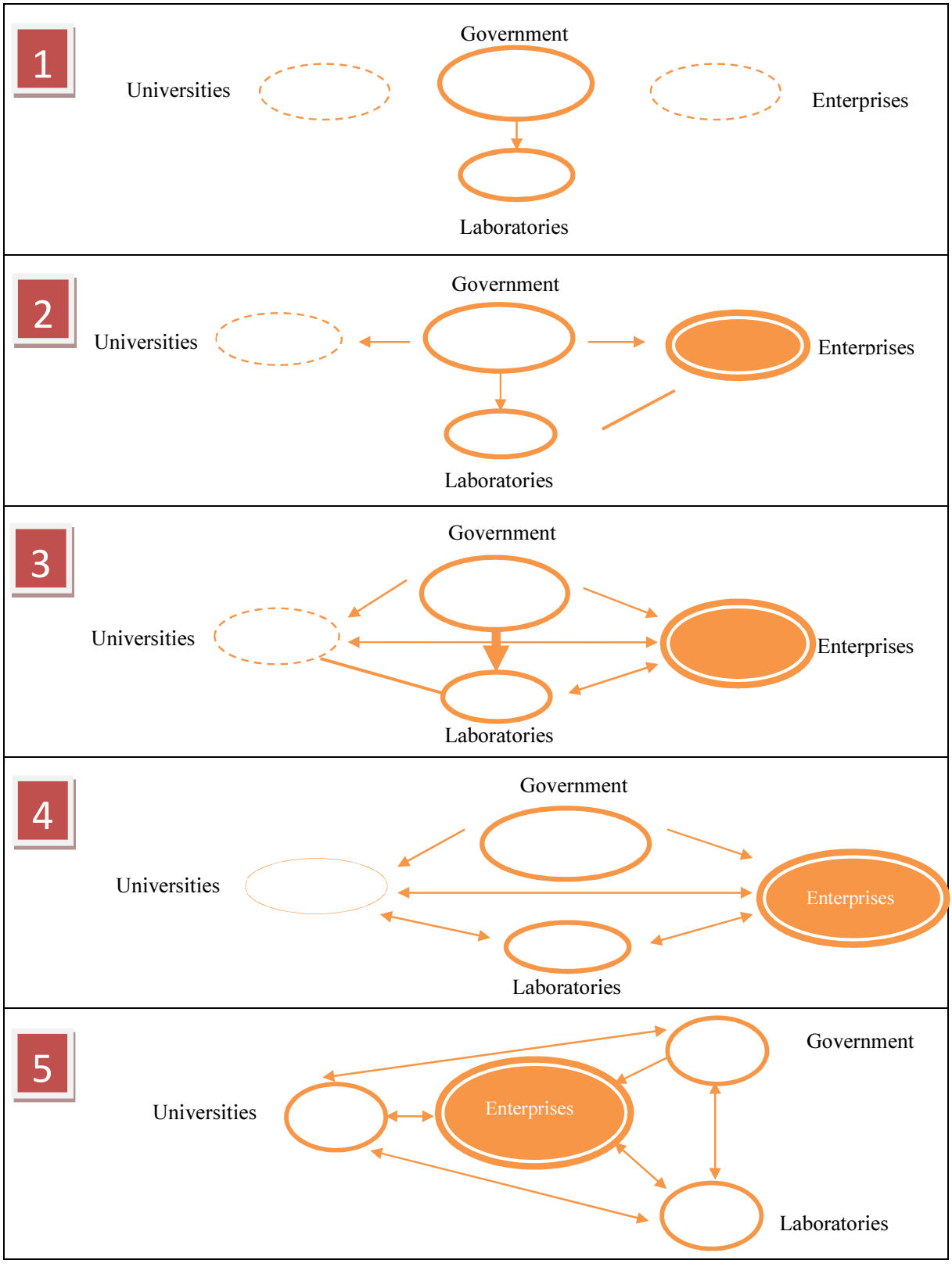
Source: Association Marocaine des Investisseurs en Capital (AMIC), 2014.

A Moroccan Centre for Innovation and Social Entrepreneurship[63] was created in 2012, focusing on civil society innovation. The Ministère de l'Enseignement Supérieur de la Formation des Cadres et de la Recherche Scientifique has also elaborated the National Strategy for the Development of Scientific Research towards 2025, which considers universities and research centres as components of a national system for research and innovation and has led to the development of various programmes.[64]

[63] See www.mcise.org/.

[64] See www.enssup.gov.ma/sites/default/files/PAGES/168/Strategie_nationale_recherche2025.pdf.

Figure 23. Moving focus from research labs towards firms



Source: AMIC, 2014.

All these programmes complement the Green Morocco Plan[65] of the Ministry of Agriculture and Sea Fishing, the Vision 2020, Strategy for the Development of Tourism[66] of the Ministry of Tourism and Handcrafts, and the National Energy Strategy towards 2030 of the Ministry of Energy, Mines, Water and Environment.

