Role of Innovation and Technology in Building Knowledge-Based Economy in the Arab region

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Role of Innovation and Technology in Building Knowledge Based Economy
In the Arab region

I. Introduction

This report addresses the role of Science, Technology and Innovation (STI) in building the Knowledge Based Economy (KBE) in the Arab region. This issue is particularly important for Arab countries facing critical developmental challenges; these are associated with the development model of each individual country – where all are essentially rentier economies in which STI still plays a marginal role in growth generation – and lack of economic integration among Arab countries leading to significant loss of growth potential.

Consequently, the region is already paying a high bill since the start of the Arab spring in 2011. In many Arab countries economic growth is slowing down and civil war is tearing four Arab countries not to mention the dismal humanitarian situation in Gaza. High-income GCC countries are not immune from this turmoil due to the recent steep fall of oil prices and fragile economies and societies highly dependent on migrant man-power and competencies and reliance on public jobs to integrate Youth.

One might legitimately question the priority of dealing with STI and KBE in such a context. It is true that – under a narrow view – where STI means innovation at the frontier of knowledge and KBE means essentially a copy of advanced western economies, such a discussion seems far from the region’s realities and priorities.

In this report, we adopt the view that STI is essentially a cognitive attitude primarily involving the application of ingenuity and critical thinking to solve concrete problems and address critical situations. We also understand a KBE as being essentially an open society where economic growth and people’s recognition and social advance primarily depend on knowledge, competency and hard work. Such an understanding is in line with ESCWA’s Arab Integration Report quoted above and previous UNDP Arab Development and Arab Knowledge Reports.

With such an understanding, the contribution of STI in building a KBE in the Arab region is not only a pertinent question but also a necessary one because of the situation outlined above.

The first chapter lays the background for a general understanding of the role STI plays in building KBE and discusses the current situation of KBE in Arab countries. The role of innovation as an engine for growth is identified with particular focus on the current context characterized by the digital revolution. Next, the emergence of the KBE concept, its definition, and how it impacts innovation and employment structure are discussed. Thirdly, the important issues of innovation policies both in developed and developing countries and innovation and KBE measurement frameworks are discussed. Finally, with data from internationally acknowledged measurement frameworks, we assess the situation of innovation KBE in Arab countries, highlighting initiatives taken by som, to develop their STI with a view of accelerating their transition to KBE.

1 See the Arab Integration Report (ESCWA, 2014b).
2 Average GDP growth for years 2011-2013 in some Arab countries: Algeria 2.8%; Egypt 2.1%; Jordan 2.65%; Lebanon 2%; Tunisia 2.52%; Sudan -6%. Only Morocco manages a decent 4.38%. http://databank.worldbank.org
The second chapter discusses best practices of STI’s contribution to the building of a KBE. In the absence of a comprehensive STI measurement in Arab countries, the chapter highlights some snapshots where data is available comparing Arab countries with developed, emerging and similar developing countries. Next, the critical issue of an innovation ecosystem is discussed: the sustainability and actors of an innovation ecosystem are identified to evaluate if successful examples exist in Arab countries. Finally, new Innovation approaches which characterize the KBE are discussed: this will be carried out under three headings: new policies (smart specialization, open specialization and inclusive innovation), ICT-enabled Innovations taking two examples from government services and the economy, and policies aimed at developing Renewable Energy Technologies (RET) to address climate change and ensure sustainable development.

The third chapter summarizes the main challenges faced by Arab countries in their transition to KBE; these are drawn from the analysis presented in this document as well as from other related studies. A set of recommendations addressing education, research priorities, innovation policies, and cultural values are presented as proposals to enable and accelerate the transition of Arab countries into KBE.
II. Role of Science, Technology and Innovation in building Knowledge-Based Economy

A. INNOVATION AND ITS CONTRIBUTION TO GROWTH

Since the early 20th century, innovation was identified as a growth engine of modern market economies. A long-term historical observation of the compound annual growth rate of GDP per capita in the World since antiquity establishes the correlation of this growth with the advent of modern STI particularly since the mid-late 19th century as shown on figure 1.

![Figure 1. World Population and GDP per capita growth components.](image)

Source: MGI, 2015.

Innovation, despite being in its foundations grounded on scientific and technical knowledge, cannot be reduced to a pure technical phenomenon. In his seminal work, Schumpeter defines the development process resulting from innovation as covering the following cases: ‘(1) the introduction of a new good… or of a new quality of a good. (2) The introduction of a new method of production… (3) The opening of a new market… (4) The conquest of a new source of supply of raw materials or half-manufactured goods… and (5) The carrying out of the new organization of any industry.’

One can observe that the breadth and scope of the above definition makes innovation a broad concept; many human, societal, cultural, and organizational factors are associated to leverage scientific and technical foundations into innovations that generate growth and development. Schumpeter ascribes a key role to *entrepreneurs* as prime actors who introduce innovations into a given society and conceptually

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4 We owe this conceptualization to the classical work of the Austrian economist Joseph A. Schumpeter (Schumpeter, 1983), first published in German in 1911 and translated into English in 1934.

5 See chapter II of (Schumpeter, 1983). Italics highlights are ours.
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distinguishes between them and the capitalists who are ‘owners of money, claims to money, or material goods’.6

The above discussion illustrates the potential difficulties surrounding any effort aimed at measuring innovation that we will eventually discuss; this concerns both defining metrics for intangible assets like knowledge and know-how and direct causalities between the above factors and the resulting economic growth.

Innovation and its role in bringing socio-economic development were recently high on the agenda of both developed OECD countries7 as well as developing countries.8 The rationale of this renewed – or heightened – interest for innovation is strongly correlated with the economic downturn following the financial crisis of 2008 and innovation potential to improve productivity and, consequently, GDP growth (see Box 1).

<table>
<thead>
<tr>
<th>Box 1. Innovation for Growth</th>
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<tr>
<td>In a recent study the McKinsey Global Institute (MGI) addressed the challenge of raising GDP growth of the world economy – G19 plus Nigeria countries were used as a proxy – up to an average compound rate of 4% per year through productivity improvement brought by innovation.</td>
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<td>The study identified growth potential in catching-up with best practices essentially in emerging/developing countries (75% of the growth potential) and pushing the frontier of innovation for the remaining 25% (essentially in developed economies).</td>
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<td>Five domains were considered: Agriculture, Food processing, Automotive, Retail and Health care.</td>
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<td>Agriculture productivity increases of up to 221 in 2025 (using a base of 100 for 2009) were identified through mechanization and scale, waste reduction, Meat production efficiency and Crop yield increase. For food processing, increases of up to 159 in 2025 (from the same base of 100 in 2009) were identified through operational improvements and shift to higher-value products. Auto manufacturing productivity can be improved up to 190 (from a base of 100 in 2013) largely thanks to operational improvements essentially in China and to a lesser extent in India, Europe and the United States. Retail trade productivity can likewise be improved up to 156 (from a base of 100 in 2012) thanks to adoption of modern trade practices (essentially in developing economies), merchandising best practices, supply-chain efficiencies, lean store operations, online migration, advanced analytics, and advanced automation. Finally health care costs can be reduced by up to 31% by 2025 thanks to the adoption of operational and procurement best practices and big data and health-care IT. Other factors like optimization of care delivery setting as well as optimization of treatment setting and length of stay are significant factors.</td>
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<td>Many of the productivity improvements outlined above leverage on a robust pipeline of innovations. Some are simply the continuation of existing industrial-research programs. Agricultural research to tailor and improve seeds and agronomical practices to raise crop yields in new geographies, and automotive industry initiatives to power cars using more efficient fuel technology are two examples. Others rely on technological innovations that have the potential to transform many industries. For example, highly efficient and intelligent robots—or bots—are beginning to boost efficiency in retail warehouses, mobile technology is increasingly being used to deliver health care in remote regions, and automobile manufacturers are installing a broader range of digital features in cars. Advanced materials such as nanolaminates—edible lipids or polysaccharide compounds—can be sprayed on</td>
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6 (Schumpeter, 1983), p 75.
7 (OECD, 2010a)
8 (World Bank, 2010)
food to provide protection from air or moisture and reduce food spoilage, while carbon-fiber composites can make cars and airplanes both more resilient and lighter. The Internet of Things can cut down time in production processes by detecting potential failures early, increase crop yields by measuring the moisture of fields, and dramatically reduce the cost of monitoring health.

Source: (MGI, 2015)

In developed countries, innovation’s role ‘if countries and firms are to recover from the economic downturn and thrive in today’s highly competitive and connected global economy’ is a particular concern. The aim is to develop innovation policies aimed at ‘empowering people to innovate, unleashing innovations, creating and applying knowledge, applying knowledge to address global and social challenges, and improving the governance and measurement of policies for innovation.’ It is further recognized that innovation accounts for the bulk of labor productivity growth in OECD countries and could play a key role in meeting global challenges like reduction of Greenhouse Gas (GHG) emissions.

By the same token and, as for developed countries, developing countries should equally adopt appropriate innovation policies if only to catch up in development. As a case in point the comparison of GDP evolution of Ghana and the Republic of Korea (figure 2) perfectly illustrates the role of innovation and knowledge accumulation in raising Total Factor Productivity (TFP) which contributes to the generation of more output per capita for the same amount of capital and labor inputs.

Figure 2. How Innovation contributes to Growth: A comparison of Ghana and the Republic of Korea, 1960-2005.


It is finally worth noting that, in the context of developing countries, the World Bank’s guide on innovation policies follows the spirit of Schumpeter’s definition stressing that ‘innovation means technologies or practices that are new to a given society.’ Particular importance is given to dissemination in low and medium-income countries stressing that ‘what is not disseminated and used is

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9 (OECD, 2010a), p 2.
10 Ibid., p 3.
11 As a case in point GHG emissions in OECD countries could be reduced to 14 Gt of CO$_2$ by 2050 due to the possible generalization of some key technologies compared to their current (2010) emission levels of 30 Gt - projected to more than double by 2050 if no effective measures are taken (Ibid., p 5).
12 The reader may refer to Annex 1 of (World Bank, 2013) - p 141-142 – for a useful theoretical framework establishing the contribution of TFP growth to output per worker’ growth.
13 (World Bank, 2010), p5; italics highlights are ours.
not an innovation.14 As we shall see in the sequel, this puts the onus on developing countries’ policy-makers to ensure large-scale dissemination of innovation proceeds (whether locally developed or ‘imported’) by focusing efforts on innovations that address and improve their countries’ populations living conditions.

B. THE KNOWLEDGE BASED ECONOMY AND ITS IMPACT ON INNOVATION AND EMPLOYMENT

The concept of knowledge-based economy (KBE) was introduced in the mid 90’s of the last century essentially as recognition of an état de fait whereby ‘OECD economies are increasingly based on knowledge and information. Knowledge is now recognized as the driver of productivity and economic growth, leading to a new focus on the role of information, technology and learning in economic performance. The term ‘knowledge-based economy’ stems from this fuller recognition of the place of knowledge and technology in modern OECD economies.15

The emergence of the KBE concept is associated with the digital revolution characterized, among others, by the development of mobile telephony and Internet access in advanced economies, dissemination of computer power in all command-and-control of industrialized processes and devices, and increased digitization of knowledge production and culture. New technological advances in life science (genome sequencing), health care, nanotechnologies, renewable energies,… equally rely ever more on sophisticated scientific knowledge and characterize KBE.

On the geopolitical and economics side, the end of cold war and emergence of China and other countries (the so-called BRICS16) as an alternative and often low-cost workshop of the World shifted significant chunks of industrial productions away from developed economies. This contributed to the ‘commoditization’ and cost reduction of many products – sometimes very sophisticated like computers and smartphones - shifting added-value and profits from industrialization and manufacturing into conception and design;17 the latter being heavily reliant on knowledge.