Although such strategic innovation plans are not set out in one long-term general vision for the country, the innovation landscape in Morocco has made significant advances in many areas, with the direct support of the King. The Moroccan national innovation system has shifted its focus from universities, public laboratories and Government towards enterprises and firms (figure 23),[67] thus better addressing the core engine.

The effectiveness of the Moroccan national innovation system is more evident than in other Arab countries. Morocco ranked ninety-fourth in the Global Innovation Index in 2011, with a score of 28.73. It rose to seventy-second place in 2016, with a score of 32.26 (table 5). This improvement is reflected in several pillar indicators, shown in red.

Table 5. Evolution of GII indicators for Morocco

GII pillar	2011 score	2011 rank	2016 score	2016 rank
1. Institutions	57.6	80	57.5	74
2. Human capital and research	38.0	61	32.3	61
3. Infrastructure	29.2	57	48.6	45
4. Market sophistication	34.4	84	38.0	98
5. Business sophistication	24.1	110	18.3	125
6. Knowledge and technology output	19.5	87	22.9	72
7. Creative outputs	22.1	109	28.2	67

Source: Cornell University and others, 2016.

Note: Improvements are marked in red.

5. *Saudi Arabia*

In 2016, the country issued Vision 2030 with ambitious goals, including increasing the share of non-oil exports in non-oil GDP from 16 per cent to 50 per cent, raising the country's ranking in the government effectiveness index from 80 to 20, in e-government from 36 to the top 5, in social capital from 26 to 10, and in the global competitiveness index from 25 to 10. Vision 2030 recognizes that innovation is key to education, advanced technologies and entrepreneurship, small and medium enterprises and government services delivery.[68]

The National Policy for Science, Technology and Innovation[69] was adopted by the Council of Ministers in 2002 to transform the country into a knowledge-based economy (figure 24). It sets out 15 programmes for the localization and development of strategic technologies essential to the future development of Saudi Arabia (water, oil and gas, petrochemicals, nanotechnology, biotechnology, information technology, electronics, communication and photonics, space and aeronautics, energy, environmental technology, advanced materials, mathematics and physics, medical and health, agriculture and building and construction). King Abdulaziz City for Science and Technology monitors the implementation of the Policy.

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[65] See www.fellah-trade.com/ressources/pdf/Hajjaji_Plan_Maroc_Vert_Strategie.pdf.

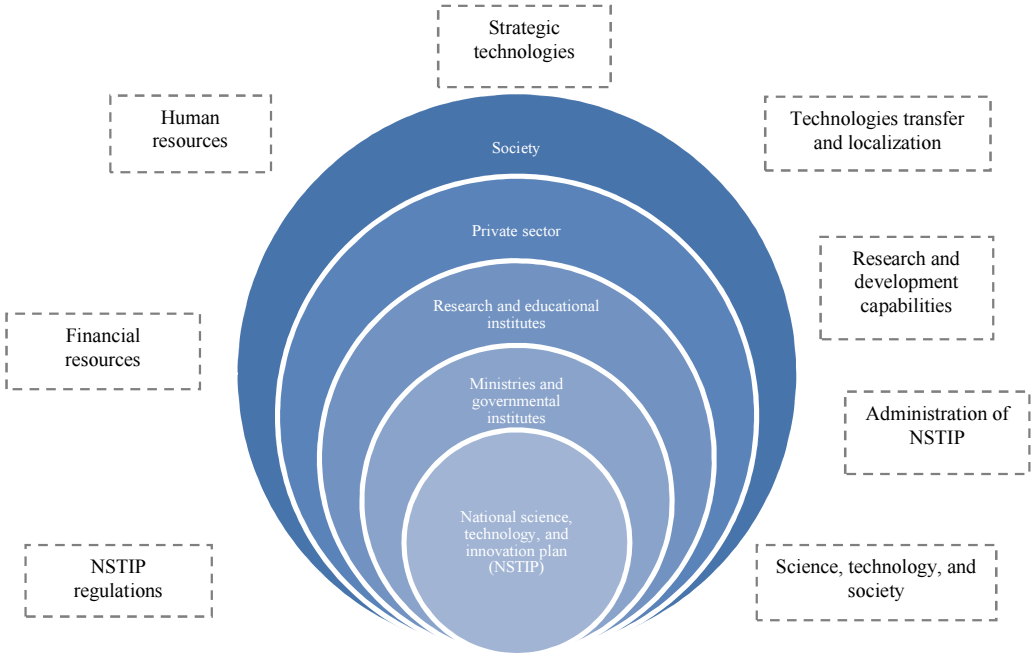
[66] See www.orientalinvest.ma/telechargementfichiers/tourisme/Plaquette-2020-FR-bat.pdf.

[67] AMIC, 2014.

[68] Kingdom of Saudi Arabia, 2016.

[69] See http://maarifah.kacst.edu.sa/.

Figure 24. National Policy for Science, Technology and Innovation of Saudi Arabia



Source: http://www.mcst.edu.sa/sites/default/files/u250/Saudi%20National%20Plan.pdf.

The Policy finances research and innovation activities, mainly in universities and large companies. It calculated the total GERD for 2008 at 0.4 per cent of GDP, around half of which was from the private sector – much below the target of 2 per cent forecast for 2024.

A review of the Kingdom innovation policies was prepared for the 2014 Euromoney Conference. It indicated that the ecosystem for an innovative, entrepreneurial society was already in place, but the most crucial challenge was bridging the gap in skills. Moreover, GERD still needed to increase as percentage of GDP. The following measures were seen as priority:

- Encourage academia-industry linkages, and develop better frameworks for knowledge transfer between various stakeholders;
- Focus on developing technology rather than importing it to facilitate technology integration within the local economy;
- Revamp the education system to teach entrepreneurial skills and foster innovative thoughts among students;
- Streamline government processes to enhance the swift implementation of development programmes.

Strategic sectors were also reviewed (figure 25), focusing on sectors that could drive innovation. The following challenges and gaps were identified:

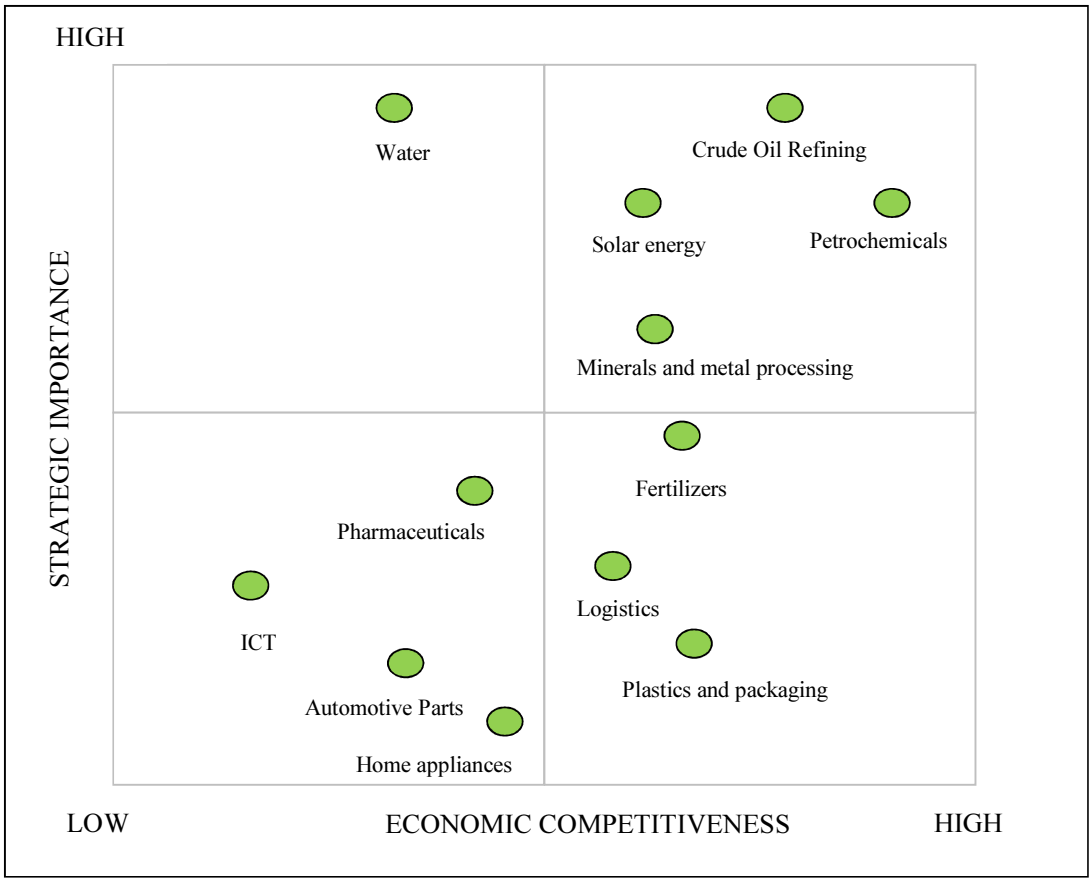
- Private investments and loans for startups;
- Weak linkages for technology transfer between foreign and local stakeholders;
- Lack of coordination and cohesion between various departments;
- A need to create a vibrant entrepreneurship culture, especially among young people.