As an illustration of this shift into intellectual added-value, a study, substantiated by an analysis of Patent data, defines the knowledge economy as ‘production and services based on knowledge-intensive activities that contribute to an accelerated pace of technical and scientific advance, as well as rapid obsolescence18 and where the key component resides on ‘a greater reliance on intellectual capabilities than on physical inputs or natural resources.’19 The value of this definition resides in its highlighting of some key consequences of the digital revolution and its associated KBE which are new with respect to previous innovation cycles. In practice, these consequences has led to, among others, significant lowering of entry barriers in many industries as well as blurring of boundaries between previously distinct industries; a genuine situation that never occurred at such scale in past major economic cycles (See Box 2).

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14 Ibid., p 5; italics highlights are ours.
16 Initially the term BRIC was coined in 2001 to designate Brazil, Russia, China and India then South Africa was eventually added to make BRICS and some recent literature – see (OECD, 2013a) for instance- uses BRICS to add Indonesia.
17 Apple epitomizes this shift. With a historical market capitalization – never reached before by any listed company - of more than 700 billion US$ in November 2014 and entry into the Dow Jones Index in March 2015 at the expense of no less than the historical telecom operator AT&T, this company is essentially worth its knowledge, know-how and value of its brand and eco-system it managed to create around; definitely not the factories which it does not even own!
18 (Powell and Snellman, 2004). Italics highlights are ours.
19 Ibid., Italics highlights are ours.
Box 2. Is the Digital revolution an engine of growth?

Maybe few people have heard about Schumpeter but the term ‘creative destruction’ he has coined is quite widely known. The ‘perennial gale of creative destruction’ is the process through which new products and processes displace old ones; a phenomenon widely known from past industrial revolutions and also lesser important innovation cycles. On balance, creative destruction was until now considered as a positive phenomenon: although it, sometimes massively, destroys employment associated with obsolete technologies and processes it eventually creates others and, often, at larger scale. Thus the fairy tale goes. As Schumpeter coined it, the really relevant problem is not ‘how capitalism administers existing structures’ but ‘how it creates and destroys them.’

This line of thinking is now debated among economists because the gale of creative destruction driven by the digital revolution has led to an impressive and rapid transformation in established industries as well as it has contributed to the creation of new industries; still, its ‘record’ – at least until now - in terms of jobs creation and lessening of economic inequalities points towards the opposite direction of the above-mentioned classical wisdom. The main observations resulting from this debate can be summarized as follows:

- ‘The digital revolution is opening up a great divide between a skilled and wealthy few and the rest of society;
- Technology is empowering talented individuals as never before and opening up yawning gaps between the earnings of the skilled and the unskilled, capital owners and labor;
- More manufacturing work can be automated, and skilled design work accounts for a larger share of the value of trade, leading to what economists call “premature de-industrialization” in developing countries;
- No longer can governments count on a growing industrial sector to absorb unskilled labor… new work for those with modest skill levels is scarce compared with the bonanza created by earlier technological revolutions.

As we shall discuss in the sequel, despite the undeniable issues that the digital revolution brings with it, developing, and particularly Arab, countries cannot decide to shy away from this transition in a context of a globalized economy. If carried out in an integrated way, Arab countries can use this transition to leverage their important human and financial resources and address their burning socio-economic issue. The skills issues outlined should also act as a wake-up call for renewed efforts towards youth qualifications and skills development.

1. KBE impact on Innovation

The OECD groundbreaking document of 1996 highlighted that, ‘the knowledge-based economy places great importance on the diffusion and use of information and knowledge as well as its creation.’ Hence the importance of knowledge networks ‘where the opportunity and capability to get access to and join knowledge- and learning-intensive relations determines the socio-economic position of individuals and firms.’

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20 Schumpeter’s quotes are borrowed from John Elliott’s introduction to (Schumpeter, 1983). Originals are from Schumpeter’s book “Capitalism, Socialism and Democracy”.
21 The fact that such debates were echoed by a widely known liberal and pro-capitalist publication (The Economist, 2014) does indicate – at least – an absence of an ideological a priori bias.
22 (The Economist, 2014). Italics highlights are ours.
23 (ESCWA, 2014b)
24 (OECD, 1996), p 14; highlights are from the original source.
25 Ibid., page 14.
One essential consequence of this observation is that the linear model of innovation with the sequence research-development-production-marketing is no more applicable in the context of KBE. Instead a more complex model (see figure 3) where innovation ideas ‘can stem from many sources, including new manufacturing capabilities and recognition of market needs’\textsuperscript{26} is now applicable.

![Diagram of the linear model of innovation](image)

![Diagram of the chain-link model of innovation](image)

**Figure 3. Models of Innovation.**

*Source: OECD, 1996.*

As we shall discuss in the next section when dealing with innovation measurement, be it at firm or country level, innovation has become –largely thanks to the digital revolution - a complex phenomenon involving interaction between different categories of actors (industry, government, academia,…) both at national and international level. In the next chapter we address how innovation currently operates through the exposition of eco-systems and models substantiated by examples from developed, developing, and Arab countries.

2. KBE impact on employment

One major – and predictable – consequence of the KBE impact on employment is the bias towards skilled workers – called *job polarization* - with firms willing to pay premiums to hire such workers at the expense of their lower-skilled peers (see also box 2); moreover, firms are more and more valuing so-called *soft skills* of workers including: independent thinking, capacity to adapt and interact with others,

\textsuperscript{26} *Ibid.*, page 14.
capacity to learn new skills,…This was strongly hinted by the OECD document of 1996\textsuperscript{27} and subsequently confirmed by more recent studies and data.\textsuperscript{28}

As an example of KBE impact on employment, the latest edition of the bi-yearly STI scoreboard of OECD provides data on percentages of workers contributing to firms’ Knowledge-based capital (KBC) in OECD countries. KBC ‘consists of assets lacking physical substance the value of which stems from their knowledge content and lasting nature’ and ‘because people are the main source and means to embody such knowledge, human capital plays a key role in generating and accumulating KBC.’\textsuperscript{29}

Data for year 2012 shows that KBC-related workers accounted for between 13\% and 28\% of total employment in OECD countries (highest percentage was in the USA); the span is larger in manufacturing (12\% to 37\%) than in services industries (21\% to 34\%)\textsuperscript{30} likely hinting that services have higher needs of KBC workers.

Depending on their occupation, percentages of workers’ contribution to firms’ KBC were provided for four categories of KBC assets: organizational capital, computerized information, design, and research and development; percentages of workers contributing to more than one asset were also provided. In all countries organizational capital had the highest proportion of workers uniquely contributing to it; among workers contributing to more than one asset, the combination of organizational capital and R&D came significantly first in the majority of countries followed by workers contributing in addition to a third computerized information category.\textsuperscript{31}

C. INNOVATION MEASUREMENT AND POLICIES

1. Genesis in Developed Countries

Efforts to measure innovation, particularly in the context of KBE, started in developed countries since the eighties of the last century; these efforts were aimed primarily at designing appropriate innovation surveys of firms and have led to the first edition of the so-called Oslo Manual in 1992 with a second edition following in 1997.\textsuperscript{32} In these initial editions the scope of innovation was still limited to technological innovation covering only products and processes which are new to a firm.\textsuperscript{33} The third – and still current - edition of the Oslo Manual of 2005 significantly enlarged the scope of innovation by removing the technological qualifier; it includes innovation in methods and hints at innovation in the public sector as an area deserving further attention.

The Oslo Manual’s definition of innovation is worth quoting: ‘An innovation is the implementation of a new or significantly improved product (good or service), a new process, a new marketing method, or a new organizational method in business practices, workplace organization, or external relations.’\textsuperscript{34} Three observations can be raised regarding this definition:

- It can be considered as an adaptation of Schumpeter’s definition coined a century ago to the early 21\textsuperscript{st} century context characterized by the advent of KBE particularly in developed economies;

\textsuperscript{27} Ibid., p16-18.

\textsuperscript{28} For a detailed discussion of those issues in the context of Arab countries and their impact on Arab youth employment see (ESCWA, 2013b).

\textsuperscript{29} (OECD, 2013a), p 88. Italics highlights are ours.

\textsuperscript{30} Highest percentage for manufacturing is in the USA whereas, for services, it is in Israel; (OECD, 2013a) page 89.

\textsuperscript{31} (OECD, 2013a), pages 88-89.

\textsuperscript{32} The reader may find this second edition at http://www.oecd.org/science/inno/2367580.pdf

\textsuperscript{33} Ibid., p 28.

\textsuperscript{34} (OECD, 2005), p 46.
- The qualifier *new* is common to all innovation aspects stressing the importance of novelty adoption by a firm irrespective if it has been previously known or implemented by others;
- The term *external relations* encompasses the whole set of the firm’s relations with peers, education and research system, market demand, country’s innovation policies, and infrastructure and institutional framework. The innovation’s measurement framework shall address all these components.\(^{35}\)

Another landmark development came five years following the third edition of the Oslo Manual through the adoption by OECD in 2010 of an Innovation Strategy\(^ {36}\) with a compendium on Measuring Innovation.\(^ {37}\)

The OECD Innovation Strategy came in a context of the deep economic slowdown which followed the financial crisis of 2008. Innovation’s role to ‘accelerate the recovery and put countries back on a path to sustainable – and greener– growth’\(^ {38}\) was particularly highlighted. Five Innovation policy principles were suggested (see box 3) on the background consideration that Innovation is not restricted to firms (government and social innovation should be considered as well) or entities engaging in research and development.

<table>
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<th>Box 3. Policy principles for Innovation</th>
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<tr>
<td>The OECD Innovation Strategy is built around five priorities for government action, which together can underpin a strategic and broad-based approach to promoting innovation for the 21st century:</td>
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<tr>
<td>1. Empowering people to innovate</td>
</tr>
<tr>
<td>2. Unleashing innovations</td>
</tr>
<tr>
<td>3. Creating and applying knowledge</td>
</tr>
<tr>
<td>4. Applying innovation to address global and social challenges</td>
</tr>
<tr>
<td>5. Improving the governance and measurement of policies for innovation</td>
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The priority assigned to each of these principles depends on the nature and state of the system of innovation in each country, as “one size does not fit all”. However, because of the interactions within the innovation system, attention must be given to all policy areas to improve its operation.

*Source:* (OECD, 2010a).

2. Innovation Policy Challenges in Developing Countries

The World bank’s Innovation Policy guide for developing countries\(^ {39}\) came at about the same time than the OECD’s Innovation strategy out of a similar concern of leveraging Innovation at the service of growth and economic development for developing countries.

Evidently, challenges faced by developing countries in leveraging innovation for development are at another scale than those faced by developed countries. Nonetheless, there are striking similarities between the high-level priorities governing the policy principles of the World Banks’ approach for developing countries and those for developed countries outlined in box 3, as witness:

1. providing basic support to innovative activity;
2. reducing obstacles to innovation;

\(^{35}\) *Ibid.*, Figure 2.1 of p 34.
\(^{36}\) (OECD, 2010a).
\(^{37}\) (OECD, 2010b).
\(^{38}\) (OECD, 2010a) p 2.
\(^{39}\) (World Bank, 2010).
3. sponsoring appropriate R&D, and;
4. fostering a receptive and creative population.