Table 6. Five pillars of the Saudi Arabian innovation ecosystem

Infrastructure	Infrastructure entails the interplay of government, industry and academia	• A network of 24 public universities, 36 technological colleges for boys, 15 technical institutes for girls and 112 vocational training centres; • Industry linkages such as KAUST's Innovative Industrial Collaboration Program; • Increasing collaboration with international universities; • Stronger intellectual property rights; Saudi Arabia also joined the Patent Cooperation Treaty to further develop its IP framework in 2013.
Human resources	A qualified and skilled labor force can drive the innovation engine	• Significant investments in building the human resource base; • Enhancing skills through targeted programs such as Tatweer, Afaq, and the King Abdullah Scholarship Program; • National Employment Strategy to hone skills and meet the needs of a diversified economy.
Technology penetration	Access to technology facilitates innovation	• Programs such as the Home Computer Initiative, Dissemination of Digital Culture and Knowledge Lectures Initiative, Internet Awareness Project (Saleem Net) and the e-Training Caravans Initiative; • 68 per cent of households have access to internet; 54 per cent internet penetration and amongst the top 5 mobile telecommunications markets.
Economic competitiveness	To create employment and generate wealth	• Efforts led by Saudi Arabia General Investment Authority (SAGIA); • Doing Business Ranking improved from 67 in 2005 to 26 in 2014; • Industrial clusters have pushed KSA's economic competitiveness higher.
Funding	Access to ready capital is essential to foster entrepreneurship	• Taqnia Ventures, The Centennial Fund, and Wa'ed Venture Arm are examples of public sector funding provided to innovative SMEs; • Annual KAUST Seed Fund gives grants totalling $250,000 to each winning student; • For SME funding, the Kafala program has been successful; • In the past decade, Saudi Arabia accounted for 23 per cent of all deals in the Arab world.

Source: Saudi Arabia, 2015.

Figure 25. Strategic sectors for innovation in Saudi Arabia



Source: Saudi Arabia, 2015.

The innovation landscape in Saudi Arabia has evolved positively. Its Global Innovation Index ranking increased from 54 in 2011 (with a score of 36.4) to 49 in 2016 (with a score of 37.8). However, the improvements achieved in some GII pillars need to be sustained and transferred to others (table 7), namely institutions, market sophistication and business sophistication.

Table 7. Evolution of GII indicators for Saudi Arabia

GII pillar	2011 score	2011 rank	2016 score	2016 rank
1. Institutions	67.5	60	57.9	72
2. Human capital and research	40.4	53	44.7	32
3. Infrastructure	27.8	62	51.4	39
4. Market sophistication	52.7	30	49.6	38
5. Business sophistication	41.3	48	31.3	66
6. Knowledge and technology output	18.3	93	22.4	75
7. Creative outputs	35.6	57	34.6	47

Source: Cornell University and others, 2016.

Note: Improvements are marked in red.

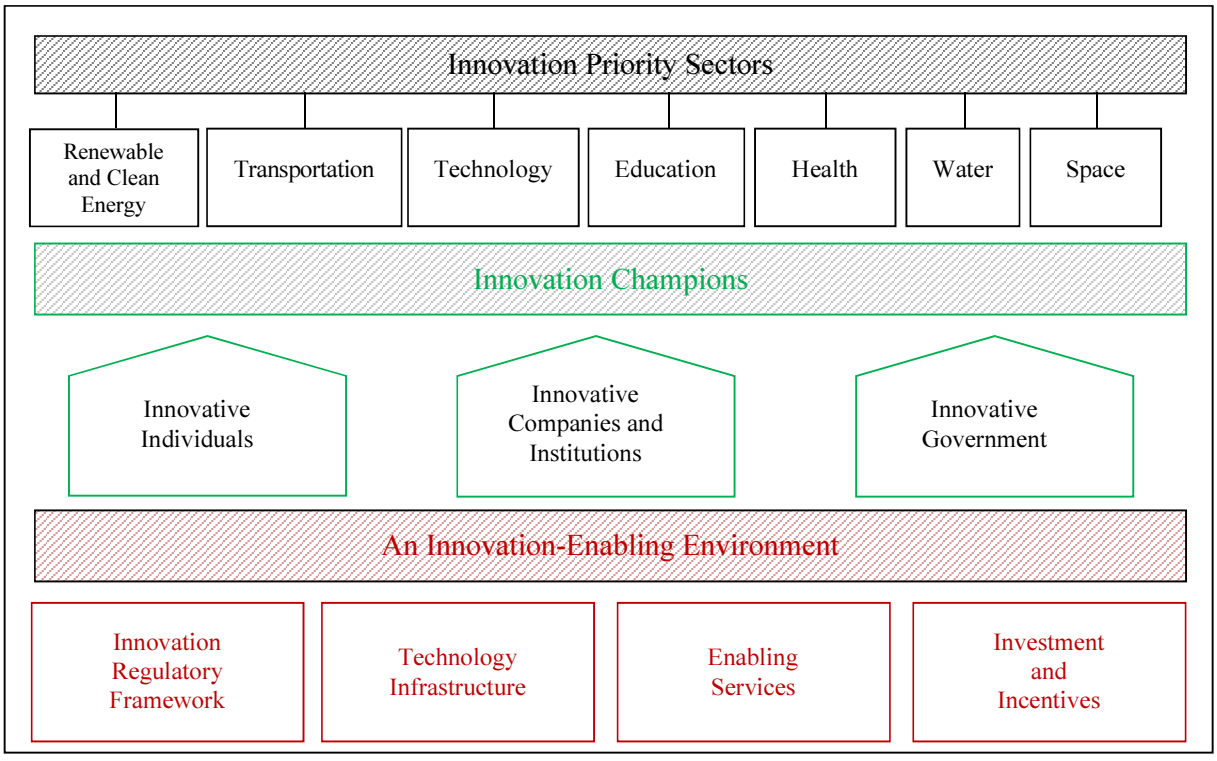
6. *United Arab Emirates*

In 2014, the Emirati Government launched the UAE Vision 2021, with the following 12 targets for a competitive knowledge economy:[70]