The World Bank document uses a nice illustrative gardening analogy in which innovation can be seen as a plant where the first priority is equivalent to watering, the second to removing weeds, the third to nurturing the soil, and the fourth to preparing the ground.\textsuperscript{40}

Similarities with developed countries stop below the headline however as witness the detailed discussion of the above four policy principles, namely:

- **On the provision of basic support to innovative activity** it is observed that ‘OECD countries often provide the business sector with fiscal incentives such as tax rebates to stimulate R&D and innovation-related efforts. Such incentives, which work best for medium and large-scale industry, are generally not adapted to the situation of low- and medium-income countries, which lack sufficient accounting capabilities and have a large informal sector of small firms with no R&D expenses.’ It is highlighted that ‘difficulties arise in the intermediary stages’ of ‘prototype testing, product development, market research, and the like’ where ‘public-private networks or groups that can bring innovation projects to fruition by gradually mobilizing private money and management competencies, marketing opportunities, and other essential elements are critical.’\textsuperscript{41}

- **As for reducing obstacles to innovation** there are similarities with some OECD practices in supporting innovation through effective procurement policies where ‘performance standards rather than set technical requirements’ can be required in association with an offering ‘small and medium firms a share of contracts.’ There is however a call for developed countries in international commerce to ‘abolish the practice of taxing processed products (with added value) more than raw materials imported from developing countries, as it undermines the efforts of developing countries to climb up value chains’ as well as relaxing of licensing regimes as developing countries ‘cannot maintain costly protection systems or afford high licensing fees;’ there is an explicit call for open-licensing particularly in ‘software, genetic engineering, and related fields.’\textsuperscript{42}

- **Concerning the sponsoring of appropriate R&D activities**, after recalling that the bulk of worldwide R&D is done in developed OECD countries and emerging BRICS and observing that in developing countries ‘public and university laboratories are often ivory towers, cut off from local needs and poorly funded and staffed,’ the following principles are outlined as remedies: (i) make research activities in public laboratories ‘partly dependent on external resources linked to explicit demands’ from ‘industry, communities, or the government’ so that they become ‘more attentive and more responsive to economic and social demands,’ (ii) equip public research laboratories ‘to respond efficiently to the need for technical research, technical assistance, certification, and quality control—functions that the business sector, which has low R&D capabilities in developing countries, is unable to perform,’ and (iii) provide incentives—as in some OECD countries—‘that facilitate collaboration by the university or public research structure with the business community, such as joint R&D projects partly funded by government agencies’ noting however that ‘such practices can also undermine long-term research efforts of collective interest and of a public good nature’ particularly when ‘multinational corporations are involved, as they often are in developing countries.’\textsuperscript{43}

\textsuperscript{40} Ibid., p 9.
\textsuperscript{41} Ibid., p 13. Italics highlights are ours.
\textsuperscript{42} Ibid., p 13-14.
\textsuperscript{43} Ibid., p 14-15.
Finally on the last, but not least challenge of fostering a receptive and creative population, without much surprise key challenges facing developing countries are highlighted by: (i) the need to develop ‘soft skills’ such as problem solving, communication, and teamwork and a good work ethic’ which ‘are important for innovation, as well as more generally in the economy, as innovators need to interact with both the business sector and the community,’ (ii) the need of proper vocational training which ‘plays a vital role in preparing workers for the labor market’ and, (iii) the need to reform an education system ‘characterized by traditional teacher-dominated classrooms and strong emphasis on rote learning’ as well as the “need to make educational strategies part of a broader innovation agenda.” It is worth noting that the above challenges related to education were discussed in a recent ESCWA report addressing Arab Youth as well as in the Arab Knowledge Reports of UNDP with similar observations and recommendations.

3. Innovation and KBE Measurement Frameworks

3.1 Frameworks addressing Developed OECD and some emerging countries

Besides being an important primer on Innovation, the Oslo Manual of the OECD has a principal objective of guiding countries in their efforts to implement innovation surveys primarily targeted at firms in the business sector whether they produce goods or services, perform innovations or not, conduct R&D or not. It is important to note that the manual is not strictly prescriptive; countries may differ in their actual implementation of innovation surveys both in methodology and design.

Firms’ Innovation activities are broken down under three categories: (i) ‘research and experimental development (R&D)’ whether it is carried out ‘intramural (in-house)’ or through ‘acquisition of external R&D;’ (ii) ‘activities for product and process innovation’ through ‘acquisition of other external knowledge, acquisition of machinery, equipment and other capital goods, other preparations for product and process innovations, market preparations for product innovations’ and ‘training,’ and; (iii) ‘activities for marketing and organizational innovations.’

Qualitative and quantitative data on Innovation should be collected on all of the above activities; the manual acknowledges that ‘Innovation expenditure questions are among the most and time-consuming to answer’ primarily because ‘expenditures on a number of [innovation] activities may not be directly available from enterprises’ accounting systems.’

One key aspect of an innovation survey addresses ‘intangible investments,’ in other words, all the firms’ training expenditures and all marketing expenditures not specifically related to a given innovation. Such expenditures are expected to provide longer-term returns than Innovations; they play for instance an important role in improving labor productivity as observed by the OECD innovation strategy where intangible assets are shown to have been at the origin of a quarter of labor-productivity growth between 1995 and 2006 in countries like Austria, Finland, Sweden, UK, and the United States.

44 Ibid., p 15-16.
45 (ESCWA, 2013b).
46 (UNDP, 2009), (UNDP, 2011) and recently (UNDP, 2014).
47 (OECD, 2005) p 118.
48 Metadata on innovation surveys carried out by OECD countries, Brazil, China, Russia and South Africa in the period from 2006 to 2008 can be found in http://www.oecd.org/sti/inno/Metada%20Innovation%20Survey.pdf
49 Ibid., p 97-98.
50 Ibid., p 99.
51 (OECD, 2010a), p 4-5.
Other issues addressed by innovation surveys relate to sources of funding innovation, objectives and effects of innovations (i.e., reasons for which a firm engage in a given innovation), impacts of innovation on turnover, costs and employment productivity, and on factors hampering innovation activities; they offer important information that serve to adapt and adjust Innovation policy.

Innovation surveys feed the OECD’s database on Innovation statistics with 53 indicators all related to firms’ Innovation activities in 33 OECD countries plus four other emerging countries (BRICS). This is an important information source but is nonetheless only limited to 37 countries; another source of information surveys following the Oslo Manual methodology is available through the UNESCO Institute of Statistics: its first compilation of Innovation data only covering the manufacturing sector in 64 countries includes emerging and developing countries with Egypt and Morocco among Arab countries.

Although firms are main innovation actors, other actors are involved not to mention the important role of Innovation Policy and the larger socio-economic and education environment affecting Innovation. The OECD’s bi-annual Science, Technology and Innovation (STI) Scoreboard provides a larger perspective through a rich set of 260 indicators (the above-mentioned 53 innovation indicators are among them). Although it is a tremendously rich source of data and analysis (see Box 4) its scope is nonetheless larger than innovation per se: as its name says it, it addresses science and technology as well as innovation but still suffers from the same limitations in terms of countries covered with limitations to OECD and BRICS.

Box 4. Some Key findings from the 2013 Science Technology and Innovation Scoreboard

Investment in innovation remains a priority. In 2012, OECD governments invested the equivalent of 0.8% of GDP in direct funding of R&D at home or abroad. 27 of the 34 OECD countries and a number of partner economies now indirectly support business R&D via tax incentives. New estimates show that the cost to a firm of investing in R&D depends on its size, location and balance sheet.

Young, dynamic firms contribute more to job creation than previously recognized. Between 2008 and 2011, net employment in the OECD area fell by 2%, or 9 million people. During the crisis, most jobs destroyed reflected the downsizing of mature businesses; net job growth in young firms (5 years old or less) remained positive.

Emerging economies increasingly play a role in science and innovation. In 2011, China was the second-largest R&D performer after the United States. It was also the second largest producer of scientific publications, accounting for more than 74 000 collaborations in 2011.

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52 (OECD, 2005), p 102-103.
54 Ibid., p 109-112.
55 Ibid., p 112-115.
56 http://www.oecd.org/sti/inno/Innovation%20Indicators%20Dataset.xls
57 Although it is claimed that “a growing number of countries in Latin America, Eastern Europe, Asia, and Africa have begun undertaking surveys based on the Oslo Manual” (OECD, 2005) p 3, their data – if any - is not included within the OECD’s database.
59 Data on innovative firms in Egypt will be discussed in the next chapter; Morocco’s data is limited to firms engaged in R&D and having external collaborations without any information on firms engaged in innovation.
60 Latest edition is (OECD, 2013a).
61 Largely because of the fact that a majority of developing countries cannot provide – at least on a regular basis - the sophisticated statistics available from developed OECD and major emerging countries. The Oslo Manual (OECD, 2005) provides useful insights on issues faced by developing countries when conducting innovation surveys (see Annex 1, p 135-148)
Researchers are increasingly mobile. The top nine international bilateral flows of researchers coming into and leaving a country involve exchanges with the United States. On average, the research impact of scientists who move affiliations across national boundaries is nearly 20% higher than that of those who never move abroad.

University hotspots are still concentrated in a few locations. Of the top 50 universities 34 are located in the United States. The rest are in Europe, and, for the first time, two are outside the OECD area (China, Taipei).

Source: OECD, 2013a (with editing)

Before addressing measurement frameworks covering developing and Arab countries, it is worth noting that the OECD compendium on measuring innovation published alongside the OECD Innovation Policy of 2010 is a serious attempt to build a more comprehensive measurement framework. The approach is still experimental – even for developed countries – and implies a long-time frame by the document’s admission. It is worth noting that this document influenced the re-design of the GII framework in 2011 that will be discussed below.

The essential added value of the innovation measurement compendium lies in the five thematic chapters addressing the principles grounding the innovation Policy document outlined in Box 3. Each chapter ‘draws on traditional indicators and proposes experimental ones to reflect the priorities for government action of the OECD Innovation Strategy. No attempt is made to choose a set of indicators for benchmarking purposes. On the contrary, the idea is to present traditional ‘positioning’ indicators that have been, and can be, used to show where countries stand on a particular issue, and, on a facing page, to present more sophisticated or experimental indicators that go beyond simple ‘pointers’.’

An example drawn from the empowering people chapter addresses the skills mismatch issue with the positioning indicator of unemployment rate among university graduates (males and females). For this issue the manual presents two experimental indicators on Supply of and demand for highly skilled employees and Percentage difference in median gross annual earnings between doctorate holders working as researchers and those not working as researchers. The first indicator shed light on the ‘skill composition of employment based on occupation and educational attainment and shows a difference between the supply of and demand for highly skilled employees in most countries.’ The second indicator reveals that ‘in most countries for which information is available, doctoral graduates are better paid when they do not work as researchers, especially outside the enterprise sector.’

3.2 Global Frameworks addressing Developing countries

3.2.1 The INSEAD’s Global Innovation Index (GII)

The INSEAD’s GII – first published in 2007- is now in its 7th edition covering Innovation in 143 countries. The GII conceptual framework is organized under 7 pillars (five are dedicated to Innovation

62 (OECD, 2010b)
63 Ibid., p 4.
64 A familiar issue in many Arab countries.
65 Ibid., p 50.
66 Ibid., p 50-51.
67 Actually no more than 14 countries.
68 Ibid., p 50-51.
69 (INSEAD, 2014).
70 (INSEAD, 2014) p 41-51.
inputs: Institutions, Human Capital and Research, Infrastructure, Market Sophistication, and Business Sophistication and two to Innovation Outputs: knowledge and Technology outputs and Creative Outputs) fed by 81 indicators: 56 are hard data from international organizations, 20 are composite indicators also fed by data from international organizations, while the remaining five are drawn from opinion survey.\footnote{INSEAD, (2014), p 373-385. The Opinion Survey indicators are drawn from the World Economic Forum’s survey of the business community that feed the Global Competitiveness Index (WEF, 2014a) and the Networked Readiness Index (WEF, 2014b).}

The GII framework evolved over the course of its successive editions - mainly in its fourth edition of 2011\footnote{INSEAD, (2011).} where no less than 20 new indicators were added – and is still refined over the years although it has reached certain stability in its last edition by its author’s admission. The GII is influenced by other work on Innovation measurement by OECD and other initiatives in developed countries;\footnote{For a detailed discussion of such influences see (INSEAD, 2011) p4-8.} for instance, it adopts the OECD’s Oslo Manual definition of Innovation\footnote{INSEAD, (2014) p 41.} and the OECD’s Innovation Strategy and measurement compendium were acknowledged as major source of inspiration when the GII underwent its major 2011 update leading to the inclusion of many new variables.\footnote{INSEAD, (2011) p 7-8.} The full composition of the GCI with its pillars and their composing indicators is given in table A.1 of the Annex.