- To increase the non-oil real GDP growth to 5 per cent;
- To raise gross national income (GNI) per capita to be among the top 10 countries globally;
- To increase net inflow of foreign direct investment as a percentage of GDP to 5 per cent;
- To rank among the top 10 countries worldwide in the Global Competitiveness Index;
- To rank the county first in the Ease of Doing Business Index;
- To double the number of Emirati nationals in the workforce;
- To increase ten-fold the Emiratization rate in the private sector;
- To increase to 70 per cent the contribution of small and medium enterprises to non-oil GDP;
- To rank the country among the top 10 in the Global Entrepreneurship and Development Index;
- To rank the country among the top 20 in the Global Innovation Index;
- To double the share of "knowledge workers" in the labour force;
- To triple the value of GERD as a percentage of GDP.

This is in addition to many other targets for sustainable development and infrastructure, public safety measures, a fair judiciary, cohesive society and preserved identity, world-class healthcare, and a top education system.

Figure 26. Innovation in the United Arab Emirates



Source: United Arab Emirates, Prime Minister's Office, 2015.

[70] See www.vision2021.ae/sites/default/files/national_agenda_summary_english.pdf.

2015 was designated as the Year of Innovation, and federal government bodies were directed to revise their policies to develop a nurturing environment for innovation.[71] A national innovation strategy was formulated,[72] with a clearly prioritized national innovation system (figure 26).

A Centre for Government Innovation was also established[73] to enrich innovation culture within the Government. A science, technology and innovation policy was also formulated.[74]

Many aspects of the 2021 Vision targets correspond to the Global Innovation Index. The score of the United Arab Emirates in the Index has risen from 42.0 in 2011 to 39.4 in 2016 (table 8). The country aims to be among the top 10 in 2021. The United Arab Emirates is already ranked sixteenth in the 2016 Global Competitiveness Index. It also ranked twenty-sixth in the 2017 Ease of Doing Business Index. More should be done to simplify starting a business, increase the number of knowledge workers in the labour force, and improve skills in mathematics and science.

Table 8. Evolution of GII indicators for the United Arab Emirates

Innovation Pillar GII	2011 Score	2011 Rank	2016 Score	2016 Rank
1. Institutions	81.8	26	80.9	22
2. Human capital and research	52.4	24	40.7	41
3. Infrastructure	35.8	31	57.5	23
4. Market sophistication	52.4	31	48.7	42
5. Business sophistication	49.5	28	44.8	24
6. Knowledge and technology output	12.6	119	20.8	86
7. Creative outputs	46.6	14	27.6	70

Source: Cornell University and others, 2016.

Note: Improvements are marked in red.

The share of "knowledge workers" in the labour force is an issue. It was estimated by the Ministry of Human Resources and Emiratisation at 23.64 per cent in 2015,[75] while the 2021 target is 40 per cent. It was, however, at 69.3 per cent in 2011 and at 36.1 per cent in 2016. The GERD was given at 0.5 per cent of GDP in 2012, according to the Federal Competitiveness and Statistics Authority, with a 2021 target of 1.5 per cent. GII 2016 considers a GERD value of 0.7 per cent of GDP, ranking the United Arab Emirates in forty-eighth place.

Emirati students in grade 4 are ranked thirty-ninth and fortieth, respectively, for mathematics and sciences in the TIMSS test. Grade 8 students are ranked twenty-third in both,[76] with a 2021 vision of being in the top 15. On the PISA scale, the United Arab Emirates ranked thirty-eighth in 2011 and 2016, with a 2021 vision of being among the top 20. In this area, the vision adds several interesting indicators including an "enrolment rate in foundation year" (share of local students who have to undergo the foundation year – a programme usually focusing on strengthening Arabic, English, math and information technology – of the local

[71] See www.thenational.ae/uae/technology/2015-will-be-a-year-of-innovation.

[72] United Arab Emirates, Prime Minister's Office, 2015.

[73] See www.mbrcgi.gov.ae/Default.aspx; and www.uaeinnovates.gov.ae/docs/default-source/pdfs/government-innovation-framework-en.pdf?sfvrsn=2.

[74] United Arab Emirates, Prime Minister's Office, 2015.

[75] https://www.vision2021.ae/en/national-priority-areas/nkpi-export-pdf and https://www.vision2021.ae/en/national-priority-areas/national-key-performance-indicators.

[76] http://www.iea.nl/.

students enrolled in universities in the same year). The Ministry of Education estimated this indicator at 45.3 per cent in 2012, and the vision aims to reduce it to 0 per cent. Lastly, the vision aims to rank the country in first place in the Online Services Index of the United Nations e-government survey, while it was ranked eighth in 2016. The GII gave a rank of 90 in 2011 and of 12 in 2014 (GII 3.1.3, infrastructure), showing a notable improvement. To achieve the 2021 vision, the country may face a number of challenges over the next five years.

V. KEY ISSUES FOR THE INNOVATION LANDSCAPE OF ARAB COUNTRIES

The innovation landscape of Arab countries discussed in the previous chapters, and the examples analysed from the six countries show that there is a move towards imbedding innovation development beyond ICT infrastructure and knowledge-based economies. However, significant differences exist in the way Arab countries define innovation strategies and landscapes, and in their formulation of visions and policies to implement those strategies. Even with advances in strategies and visions, most countries have made no, little or partial improvements in their GII rakings between 2011 and 2016. Some key issues should therefore be addressed to advance innovation strategies and landscapes.

A. NATIONAL VISIONS AND THE CORE ENGINE

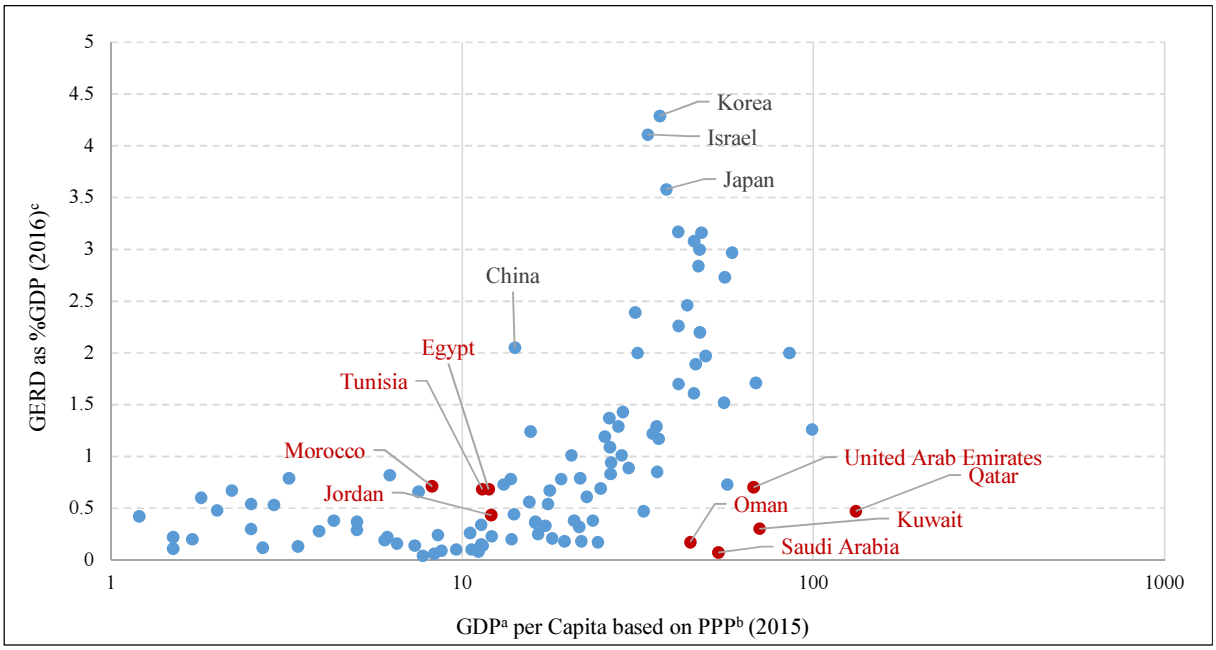
Many countries need to establish their national innovation visions and imbed them in a sustainable development plan. Even in cases where such a vision is formulated with specific targets, it is only for the medium term as 5-year plan, without detailed planning by relevant ministries and authorities.

More importantly, visions often lack focus on ways to fuel the core engine of an innovation landscape, i.e. partnerships between universities, public research centres and enterprises to boost innovation and the transfer of technology and knowledge. This focus, and the commitment to it by the highest authorities of the country, can be best measured through GERD. All Arab countries' GERD is below 1 per cent, and most are below 0.5 per cent. Morocco has the highest level at 0.71 per cent. China is above 2 per cent and Israel and Korea are above 4 per cent. The Egyptian constitution sets out a target of 1 per cent[77] compared with its current level of 0.68, and the United Arab Emirates is aiming for 1.5 per cent compared with its present level of 0.7 per cent (figure 27).

However, there is a major difference between Egypt and the United Arab Emirates. Around 92 per cent of the Egyptian GERD is financed by the Government and conducted in government research centres, while businesses finance 74 per cent of the Emirati GERD and most of the research is performed by enterprises (table 9). Egyptian innovation policies should focus on boosting spending by local and foreign businesses on research and development, enhancing the efficiency of government spending, and supporting the core engine by transferring technology and knowledge from education and research institutions to the productive enterprises. In contrast, the United Arab Emirates should increase government spending on research and development.

[77] Of GNI not GDP, but the difference is small in the case of Egypt.