3.2.2 The World Economic Forum’s (WEF) Global Competitiveness Index (GCI)

The WEF’s GCI is not specifically related with innovation but includes a specific pillar on this issue when evaluating a given country’s competitiveness. The GCI is yearly published in the Global Competitiveness Report\footnote{WEF (2014a) is the last edition covering 144 countries.} of the WEF and, quite significantly, leverages on indicators drawn from the executive opinion surveys of the business community carried out in each covered country. This has the advantage of compensating for the absence of hard data on some difficult and hard to measure – particularly in developing countries – output and impact issues; it might however introduce a bias in some critical issues where the opinion of other stakeholders (Government, Civil Society, NGOs,…) is at least equally worth a voice.\footnote{The reader may refer to (ESCWA, 2013a) for a detailed discussion on difficulties surrounding the establishment of Indicators related to outputs and impact as well as the opinion survey bias; even if the discussion is focused on ICT Indicators, it is nonetheless of more general interest and could be applied as well to innovation.}

The GCI’s Innovation Pillar is made up from seven Indicators: Capacity for Innovation, Quality of scientific research institutions, Company spending on R&D, University-industry collaboration in R&D, Government procurement of advanced technology products, Availability of scientists and engineers, and PCT patents, applications/million pop. The first six indicators are all drawn from the executive opinion survey while only the last one on patents is drawn from hard data. It is worth noting that the combined weight given to the Innovation pillar and its companion Business Sophistication pillar (they both make up the so-called Innovation and Sophistication Factors) depends on the economy’s development stage.

3.2.3 The World Bank’s Knowledge Assessment Methodology and Index (KEI)

The World Bank’s Knowledge Assessment Methodology (KAM)\footnote{http://www.worldbank.org/kam} is an interactive benchmarking tool based on 148 variables covering 146 countries; it is aimed to help countries identify challenges and

\footnote{It seems that the tool (see link in previous note) is not anymore maintained with links towards the variables database broken (returning “error 404” as of March, 2015). This could not allow for any customized analysis and/or enlargement beyond the 12 scorecard variables.}
opportunities they face in making the transition to the KBE. Actually, only 12 variables are used as representatives (or scorecards) of the larger set of 148 variables. These feed four pillars (three variables under each) of the KEI addressing Economic and Institutional Regime, Education and Human Resources, Innovation, and Information and Communication Technology.

The Innovation pillar is made up of three variables measuring Royalty and License Fees Payments and Receipts (US$ millions), Scientific and Technical Journal Articles, and Patent Applications Granted by the USPTO. All are per Million Population and reference years (for the last measurement of 2012?) are respectively for years 2009, 2007, and average for years 2005-09.

The KAM, despite its data continuity and tool maintenance issues, represents however an attempt which specifically addresses the transition to KBE where, in the absence of other sources, presents an interest to evaluate this phenomenon in developing (and Arab) countries. However, if the KEI is reduced to its 12 scorecard variables, the GII offers a broader measurement and – although it claims to measure innovation – its scope is no less broad than the KEI (it definitely covers the economic and institutional regime, education and human resources, and ICTs) and could claim to be considered as well a measure of transition to the KBE.

We refer to another document for a detailed discussion of Arab countries’ performance in the KEI and its four pillars; we only recall for the purpose of this document two main findings drawn from this document: in the period between 2000 and 2011 – that is, prior to the political turmoil witnessed in the region – the values of the KEI have stagnated to lowered for most Arab countries – particularly notable among some GCC – with only few countries showing slight improvements. In the Innovation Pillar of the KEI, only the UAE and Oman and, to a lesser extent, Qatar, seem to have significantly improved their respective scores over the same period.

D. STATUS OF ARAB COUNTRIES IN INNOVATION AND TRANSITION TO KBE

1. Innovation and transition to KBE in Arab countries as measured by the GII

Arab countries’ status in Innovation as measured through the GII is summarized for the last four editions of this index on figure 4. As is often the case with many international indexes, high-income GCC have a lead due to their resources, political stability, and smaller-scale population.

The GII offers some exception as at least three lower-income countries (Jordan, Lebanon and Tunisia) manage to obtain comparable scores with three GCC countries (Oman, Kuwait and Bahrain). Only the UAE, Qatar and Saudi Arabia seem to be on a class of their own; the observation of their respective scores evolution between 2011 and 2014 highlights quite a significant fall of Qatar – the region’s leader in 2011 – associated with significant improvement of Saudi Arabia with UAE becoming the region’s leader by maintaining and slightly improving its performance over the same period.

It is worth noting that the region’s three leaders - respectively ranked at 36, 38 and 46th global positions in 2014 – are at a notch below the top 10 and also top 25 countries in the ranking. Over the same period of 2011 to 2014 movement at the top 10 of the GII ranking was nearly insignificant with nine countries being stable among the top 10 (some even maintaining the same position like Switzerland the leader) and

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80 See link to the variables’ list from the main page; this one -at least- works!
82 Ibid., p 28.
83 Ibid., p 34.
three others making entries for one or two years. The last report highlights that all of the top 25 countries in the GII are high income countries and are at a class of their own hinting at a persisting *Innovation divide*. Particularly the spread between them and the following still high-income countries (all GCC countries belong to this latter group) in all of the seven GII pillars is the largest among income groups. Factors driving success in Innovation seem thus to rely on qualitative factors beyond income levels; all Innovation leaders are high-income countries but all high-income countries are not necessarily Innovation leaders!

Finally, despite undeniable and laudable efforts (see Box 5) taken by some Arab countries to develop and nurture innovation over the last decade, a major source of concern lies in the fact that the GII classify a majority of Arab countries – eight out of fourteen as *underperformers* - relative to their GDP; among them are four GCC countries. Only Jordan and Morocco are in the *learner’s category* and none are among the *leaders group.*

![Figure 4. GII scores of Arab countries (2011-2014).](image)


In order to highlight critical issues facing Arab countries with innovation and transition to KBE it is useful to analyze deeper into the individual pillars of the GII to identify relative weaknesses and strengths. We adopt a method whereby the global GII rank of each country is taken as a ‘reference point’

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84 (INSEAD, 2014), page 9. These are: Switzerland, Sweden, Singapore, Finland, Hong Kong (China), Denmark, Netherlands, United Kingdom and the United States. Canada was among the top 10 in 2011, Ireland in 2012 and 2013, and Luxembour in 2014.

85 Ibid., page 10. The radar chart within box 2 speaks volumes.

86 As highlighted above and will continue to be in the next chapters.


88 Ibid., see figure page 26. Egypt, Tunisia, UAE and Saudi Arabia are below the trend curve but not clear under-performers.
and chart its rank relative to this reference for each of the seven pillars of the GII. The results are summarized on figure 5 for 12 Arab countries.

The Institutions pillar addresses political environment, regulatory environment and business environment. It highlights particular weaknesses in Egypt and Saudi Arabia, essentially in the political and regulatory environment, and strength for Oman thanks to good regulatory environment and political stability while its business environment is significantly beyond level with the exception of the ease to pay taxes indicator.

The Human capital and research pillar which address education, tertiary education and R&D is essentially a dividing line between high-income GCC – bar the UAE - and remaining lower-income countries. GCC countries underperform particularly in the education and R&D indicators families with

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89 The GII provides this data for all countries. See detailed countries profiles (Annex I) in (INSEAD, 2014).
90 Sudan, Yemen and Algeria were surveyed in the last edition of the GII but we excluded them from this analysis as, due to their low global GII rank, spreads between each pillar and global rank are not significant and informative.
91 The UAE and Qatar equally benefit from good scores for this indicator.
92 Although there are some bright spots in tertiary education like Qatar and Saudi Arabia’s high rank in Graduates in Science and Engineers or Qatar and Bahrain’s tertiary inbound mobility.
the exception of the UAE which scores very high (2\textsuperscript{nd}) in education.\textsuperscript{93} Egypt and Tunisia over-perform respective to their global rank in Education, while Tertiary education seems to be a particularly strong point of Tunisia and Lebanon (respectively 25\textsuperscript{th} and 26\textsuperscript{th}); All non-GCC countries have a much better showing in R&D relative to their global rank (Egypt 50\textsuperscript{th}, Lebanon 41\textsuperscript{st}, Tunisia 46\textsuperscript{th}, Morocco 70\textsuperscript{th}, and Jordan 59\textsuperscript{th}).

The **Infrastructure** pillar addressing ICTs, general infrastructure and ecological sustainability is the forte of the region. All countries outperform in ICT sometimes with excellent margins, like some GCC, but Jordan underperforms due to low scores in the two e-government indicators of UN DESA. General infrastructure is particularly strong among GCC and quite weak in many non-GCC with the notable exception of Morocco and, to a much lesser extent, Tunisia. Ecological sustainability is particularly weak in the region with all GCC countries showing bad scores in the GDP per unit of energy use indicator.

The **Market Sophistication** pillar measuring credit, investment, and trade and competition is a weak point of the region with the exception of Saudi Arabia.

Access to credit is a weak point in all of the region’s countries, even among GCC. Investment is only slightly better thanks to the notable good score of Saudi Arabia (22\textsuperscript{nd}) with Bahrain and Jordan showing good scores in the market capitalization as a percentage of GDP indicator (18\textsuperscript{th} and 19\textsuperscript{th} respectively).

Trade and competition is a strong point in Qatar, Saudi Arabia and Oman; Lebanon has a good score notably in the intensity of local competition (23\textsuperscript{rd}) while Morocco fares better (61\textsuperscript{st}) than its global rank for this same indicator.

The **Business Sophistication** pillar addressing knowledge workers, innovation linkages and knowledge absorption offers a contrasting picture. The two leaders, the UAE and Saudi Arabia, are quite neutral while Bahrain, Qatar, Jordan and Lebanon show a much better overall performance than remaining countries.

Knowledge workers are a bright spot in Lebanon (18\textsuperscript{th}), while notable are the particular low scores of Oman, Qatar and the UAE.

Innovation linkages are particularly strong in Qatar, the UAE, Oman and Bahrain while it is a weak point in Morocco and Tunisia largely due to a bad university/industry research collaboration indicator.

Finally, knowledge absorption is at best on average (in Jordan and Lebanon) while all remaining countries under-perform; FDI net inflows as a percentage of GDP is notably weak in many countries as well as the percentage of high tech imports less re-imports.

The **Knowledge and Technology Outputs** pillar addressing knowledge creation, knowledge impact, and knowledge diffusion is a weak point in a majority of countries particularly among the three leaders who significantly underperform in all of its three components; only Kuwait, Egypt, Morocco, and Jordan fare better than their global rank.

Knowledge creation which includes indicators related to patenting and quality of research production is significantly low in all six GCC countries; Egypt has the highest rate of citable documents in the H Index among Arab countries (48\textsuperscript{th}) hinting at a relative good quality of its research output, while Jordan (34\textsuperscript{th}) and Tunisia (38\textsuperscript{th}) benefit from good ranks in the Scientific and technical articles relative to their GDP.