Figure 27. Gross domestic expenditure on research and development (GERD), 2016



Sources: UNESCO Institute of Statistics, 2016; World Bank, 2017.

Notes: [a] In thousands of United States Dollars.

[b] PPP = Purchasing Power Parity.

[c] Gross domestic expenditure on research and development (GERD) as a percentage of GDP is the total intramural expenditure on research and development performed in a national territory or region during a given year, expressed as a percentage of GDP of the national territory or region.

Morocco and Tunisia show similar levels of total GERD (table 9). The share of private financing is greater in Morocco than in Tunisia, which may partially explain the better performance of Morocco.

Table 9. GERD spending in Arab countries

Countries	GERD (%GDP)	Gross capital formation (%GDP)	GERD performed in business (%GDP)	GERD financed by business (%GERD)	GERD financed abroad (%GERD)
Saudi Arabia	0.07	29.67			
United Arab Emirates	0.70	24.24	0.52	74.29	
Qatar	0.47		0.12	24.18	2.42
Bahrain		17.62			
Oman	0.17	29.50	0.04	24.55	0.00
Lebanon					
Jordan	0.43	20.32			
Tunisia	0.68	21.47		18.70	4.40
Kuwait	0.30	20.81		1.41	1.18
Morocco	0.71	33.44	0.21	29.94	1.71
Egypt	0.68	14.78	0.05	8.09	0.12
Algeria		49.05			
Yemen		2.33			
Sudan					
Iraq	0.03				

Source: UNESCO Institute of Statistics, 2016.

The share of gross capital formation in GDP shows whether a country's innovation strategy is built on an industrial policy for development. High rates of gross capital formation correlate well with better GII indicator and innovation performance. In more general terms, innovation policies and strategies should focus on the central role of the State in terms of regulating, reforming, boosting demand and supply, financing, and transferring technology and knowledge.

B. TARGETING AND REFORMING

Developing a vision for a country's innovation strategy and landscape necessitates developing effective sub-indexes and measures, while monitoring progress in implementation. The choice of indexes should result from an analysis of the innovation landscape, identifying the most critical issues and bottlenecks.

Relevant authorities must investigate the best ways to alleviate weaknesses or bottlenecks, and how to move forward. They should also look at the nature of reforms, building on international best practices. Some reforms might be challenging, and necessitates major organizational change.

The main target indexes must result from a detailed analysis of the structure of a national innovation system and of the necessary reforms at all levels, namely the core engine, the framework, the infrastructure, and the economic and the social environments.

C. INNOVATION AND ECONOMIC DEVELOPMENT

Innovation in its broad sense does not only entail the development of some companies with innovative products or services (such as mobile phones networks or Internet providers), but addresses how the whole economy adapts to globalization, and how entrepreneurship can move from an informal to a formal setting. An innovation strategy is therefore developed to foster innovation within enterprises – international companies, local large firms, or small and medium enterprises.

The main target of an innovation policy should focus on collaboration between education institutions, research centres and firms in both hosting and financing research. This implies government intervention on multiple levels, including the following:

- Inciting large multi-national firms to localize research and development activities in the country, and to transfer technology and knowledge (for example, regulations may state that a share of profits and royalties must be invested in the country, particularly in research and development);
- Encouraging local firms to establish research and development partnerships with local research centres, regulating complex intellectual property issues between firms innovating for private interests and research centres innovating for the public good;
- Fostering innovation across the whole spectrum of small and medium enterprises, from top-notch technological companies to informal and own-account enterprises.

A country's innovation vision and policies should not only address a few technological and ICT firms, but rather the overall functioning of the production economy.

D. INNOVATION AND SOCIAL DEVELOPMENT

Unquestionably, an innovation vision is developed to ensure the welfare of a country's population. Innovation policies should therefore greatly focus on issues such as education, healthcare, the environment, water scarcity, clean energies, and urban development. However, special attention must be given to two main characteristics of Arab societies: the "youth tsunami" and "non-citizens".

Most Arab countries are currently experiencing a "youth bulge" – a wave of young people coming to age from an older baby-boom. This is combined with an increase in rural-urban migration. This young population

could be a unique opportunity if it drives innovation and development. Arab countries must therefore invest in education, especially higher education, to prepare the "youth bulge" generation for the future.

Similarly, innovation strategies should focus on creating decent, formal and innovative job opportunities for young people, so as to avoid the "brain-drain" of the educated. However, in Lebanon, for example, brain-drain is accepted as it brings financial transfers to Lebanese banks.

A large number of people in many Arab countries are identified as non-citizens. This is particularly true of Gulf Cooperation Council countries, but also Jordan and Lebanon. Access of young non-citizens – refugees or children of migrant workers – to the education systems and the job market is a critical issue. Current policies will further fragment the economy and the labour market between the formal and informal sectors. Innovation policies should benefit the entire population, both citizens and non-citizens.