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\textsuperscript{93} Though with 3 out of 5 education indicators related to education expenditures and school life expectancy not available, and remaining two below average, it is difficult to understand why the overall education performance of the UAE is so high!
In knowledge impact, no Arab country seems to witness a good showing in this group of indicators; only Kuwait benefits from the highest score (18th) among Arab countries in the growth rate of GPP per person employed indicator which is a measure of labor productivity.

Knowledge diffusion which measures the receipts a country gets from its high technology activities - and also its net FDI outflows as a percentage of GDP - witness an exceptional showing of Kuwait (6th) and to lesser extent Bahrain (34th) thanks to good values in computer and info services exports as percentage of total trade (1th) and FDI net outflows (12th). Morocco, Egypt, and Tunisia fare relatively well thanks respectively to computer and info services exports as percentage of total trade (21th), royalty and license fees as percentage of total trade (34th), and percentage of high-tech exports less re-exports (34th). Finally, one could note the low scores of the three regional leaders UAE (141st), Saudi Arabia (109th) and Qatar (94th) in this pillar.

Finally, the Creative Outputs pillar which addresses intangible assets, creative goods and services, and online creativity illustrates some strong points of the region’s leaders relative to other countries largely thanks to intangible assets: the UAE (1st), Saudi Arabia (5th), Qatar (9th) and, to much lesser extent Jordan (44th) have from exceptional to good scores thanks to ICTs and business model creation95 and ICTs and organizational model creation96 indicators. Both, however, are survey indicators.

Creative goods is a strong point of Lebanon (39th) thanks to its percentage of printing and publishing manufactures (9th) and Tunisia (44th) thanks to its percentage of creative goods exports relative to total trade (19th); Egypt also benefits from a good score in cultural and creative service exports as percentage of total trade (31th).

Finally, online creativity which measures a country’s impact and presence on the Internet does not show particular strengths in the region particularly among its GCC leaders who all underperform in this respect relative to their global GCI rank.

2. Innovation in Arab countries as measured by the GCI Innovation Pillar

The GCI, through its innovation pillar, offers a complementary – albeit consistent - perspective on the status of innovation in Arab countries. Table 1 summarizes scores values obtained by 14 Arab countries for each of the seven indicators making this pillar. Similarly to the principle of the previous chart for the GII we give color codes to indicate if the country’s ranking for any indicator is below (red), above (green) or consistent/neutral (yellow) with its overall GCI rank.

It is striking how the red color is dominant in this table particularly for the first four indicators where, with the notable exception of Qatar and, to a lesser extent, Jordan and Lebanon, Arab countries dominantly underperform respective to their GCI rank. The green spots seem primarily to reside in the Availability of Scientists and Engineers indicator where a clear divide exists between GCC leaders (bar the UAE and Qatar)97 and many lower-income countries; this is fairly consistent with the discussion of Human capital and Research pillar of the GII above.

On the opposite, in the Government Procurement of Advanced Technology indicator shows a reverse divide between GCC – bar Kuwait - and remaining lower-income countries – bar Jordan – in favor of the former group which is also reflected in the GII infrastructure pillar.

94 Bahrain’s scores for these two indicators are respectively 16th and 22nd.
95 UAE (4th), Qatar (6th), Saudi Arabia (23rd), and Jordan (34th).
96 Qatar (2nd), UAE (8th), Saudi Arabia (20th), and Jordan (31st).
97 It is probable that – in the case of the UAE and Qatar - respondents to this survey considered the capacity of their respective countries to attract highly qualified migrant workers.
All leading Arab countries in the GCI are weak performers in the *PCT Patent per Million/pop* indicator and this is consistent with the knowledge and technology output pillar of the GII (particularly knowledge creation); the green color attributed to countries like Lebanon, Egypt and Tunisia for this indicator reflects their relative good university research infrastructure compared to GDP level and global GCI rank.

![Table 1. Arab Countries ranks in Indicators of the GCI’s Innovation Pillar (2014).](image)

**Box5. Science cities, Incubators, and Technology parks in Arab countries**

Many Arab countries have launched initiatives aimed at nurturing innovation, improving science transmission and technology, and incubating startups. The following examples are by no means meant to be an exhaustive list.

**Berytech** ([http://www.berytech.org](http://www.berytech.org)) was created in 2001 by Saint-Joseph University in Beirut, Lebanon. It is one of the leading techno-poles in Lebanon and the region. To date, Berytech has housed more than 170 entities, assisted more than 2,000 entrepreneurs in several outreach programs, disbursed more than US$350,000 in grants to start-ups, and invested more than US$5 million in Lebanese technology companies.

**King Abdul-Aziz City of Science and Technology KACST** ([http://www.kacst.edu.sa](http://www.kacst.edu.sa)) in Saudi Arabia is host to both the Saudi Arabian national science agency and its national laboratories. It has 15 research teams in different disciplines and three programs on industrial property, an incubator and innovation centers, plus a grant system “to encourage excellence and innovation.” Only 23 per cent of KACST’s budget is invested in basic science, while the remainder is distributed among the applied sciences (31 per cent in medicine, 27 per cent in engineering and 16 per cent in agriculture).

The **Qatar Science and Technology Park QSTP** ([http://www.qstp.org.qa](http://www.qstp.org.qa)) aims to provide a sturdy and productive platform for technology-focused research, commercialization and enterprise growth. It is essentially a Free Zone that provides accommodation (land and buildings) and services for private and public research and development (R&D) facilities and technology-based companies. Financial support is
offered through three funds: *Proof of Concept, New Enterprise* and *Technology Ventures*. On the technology side a *Corporate Research Program* stimulates and directs the development of corporate-driven applied research activities. A *Research Grand Challenge* program aims to build world-class research, technology development and commercialization activities in Qatar in areas of energy, environment, healthcare and information and communication technologies, by identifying gaps where innovation is needed. Finally entities hosted by the QSTP benefit from Mentoring and tailored training programs. To date 34 companies are listed as hosted by QSTP; a significant proportion of them are affiliates of global companies.

**Jordan’s iPark** ([http://www.ipark.jo](http://www.ipark.jo)) specializes in enabling and accelerating the growth of startup companies through a range of programs, including the Queen Rania Center for Entrepreneurship (QRCE), the Intellectual Property and Commercialization Office (IPCO), and the Bedaya Business Angel Network; iPark services include Incubation services, Intellectual property and commercialization service, Entrepreneurship development and investment. To date 28 startups are incubated within iPark; graduate companies of iPark are collectively valued at over USD 50 million, generate millions of dollars in revenues, and provide thousands of high valued jobs.

*Source:* (ESCWA, 2014a) p 47 for Berytech and KACST; web sites for QSTP and iPark (accessed March 24, 2015).
III. Best practices from Developed and Emerging countries in building KBE

A. STI IN ARAB COUNTRIES: SOME SNAPSHOTS

As outlined by a previous research, ‘no reliable statistics exist on research and innovation in the Arab region, and no statistical infrastructures or institutions have been designed to produce them.’ The UNESCO Institute of Statistics (UIS) database provides some detailed Research and Development data for only a handful of Arab countries and, as already noted, firm innovation survey data for Egypt only recently became available.

The GII indicators discussed above shed some useful lights on Arab countries’ STI, nonetheless, the observation regarding lack of reliable data remains valid with the consequence that it is difficult to elaborate a comprehensive STI review of Arab countries.

In this section, we provide some additional snapshots on STI in Arab countries, focusing on area where some data is available from the UIS and other sources. Arab countries will be compared with developed as well as other emerging and culturally similar – like Turkey and Malaysia – developing countries.

1. Human Resources in Research and Development

An examination of statistics available for some Arab countries substantiates the observation that ‘the bulk of research in the Arab region is carried out within the higher education system.’

### Table 1. R&D Personnel (FTE). Arab countries, 2011.

<table>
<thead>
<tr>
<th>Country</th>
<th>Total (FTE)</th>
<th>% in Business enterprises</th>
<th>% in Government</th>
<th>% in Higher Education</th>
<th>% in Private Non-profit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Egypt</td>
<td>89,764</td>
<td>0.2</td>
<td>77.7</td>
<td>22.1</td>
<td>-</td>
</tr>
<tr>
<td>Iraq</td>
<td>17,633</td>
<td>-</td>
<td>16.2</td>
<td>83.8</td>
<td>-</td>
</tr>
<tr>
<td>Kuwait</td>
<td>850</td>
<td>-</td>
<td>100</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Morocco</td>
<td>32,584</td>
<td>4</td>
<td>14.7</td>
<td>81.2</td>
<td>-</td>
</tr>
<tr>
<td>Oman</td>
<td>1,030</td>
<td>12.1</td>
<td>34.8</td>
<td>53.1</td>
<td>-</td>
</tr>
<tr>
<td>Palestine</td>
<td>2,074</td>
<td>-</td>
<td>26.3</td>
<td>51.6</td>
<td>22.1</td>
</tr>
<tr>
<td>Tunisia</td>
<td>20,756</td>
<td>4</td>
<td>15.9</td>
<td>80.1</td>
<td>-</td>
</tr>
</tbody>
</table>

Notes: a: zero or negligible; b: 2010; c: 2008.

### Table 2. Researchers (FTE). Arab countries, 2011.

<table>
<thead>
<tr>
<th>Country</th>
<th>Total (FTE)</th>
<th>Researchers per million inhabitants</th>
<th>% in Business enterprises</th>
<th>% in Government</th>
<th>% in Higher Education</th>
<th>% in Private Non-profit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Egypt</td>
<td>41,568</td>
<td>524</td>
<td>0.2</td>
<td>52</td>
<td>47.8</td>
<td>-</td>
</tr>
<tr>
<td>Iraq</td>
<td>13,559</td>
<td>426</td>
<td>-</td>
<td>17.2</td>
<td>82.8</td>
<td>-</td>
</tr>
<tr>
<td>Kuwait</td>
<td>411</td>
<td>132</td>
<td>-</td>
<td>100</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Morocco</td>
<td>27,714</td>
<td>864</td>
<td>0.7</td>
<td>5.1</td>
<td>94.8</td>
<td>-</td>
</tr>
<tr>
<td>Oman</td>
<td>484</td>
<td>160</td>
<td>7.2</td>
<td>35.3</td>
<td>57.4</td>
<td>-</td>
</tr>
<tr>
<td>Palestine</td>
<td>1,312</td>
<td>327</td>
<td>-</td>
<td>17.8</td>
<td>57.9</td>
<td>24.2</td>
</tr>
<tr>
<td>Tunisia</td>
<td>19,086</td>
<td>1,837</td>
<td>4.3</td>
<td>8.5</td>
<td>87.1</td>
<td>-</td>
</tr>
</tbody>
</table>

Notes: a: zero or negligible; b: 2010; c: 2008.

99 Readers might usefully consult (OECD, 2013a) for a comprehensive STI review example.
100 (ESCWA, 2014a), p 51.
What strikes both with total R&D personnel and researchers data of Arab countries are the low
percentages in Business enterprises with three countries even reporting zero or negligible percentages;
only Oman reports a two-digit percentage (still, only 12.1) for R&D personnel in business. This can be
opposed with the situation of many developed economies where the proportions are at least near 50% and
up to 60% for both categories of R&D and researchers. In some emerging countries like China these
proportions reach as high as 76.6% for total R&D and 62.1% for Researchers while in Turkey they are at
respectively 50% and 42.2%.\textsuperscript{101}

The ratio of researchers per million inhabitants illustrates the good values of Tunisia and to lesser extent
Morocco. Such ratios might be misleading due to the demographic size of countries with large – often
rural- population; this demographic size, however, acts as a multiplier like for China where with a ratio of
only 1020\textsuperscript{102} this results in an impressive 1.4 million researchers more than the United States’ 1.25
million. This leads us to the second observation that developed countries are still at a category of their
own with many at near 4,000 researchers and above (5,158 for Japan and 7,423 for Finland) per million
inhabitants. Nonetheless among Arab countries the values of Morocco and Tunisia are comparable to
those of Turkey (987) and Malaysia (1,643).\textsuperscript{103}

2. Financing Research and Development

Table 3 summarizes data related to Global Expenditure on Research and Development (GERD) in Arab
countries with breakdown – when data is available - by financing entities and – between brackets –
etentities performing Research and Development.

<table>
<thead>
<tr>
<th>3.</th>
<th>% GDP</th>
<th>Per Capita in PPP $ (thousands)</th>
<th>% financed (performed) by Business enterprises</th>
<th>% financed (performed) by Government</th>
<th>% financed (performed) by Higher Education</th>
<th>% financed by Abroad</th>
<th>% financed (Not Specified)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Algeria\textsuperscript{b}</td>
<td>0.07</td>
<td>4.6</td>
<td>-*</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Egypt</td>
<td>0.43</td>
<td>27.7</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Iraq</td>
<td>0.03</td>
<td>2.3</td>
<td>-</td>
<td>100(92)</td>
<td>-(8)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Jordan\textsuperscript{c}</td>
<td>0.43</td>
<td>23.3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Kuwait</td>
<td>0.09</td>
<td>42.4</td>
<td>5.2 (20)</td>
<td>94.8 (80)</td>
<td>-</td>
<td>1.2</td>
<td>-</td>
</tr>
<tr>
<td>Morocco\textsuperscript{d}</td>
<td>0.73</td>
<td>35.6</td>
<td>29.9(29.9)</td>
<td>23.1(23.1)</td>
<td>45.3(47)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Oman</td>
<td>0.13</td>
<td>35.6</td>
<td>4.6 (23.9)</td>
<td>41.6 (30)</td>
<td>32.1 (46.1)</td>
<td>-</td>
<td>21.7</td>
</tr>
<tr>
<td>Saudi Arabia\textsuperscript{d}</td>
<td>0.07</td>
<td>18.8</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Sudan\textsuperscript{a}</td>
<td>0.3</td>
<td>5.7</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Tunisia\textsuperscript{d}</td>
<td>1.1</td>
<td>99.2</td>
<td>20 (20)</td>
<td>65 (80)</td>
<td>-</td>
<td>14.9</td>
<td>-</td>
</tr>
<tr>
<td>UAE</td>
<td>0.49</td>
<td>196.7</td>
<td>-(28.6)</td>
<td>-(39.6)</td>
<td>-(29.3)</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 3. GERD. Arab countries, 2011.

Notes: a: zero or not available (depending on context); b: 2005; c: 2008; d: 2009; e: 2010. Values between () refer to percentage
performed by the given category of entities.

Source: UNESCO Institute for Statistics, UIS online database: \url{http://stats.uis.unesco.org}

Regarding GERD as a percentage of GDP, it is striking that only Tunisia crosses the threshold of 1% with
some Arab countries at even below 0.1%. One might argue that the GDP denominator of some high
income GCC might be very high and distorting; still, if one considers the figures of GERD on a per capita
basis, only the UAE thanks to its high GDP and small population oversteps Tunisia. Compared to other
developed countries, their GERD average stands at 2% of GDP and above (United States is at 2.79%}

\textsuperscript{101}UNESCO Institute for Statistics, UIS online database, \url{http://stats.uis.unesco.org}
\textsuperscript{102}The second largest populated country, India, is at only 160 researchers per million inhabitants.
\textsuperscript{103}UNESCO Institute for Statistics, UIS online database, \url{http://stats.uis.unesco.org}
while Israel is at as high as 3.93%); China managed to reach comparable spending levels to developed countries with GERD at 1.98% of its GDP while Turkey and Malaysia are near or above the threshold of 1% at respectively 0.86% and 1.07% of their respective GDP. On GERD spending per capita, developed countries are on averages of 1,200 PPP$ and above (Sweden has as high as 1,461); China is still at 176.7 PPP$ but, thanks to its demographic multiplier, this results in an impressive amount of spending; Turkey and Malaysia are at comparable levels to the UAE at respectively 154.7 and 170.5 PPP$ per capita.

The main observation as regards GERD spending and performance by entities resides in the relative low percentages of business entities in the few countries for which data is available. Developed OECD countries are at averages of 67% for business, 12% for government – of which a good percentage goes to industry (government funds 9% of industry R&D) – while higher education accounts for 16% and the few remaining percent are for private non-profit organizations. An important emerging indicator, due to the globalization of science and technology, is the percentage of R&D financed from abroad; only three Arab countries report data for such a financing with only Tunisia having a significant percentage at 14.9%. In the EU 28 countries, on average 10% of business enterprises R&D funding comes from abroad but many developed countries are above that average (Australia, the UK and Ireland are above 20% while Israel is at a staggering 53%).

3. Quality of Research output

Science production in Arab countries is considered as low in quantity and marked by specialization where ‘energy sciences (engineering mostly) accounted for 47 per cent, followed by the environment and agriculture sciences with 24 per cent and basic sciences with only 15 per cent.’

Moreover, quality of research output is equally estimated as low. It is highlighted that ‘the average number of citations for a single paper from the United States is 3.82 (one of the highest averages worldwide), and the average for a South Korean paper is 1.51, the average number of citations from the Arab region ranges from 0.99 for Lebanon to 0.60 for Egypt.’

An often used index, measuring the impact of scientific publications, is the H-index; simply stated it measures ‘the number of articles within a given country (H) that have received at least H citations.’ The GII uses the H-Index as one of the components of measuring knowledge creation and table 4 summarizes values and ranks of Arab countries with respect to this Indicator.

<table>
<thead>
<tr>
<th></th>
<th>H-Index Score</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Egypt</td>
<td>132</td>
<td>44</td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>123</td>
<td>53</td>
</tr>
<tr>
<td>Morocco</td>
<td>99</td>
<td>65</td>
</tr>
<tr>
<td>Lebanon</td>
<td>97</td>
<td>67</td>
</tr>
<tr>
<td>UAE</td>
<td>87</td>
<td>71</td>
</tr>
<tr>
<td>Tunisia</td>
<td>85</td>
<td>74</td>
</tr>
<tr>
<td>Kuwait</td>
<td>83</td>
<td>76</td>
</tr>
<tr>
<td>Jordan</td>
<td>82</td>
<td>78</td>
</tr>
<tr>
<td>Algeria</td>
<td>78</td>
<td>82</td>
</tr>
<tr>
<td>Oman</td>
<td>63</td>
<td>93</td>
</tr>
<tr>
<td>Sudan</td>
<td>52</td>
<td>109</td>
</tr>
<tr>
<td>Qatar</td>
<td>50</td>
<td>111</td>
</tr>
</tbody>
</table>

104 (OECD, 2013a), p 100.
105 Ibid. p 108.
106 (ESCWA, 2014a), p 33. We refer to the whole chapter p 30-41 for a good discussion of Arab countries scientific production.
107 Ibid., p 36.
108 Ibid., p 36.
Only Egypt and Saudi Arabia seem to cross the threshold of 100 in the H-index while Morocco and Lebanon are nearing it. One must compare these values with those of developed countries where the United States sits on a category of its own with a value of 1,380 with the closest follower, the UK, is at 851, next followed by Germany 740 and France 681; all other countries of the top 10 for this Indicator being at above the threshold of 500.\footnote{\textit{INSEAD}, 2014, p 347.}

The H-index may favor countries with established scientific institutions\footnote{See discussion on p 36 of (ESCWA, 2014a) \textit{not to mention, again, Israel at 414.}} nonetheless emerging countries like China (385), Brazil (305), and India (301) are not far away from developed countries scores.\footnote{See Table 5 of p 58 in (ESCWA, 2014a).}

### 4. Brain Drain and the role of Diasporas

The Brain Drain phenomenon in Arab countries has been extensively discussed. It is reported that ‘around one million highly qualified persons of Arab origin reside in the OECD countries’ with their proportion ranging between 15\% up to more than 50\% of the total diaspora of their respective countries.\footnote{\textit{Ibid.} p 58.} The highest Diasporas in number are those of Morocco and Algeria – more than 1.3 million each – with Jordan – a close follower at more than 0.5 million. The highest proportions of highly qualified people – at near or above 50\% - are among Egyptians and Jordanians and a majority of Arab countries Diasporas are above the significantly high threshold of 25-30\%.\footnote{Whose historical constitution dates back to immigration – mainly to France and other EU countries – of lower-qualified people; however, due to their size – and thanks to better educated second-generation - even with more modest proportions of qualified people (around 15-17\%) they provide large cohorts of qualified immigrants.}

The above figures hint that Arab Diasporas – with the exception of those of Algeria, Morocco, and Tunisia\footnote{\textit{Ibid.} p 58.} - are to a significant degree constituted from people who initially moved to developed countries for studies and found – after finishing studies - that working and living in these countries is a better option. Socio-economic and political factors evidently – and sometimes significantly – play a role; nonetheless with the observation that ‘45 per cent of Arab students who study abroad do not return to their home countries’\footnote{(ESCWA, 2014a), page 58.} one has to seek an explanation whereby their countries were generally unable to offer them acceptable conditions\footnote{Despite sometimes good financial and managerial incentives.} where they could exercise their talent.

The best proof of such an explanation lies in initiatives launched by some Arab countries to attract their pool of expatriate talent (see box 6 for the example of Morocco); these initiatives illustrate through a ‘mirror effect’ what has been missing until now, mainly (and not exhaustively): (i) recruitment –even on a temporary basis - of expatriate experts for concrete developmental projects of the home country; (ii) offering expatriates the possibility to exercise their entrepreneurship spirit and launch businesses in their home country without hindrance from – an often – inefficient and corrupt administration and other red tape; and, last but not least, in an age of global scientific networks, (iii) offering expatriates who chose to definitely return home the conditions of work where they can feel that they are still ‘connected’ with the...
mainstream knowledge hubs in their respective specialties. Nonetheless, the track record of such initiatives is still fragile\textsuperscript{117} and further evidence and time are needed to prove their effectiveness.

**Box 6. Leveraging Diasporas: the case of Morocco.**

Highly skilled Moroccans (those with a tertiary or graduate degree) make up 15% of the Moroccan Diaspora estimated at 4.5 million. This comes to more than 400,000 Moroccans living abroad who have either a bachelor’s or graduate degree.

Aware of the Moroccan Diaspora’s role in the development of innovation in Morocco, since the 1990s the government of Morocco has made major efforts to involve the Moroccans Living Abroad -MLAs. Some examples of these efforts include:

- **Maghribcom**: launched in January 2013, it is a web platform for MLAs to encounter the initiatives and policies of the Ministry in Charge of Moroccans Living Abroad. It offers Moroccan professionals an appropriate information framework in terms of business opportunities, ad hoc collaboration, investment, and employment.

- **FINCOME** (Moroccan Forum of International Competences Abroad): this program aims to involve Moroccan professionals residing abroad in supporting the economic, social, and cultural development of Morocco in terms of training, research, expertise, consultancy, or investment initiatives of their own.

- **International University of Rabat (UIR)**: is the first public-private partnership in the field of higher education in Morocco. The strategic orientation of the UIR—research, development, and innovation (RDI)—consists of the establishment of applied research with a strong, innovative market-oriented component in order to meet the socioeconomic needs of the country. The majority of UIR researchers are from the academic and scientific Moroccan Diaspora.

A study conducted by the European Training Foundation in 2012 revealed a steady return of migrants of working age in the last decade, more than two-thirds of them having their own businesses. The projects of those who have returned to Morocco are often innovative projects that were designed and built out of their experience abroad.