E. Innovation cooperation between Arab and other countries

Cooperation between Arab countries on innovation is currently almost negligible, although the Arab League was established before the European Union. Moreover, Arab countries selectively attract some research potential from other poorer countries. Arab countries should take advantage of their common language, and of a population of around 500 million to create strong opportunities for innovative products and services.

An Arab policy for innovation should be developed, targeting domains of interest for all. Such a policy should be managed by an agency supported by the leadership of Arab countries. Substantial funding should be dedicated to establish university student exchanges, and collaborative research between Arab countries. In parallel, partnerships and free-trade agreements between Arab countries and others, such as the European Union, the United States and China, should foster similar exchange programmes for research students, collaborative research in sciences and technology, and programmes for technology and knowledge transfer.

VI. CONCLUSIONS AND RECOMMENDATIONS

The present report assesses the current focus on innovation, following its embedment in the Sustainable Development Goals. Today, technology and knowledge transfer is widely seen as key for social and economic development, much more than the concepts of information or knowledge societies. This had led to a renewed interest in innovation policies at the country, regional and international levels.

The report discusses the various definitions of the innovation landscape in the international literature. It defines the components of a national innovation system. The core engine of this model consists of higher education institutions, research centres and production enterprises, and interactions among them. The role of the State is essential in this model – it must regulate the system and foster innovation for the welfare of the people. It also has a crucial role in addressing the socioeconomic impacts of innovation and coping with the disruptive nature of technology, taking into account the risks and changes to employment relationships.

The report assesses the innovation landscape of Arab countries using data from the Global Innovation Index and by considering countries' GDP. The analysis indicates that medium income Arab countries compare well with their international counterparts, while low and high income countries are generally underperforming. In addition, most Arab countries' innovation ranking and scores deteriorated between 2011 and 2016. Regarding the core engine, weaknesses lie in a lack of research and development activities, and in the links between these activities and the productive system, resulting in weak knowledge and technology outputs. Moreover, institutional frameworks remain largely insufficient to foster and regulate innovation, and market sophistication (financing) is weak, although infrastructure meets global averages. No indicators assess the socioeconomic impact of innovation and technologies. Special studies are therefore needed in these areas.

There is no common Arab vision for innovation similar to that of the European Union. In addition, partnerships and free trade agreements between Arab countries and other economic blocs do not consider innovation, research and development collaboration, and researcher mobility.

Major disparities were found when comparing the national innovation landscape, visions and systems of six Arab countries: Egypt, Jordan, Lebanon, Morocco, Saudi Arabia and the United Arab Emirates. The Moroccan case showed strengths in many policies implemented with active support from the highest authority, the King. The improvements were measurable between 2011 and 2016. This is not the case for the five others, where bottlenecks still need to be removed and reforms need to be implemented. The situation of Lebanon is of particular interest, as the central bank is acting as the main promoter of innovation in a free market with almost no government regulation or intervention.

The key issues for the innovation landscape in Arab countries concern investment. Most Arab countries spend well below 1 per cent of GDP on research and development, including investments from public, private and foreign enterprises. Another main concern is the structure of the core engine of national innovations systems, and technology and knowledge transfer from research to production. Moreover, an innovation strategy should include multinationals, local large firms and small and medium enterprises, and it should address specific policies for each, especially since the informality of small and medium enterprises is rarely tackled. Innovation policies should also focus on transforming the youth bulge into an opportunity for Arab countries.

The report's assessment of the innovation landscape in Arab countries has resulted in the following recommendations:

- Encourage Arab countries to formulate and adopt innovation policies and strategies, addressing their commitments to implementing the SDGs, especially Goal 9 on building resilient infrastructure, promoting inclusive and sustainable industrialization and fostering innovation;
- Support Arab countries in implementing and monitoring the progress of their innovation policies and strategies;
- Promote agreement on a common framework for the innovation landscape in Arab countries to clarify how each level and component is addressed and monitored;
- Develop common references for measuring innovation at the national and regional levels, establish an Arab innovation observatory, and periodically assess the innovation landscape at the regional and national levels;
- Request Arab countries to address legal, economic and social issues needed to drive their innovation strategies, to overcome the bottlenecks and to alleviate side effects. This is particularly important given the disruptive nature of technologies, the dominant informality of the private sector and of employment, and the changing nature of employment relationships;
- Support Arab countries in addressing technology and knowledge transfer to local production systems (agriculture, industry, services), and in adopting measures to make them more effective;
- Work with Arab countries to prioritize research, technology and knowledge transfer in key sectors, especially those linked to energy efficiency, water usage, environment and health;
- Encourage Arab countries to develop key initiatives to boost innovation, in line with best international practices, including financing instruments, research-production partnerships, young researcher mobility, and Arab and international research cooperation.

Furthermore, various lists of recommendations resulted from the ESCWA expert group meetings on innovation held in 2015[78] and 2016.[79]

[78] See https://www.unescwa.org/events/mechanisms-innovation-sustainable-development-arab-region.

[79] See https://www.unescwa.org/sites/www.unescwa.org/files/events/files/recommendation_escwa_egm_innovation_2016_en-vfinal.pdf.

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