However, policies and actions towards MLAs are not yet fully adequate to address the needs of the Moroccan economy. Impact, to date, is still limited. Moreover, more data is needed as regards highly skilled Moroccans living abroad - their research and the innovations they have contributed to, as well as the impact of the different actions taken in Morocco towards mobilizing innovative migrants of the Moroccan Diaspora. This would provide an opportunity to tailor policy towards more targeted ends.


5. **Innovation in firms**

Innovation surveys of firms as per the OECD’s Oslo Manual are now carried out in many emerging and developing countries following the footsteps of developed OECD countries. Egypt is the unique Arab country for which data has recently became available (see Table 5). Although one country cannot be representative of all Arab countries’ diversity of situations, it is nonetheless the largest populated Arab country with a long history of industrialization; conclusions drawn from the analysis of its data are certainly of general interest.

\textsuperscript{117} See discussion in p 67-69 of (ESCWA, 2014a) not to mention the current dramatic and, at best, fragile socio-political situation in many Arab countries which— to say the least – does not motivate expatriates.
Global percentage of innovative firms Egypt is significantly lower than developed countries whose values vary from 30-60%; Malaysia at 53.5% and Turkey at 35% have percentages comparable to those of many developed countries. Large innovative firms – and this applies to all innovation categories – are significantly higher than average but this is a general trend observed in the majority of countries developed and developing alike (although the difference can sometimes be as low as only 50% difference). Medium innovative firms are above the global average for Egypt but compared to Malaysia’s 52.2% and Turkey’s 41.5% they are still significantly lower in comparison; the difference is more marked for small firms where at 41.4%and 32.3% Malaysia and Turkey’s averages are significantly higher. Data for micro firms is absent for many countries and could not allow for meaningful comparisons.

What is striking with innovation categories are the lower values of marketing and – more significantly – organizational innovation of Egypt with respect to the global average of its innovative firms. Marketing innovations among firms is at 25% and above in developed countries while Malaysia and Turkey are at very decent values of 50.2% and 38.4%. Organizational innovation highlights the deep gulf separating Egypt from developed and some emerging countries whose averages are at 30% with Brazil standing at an impressive 57.8% while Malaysia and Turkey are still at very decent 37.7% and 23.9% respectively.

The above data and discussion substantiate the following conclusion as regards the largest Arab country: percentage of innovative firms is significantly lower, even compared to other emerging and culturally similar countries; marked differences reside in the category of small and medium firms as well as in innovation in firms’ intangible assets of organization and marketing.

### B. INNOVATION ECOSYSTEMS

The term ecosystem draws its origins from biology and denotes a ‘community of living organisms (plants, animals and microbes) in conjunction with the nonliving components of their environment (things like air, water and mineral soil), interacting as a system.’[120] A biological ecosystem is ‘a complex set of relationships among the living resources, habitats, and residents of an area, whose functional goal is to maintain an equilibrium sustaining state.’[121]

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118 The Oslo Manual prescribes typical firm size breakdown to follow when conducting surveys – see (OECD, 2005), p71 – without specifying any names. UIS does not specify which it used for its own survey; most likely micro means less than 10 employees; small 10-49, medium 50-249, and large 250+.

119 Percentages are not exclusive; the UIS survey also provides data on firms carrying product-only, process-only, and product and process innovation. It is sad that UIS does not provide data as per mixed categories often adopted in OECD data of firms carrying out ‘product or process’, ‘innovation or organizational’, and both of the above two categories of innovations – see (OECD, 2013a) p 180-183. Moreover, it is important to note that the UIS survey is limited to manufacturing sector whereas OECD data includes the important service sector as well.


121 (Johnson, 2013), p1. Italics highlights are ours.
The association of the ecosystem analogy with innovation originates from successful examples of *agglomeration* whether in geographic, economic, industrial or entrepreneurial terms. In Schumpeter’s words, innovation ecosystems are primarily about *successful innovative regions* (Silicon Valley, Bangalore), *successful ICT platforms* (iPhone, Android) or *new industries* (cloud computing) and entrepreneurs and investors from all over the world jump on the bandwagon of these successes.\(^{122}\)

The term innovation ecosystem thus essentially denotes *successful outcomes* which might—or might not—result from a deliberate innovation policy. It should therefore not be confused with the latter or a national innovation system but rather indicates its expected outcome. Sometimes this distinction is not clear in the literature as the example of the UAE example discussed in box 7 illustrates; the essence of this exposition concerns policy measures aimed at producing an effective innovation ecosystem.\(^{123}\)

The identification of an innovation ecosystem as being in its essence an *outcome* does not evacuate the question of its impact on innovation policy. If we revert back to the above definition of an ecosystem two key-words bear particular importance: *agglomeration* and *sustainability*. Applied to innovation the former means managing the complex web of relationship that exist between innovation actors and the latter the sustainability of this web of relation meaning concretely—and, again, using a biological analogy—that every actor has something to ‘eat’ and the system does not fall apart due to a mighty predator, scarcity of resources or incapacity to deal with an outstanding external event. An innovation policy aimed at producing a thriving innovation ecosystem has thus to address those issues.

1. Relationship between Innovation actors

Prior to discussing relationship between Innovation actors it might be helpful to identify them. An identification of innovation actors is not necessarily unique and often depends on the specific geographical, economic, industrial, and entrepreneurial context in which innovation takes place. However, the following general taxonomy is often applicable:

- the *science and technology system* represented by universities and research centers who produce the basic knowledge on the basis of which technical innovations could happen;
- *firms*—whether established or created by new entrepreneurs— who are the prime actors who introduce innovations to create new goods and services, gain a competitive advantage, or address—or even create—new markets;
- *economic agents* who fund innovators—the ‘capitalists’ in Schumpeter’s terminology—like banks but also venture capitalists, equity managers, business ‘angels’, … and, last but not least;
- *Governments* who act on all of the above actors through funding and other regulatory and economic incentives; governments might also be innovation actors through their procurement of products and services and innovations they might introduce in services they offer to citizens.

In a classical wisdom, science and technology actors had a certain autonomy seeking primarily academic research; it was firms\(^{124}\) supported by economic agents who leveraged their findings in an ‘opportunistic’ way to introduce innovations. Governments—particularly in the 20th century—and largely as a result of the two world conflicts and subsequent cold war, played a key role in creating national science systems

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\(^{122}\) (Andersen, 2011). Italics highlights are ours.

\(^{123}\) The last edition of the GII criticizes some high-income countries—among them a majority of GCC—for ‘weaknesses in their innovation ecosystems when compared with countries of similar income levels’ because of their low GII score as well as their low innovation efficiency ratio (innovation outputs relative to innovation inputs). (INSEAD, 2014), p 28.

\(^{124}\) We remind that the term firm refers to established firms or new ones created by entrepreneurs.
and integrating them with the economy and also through their major procurement programs primarily in defense, nuclear technology, space, and to lesser extent health.\textsuperscript{125}

In a post-cold-war and nascent Digital revolution context, a book by ‘Gibbons et al. (1994) has been highly influential in the literature on innovation. These authors label traditional 19\textsuperscript{th} and early 20\textsuperscript{th} century research as ‘mode 1’ characterized by a cleavage between academia and society, this type of research is academic, autonomous, self-sustained, investigator-initiated, peer-reviewed, and discipline-based in nature. By contrast, ‘mode 2’ refers to more recent forms of knowledge production, which is centered mostly around the firm where research is increasingly context-driven, problem-focused, application-oriented, and interdisciplinary—task-force teams and tailored processes are created to work on specific projects. Other theorists, such as those of the ‘Triple Helix of Innovation’, have stressed the historical continuities and linkages in the relationship among academia, industry, and government.\textsuperscript{126}

Despite these very interesting debates among theoreticians, one practical and actual example is worth quoting: ‘the main novelties for today’s innovation ecosystems compared with earlier times can be found in the Internet/mobile/ICT systems’ platform dimension and web 2.0. This is because, today any entrepreneur with a good idea can, irrespective of geographical location, can launch a business application for Apple’s or Google’s iPhone or Android platforms and become a successful business. ‘\textsuperscript{127}Networking and open communication are therefore key for success.\textsuperscript{128} Any innovation policy seeking to control communications between actors through top-down dirigisme is likely doomed to failure or, at best, leads to low efficiency ratio;\textsuperscript{129} new innovation approaches that will be discussed in the next section illustrate the power of dynamic – and often less formal – communication channels. This is not to conclude that governments can – or should – do nothing: their policies should primarily aim at creating environment(s) where relationship and collaborations can be established between actors without much preconceived ideas. Governments should definitely abandon any ambition of being the omniscient planner in innovation.

2. Innovation Ecosystem Sustainability\textsuperscript{130}

As already outlined in the previous chapter, innovation contributes to growth primarily through the generation of more economic output for a given amount of labor and capital inputs. For an innovation ecosystem to be sustainable and thriving, a virtuous circle (see figure 6) should be established whereby the proceeds of economic gains from the so-called ‘normal economy’ feed research and development efforts in the ‘knowledge economy’ generating in turn technological breakthroughs leading to the introduction of new product, features and processes which generate more economic outputs and allow to sustain the financing of the knowledge economy.\textsuperscript{131}

\textsuperscript{125} We refer the reader to (World Bank, 2010) – p 56-57 - for a good history of science system in developed OECD countries.
\textsuperscript{126} (INSEAD, 2011) page 5.
\textsuperscript{127} (Gibbons et al., 1994) has critically reviewed, and discipline-based in nature.
\textsuperscript{128} (Anderson, 2011).
\textsuperscript{129} (OECD, 2013a) data substantiate that claim; see in particular chapter 3 “connecting to knowledge”.
\textsuperscript{130} As a matter of fact a majority of Arab countries are categorized by the GII as inefficient innovators; that is their innovation outputs to their innovation inputs ratio is below the threshold of 0.74. This is particularly the case among two regional GCC leaders: the UAE (0.5 – 127\textsuperscript{th}), and Qatar (0.6, 114\textsuperscript{th}). (INSEAD, 2014).
\textsuperscript{131} This section is inspired from (Jackson, 2013).
\textsuperscript{132} Though one might raise reservation on the terminology distinction between ‘normal’ and ‘knowledge’ economies – likely the knowledge economy could be considered as a whole with a ‘boundary’ between commercial/business and research and innovation aspects - the subsequent analysis and conclusions of (Jackson, 2013) are perfectly sound.
A key condition to ensure the sustainability of the above virtuous circle lie in the translation of R&D efforts breakthroughs into products that will lead to new profits; this is not an evident task and definitely not an ‘exact science’ as some might claim. A high percentage of R&D and innovative ideas – particularly when carried out by young entrepreneurs – are doomed to failure.

An innovation spectrum showing the distribution of resources invested in activities aimed at discovery, technology demonstration, technology development, and commercialization is shown on figure 7a. It highlights a ‘Death Valley’ through which young entrepreneurs – and/or new concepts or products even if brought out by established firms – could fall.

Reducing the breadth and depth of the Death Valley by pouring more resources into technology demonstration and development is economically unsustainable thanks to the high rates of failures.

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132 Venture capitalist/business angels for instance work on the assumption that only one out of ten of their investments will turn into a commercial success. That’s why their request of a ten-fold return as a minimum for successful operations can be explained by the necessity of at least recouping the losses from other investments.

133 See (Jackson, 2013) for a rigorous demonstration.
already outlined. The solutions prescribed (see figure 7b) consist in a mixture of measures – all impacting Innovation policy whether at national or sector/region specific level. One can view such measures metaphorically as aiming at shifting the walls of the valley close to each other and reducing its depth turning it form a ‘Death Valley’ into a ‘Challenge Basin’. This is done through:

- Training a cadre of champions whose job it is to ferry an innovation concept across the valley by championing it until it becomes commercially viable will effectively move the academic side to the right. Concretely this could be done by providing a means of subsistence or incentives for innovators to stay within the ecosystem. For example, the marginal and moderate growth enterprises that are considered as failures in the venture capital scenario could serve as habitats for champions between enterprise ventures transforming experience of failure into a valuable, experience because it teaches the champions to know when to cut their losses.

- Moving the commercial side of the valley wall further to the left would be to find ways of lowering the perceived risk for investors. Translating knowledge of discoveries developed in the academic community into a context that is relevant to the industry investors reduce the perceived risk for the investor so that he/she might be inclined to invest in the technology at an earlier stage. Academics could establish regular brainstorming dialogs with members of the investor communities about nascent technology and its potential capabilities.

- The above two axes act on intangibles where human relationship, capabilities and trust are key. The third axe is more material and involves infrastructure investments designed to benefit the innovation ecosystem through for example, putting in place rapid prototyping infrastructure lowering the entry costs for start-ups to engage in innovation and raising the success rate by increasing the number of attempts at translating the Valley of Death.

3. Innovation Ecosystems in Arab countries?

Box 5 from the previous chapter outlined initiatives launched by Arab countries which could be considered as policy initiatives aimed at creating an innovation ecosystem. Box 7 provides a more comprehensive example from the UAE. Still, as it has been outlined elsewhere, ‘a first appraisal of innovation policies in some Arab countries has concluded that measures to promote innovation cannot be evaluated properly because of the lack of comparative standards.’\(^{134}\) Even ‘direct measures to promote innovation through SME-oriented programs, techno-parks and incubators’ could not be evaluated ‘because statistics on the productive sectors are not sufficient.’\(^{135}\)

The establishment of techno-parks, science parks, subsidiaries of leading foreign universities and a host of incubators in many Arab countries - particularly over the last ten years with huge investments in some GCC countries – are certainly useful steps in the right direction. However complacency will be ill-advised. These initiatives – despite good scores obtained in some international indexes, primarily by some GCC countries thanks to good results in opinion surveys of business community,\(^{136}\) have not yet materialized into significant and ground-breaking outcomes.

The detailed analysis of Arab countries scores in some international indexes related with innovation in the previous chapter and the concrete anecdotal difficulties outlined in Box 7 for the UAE and Box 6 for Morocco substantiate the claim that no Arab country has reached a status where it could claim to have created a successful innovation ecosystem.

\(^{134}\) (ESCWA, 2014a), p 47.

\(^{135}\) Ibid.

\(^{136}\) (ESCWA, 2014a) p 45, rightly criticizes the representativeness of such surveys though – in the absence of hard data statistics – they are a lesser evil than nothing – see also (ESCWA, 2013a). The problem lies more in optimistic over-interpretations of their results by some governments in the region than in these surveys’ methodology which is clearly – and quite candidly - explained by its authors... for those willing to keep a cool head.
Box 7. The United Arab Emirates Innovation Ecosystem

The innovation ecosystem of the UAE is organized under three pillars of human capital, financial capital, and technological capital.

**Human capital** is fundamental to all innovative change. To this end the UAE’s budget allocation to education represents more than 20% of its total government budget, among the highest in the world. Higher education institutes are expanding by establishing world-class local universities, attracting top universities to open branches in the UAE. **Attracting foreign talent** is an important aspect of establishing and maintaining an innovative environment. Collaborative efforts among government authorities, private corporations, media, and entrepreneurial organizations are driving a cultural shift towards innovation- and entrepreneurship culture among nationals. More than 10 incubators/accelerators are operational in the country—a substantial increase from the three that were active in 2008.

**Financial capital** is provided through several sources of funding, including government funds, equity investing, and crowd funding or crowd investment. Government funds typically provide early-stage funding and include the TRA’s ICT Fund, the Khalifa Fund, the Expo 2020 fund, and others. In terms of equity investment in the UAE, venture capital (VC) is the most accessible, despite the low risk tolerance of VC funds. Seed capital and angel investment are still scarce and are not yet institutionalized. Crowd-based funding and investment is a nascent form of funding within the UAE, and provides early stage funding for start-ups.

The UAE’s R&D expenditure as a percentage of its GDP was 0.47% in 2011 (0.74% of non-oil GDP), below the global average of 2.08% and the OECD average of 2.32%. Targeted and industry-focused initiatives to develop R&D aim to raise **technological capital**. A robust and enforceable intellectual property rights system was reinforced thanks to a recent review of laws on intellectual property and copyright that has led to their harmonization with international standards.

Despite these efforts many challenges lie ahead in each of the above components.

**Limited technical talent** in STEM (Science, Technology, Engineering, and Mathematics) fields is still low compared with international standards. As a result, there are limited specialists with deep technical skills who can contribute to ground-zero innovation.

Although the UAE government has put several initiatives in place to stimulate R&D activities, the overall spending in the country still lags behind because of **limited spending by the private sector**. Another issue of concern lies in financing gaps of innovative firms with two identified death valleys: the first lies between incubators and crowdsourcing funding on one hand and Venture Capital (VC) funding on the other; the second, even larger gap, lies between VC and the – still nascent – private equity funding (see figure 3 of the source).

Finally, two issues related with environmental sustainability and increased prevalence of health issues like high incidence of diabetes, early onset heart conditions, and widespread obesity (among UAE nationals) needs addressing through respectively: lowering the country’s ecological footprint and effectively addressing climate change, and promoting healthy lifestyles; both are deemed critical for supporting the development of a progressive, knowledge-based economy.

**Source**: Ahmad bin Byat and Osman Sultan. *The United Arab Emirates: Fostering a unique innovation ecosystem for a Knowledge-Based Economy*. In (INSEAD, 2014), p 101-111.
C. INNOVATION IN INNOVATION: NEW APPROACHES

STI was never autonomous from socio-economic realities: both interact and impact each other through a complex web of relationship. For what concerns the scope of this study it is worth evaluating the effects of this interaction on STI by discussing: (1) new innovation policies approaches, (2) ICT-enabled innovation in public services and the economy, and (3) innovation policies to develop Renewable Energy Technologies (RET).

1. New Innovation Policies

New innovation policies often result from scholar and theoretical work. However, the three example of innovation policy approaches that will be discussed here share a common feature of owing their initial development – and subsequent formalization – to the fact that they address concrete situations and problems, namely: (i) the need for regions within the European Union (EU) to differentiate and attract investments (smart specialization); (ii) the globalization of the economy and STI networks – helped by modern ICT - that has led to a de facto situation where no firm can solely rely on its internal competencies and knowledge to innovate (open innovation), and; (iii) the development of innovations not necessarily at the frontier of knowledge to provide affordable economic and social services to the poor and help integrating them within the formal economy (inclusive innovation).

1.1 Smart specialization

Smart Specialization emerged as a policy approach from the work of Knowledge for Growth expert group of the European commission set in 2005 and aimed at improving the attractiveness of European regions to foreign investments. ‘From the start, the idea of smart specialization policy was not conceived as a planning doctrine.’ The aim was not to establish strength of a given region but rather ‘the formation of capabilities and the design to support entrepreneurial discoveries;’ smart specialization ‘must address the missing connections that should be made between R&D and Innovation activities, on the one hand, and the sectorial structure of the economy, on the other.’

Entrepreneurial discoveries thus play a key role. An entrepreneurial discovery ‘precedes the innovation stage’ and establishes ‘a new domain of opportunities (technological and market), potentially rich in numerous innovations that will subsequently occur.’ Examples of entrepreneurial discoveries illustrate their importance; they can be considered as being essentially a vision (see Box 8 for an example) – sometimes elaborated as a response to a crisis situation - eventually realized thanks to innovation and technical knowledge found within the region though this knowledge could be brought from elsewhere. Not all entrepreneurial discoveries visions necessarily become successful smart specializations but the reverse is true in that all smart specializations have at their origin an entrepreneurial discovery. It is finally very important to highlight that competencies needed for entrepreneurial discovery involve different bodies of knowledge: technologies are key of course but no less are knowledge of markets and competitors as well as the whole set of inputs and services required for launching a new activity.

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137 To provide some examples: it is no ‘coincidence’ that the Digital revolution and diffusion of Internet – initially a national US system - in every country came in the decade that followed the end of Cold War. The emergence of KBE concept, as we saw in the previous chapter, is closely associated with that of new countries –China and others – within the global capitalist system equally after the end of Cold War. Closer to the region, the sophisticated STI ecosystem in Israel is not independent from its military industry complex and permanent state of war resulting from its occupation of Arab territories.
138 (Foray, 2015), p 11. Italics highlights are ours.
139 Ibid., p 11. Italics highlights are ours.
140 Ibid., p 23. Italics highlights are ours.
141 Ibid, p 25.
Box 8. From Silk to Glass Fiber

As a result of a crisis situation faced by traditional markets in the silk industry (that began to decline in the 1960s), a dozen firms broke away from the Lyon (France) factory to explore ways of orchestrating a fundamental transition from silk to technical fabrics. They discovered that the Americans were using glass fiber in the aeronautics sector and worked on the integration of these new materials (glass fiber and then composite materials) into their processes.

This marriage between textile and chemistry opens the way to a multitude of products for new outlets in aerospace and transport equipment, sports, protection and decoration items, medical prostheses and geotextiles. In the big Lyon chemical complex, firms found the specialists they needed to resolve complex knowledge integration issues relating to the spinning of glass fiber, address warping problems, and master the adhesion of the resin to the glass fiber.

Entrepreneurial discovery, agglomeration and structural changes characterize the dynamic that has led to the construction of strong competitive advantages. This resulted in the creation of over 2000 jobs between the early 1970s and end of the 1980s.


Smart specialization is in its essence a vertical approach; in any given context of its application, it is necessarily focused on a narrow set of technologies and businesses. This poses a great challenge for policy design as they have been, traditionally, horizontally oriented (i.e., developing human capital, creating incubators,…). One way to address this difficulty is to focus – and assist – policy-makers in identifying ‘desirable areas for innovation policy intervention.’ In such a context ‘smart specialization can be viewed both as a policy objective, to encourage regions and countries to take risks in selecting a few priorities, and a process to help policy-makers identify domains and activities for potential specialization.’

Although Smart Specialization was conceived primarily as a regional approach it is claimed that ‘it can be applied without any problem to a particular sector as well as any geographic or political entity.’ The fact that smart specialization concept has been quickly adopted by the EU 2020 Innovation Union Initiative launched in 2010 leads to its experimentation in the 153 regions making the EU; the evaluation of such a large-scale experimentation of the concept will eventually draw useful lessons for other parts of the world – particularly developing countries – willing to apply it. It is mentioned that the OECD and World Bank are promoting smart specialization in other parts of the world though we couldn’t find as yet application examples from developing countries.

1.2 Open Innovation

As defined by W. Chessbrough in a book that popularized the concept, ‘Open innovation is a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as the firms look to advance their technology.’

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142 Ibid. p 36.
143 Ibid. p. 37. Italics highlights are from the original text. Chapter 3 of (Foray, 2015) discusses the design of smart specialization strategies to which the interested reader is referred.
144 Ibid., p 91.
145 Ibid. p 7.
The last edition of the OECD’s STI Scoreboard amply substantiates that open innovation has become a *de facto* reality in many developed OECD, and some other emerging, countries, as witness:

- Among product and/or process innovative firms, a significant percentage cited external sources of information as having been ‘highly important’ in their innovations. This is more marked for market sources (suppliers, customers, competitors) where percentages vary from 90% to below 40% while percentages for institutional sources (universities, government) are significantly lower generally at below 10%;
- Externally developed goods and services innovations among innovative firms were at least as high as 30% for services in a majority of countries reaching as high as 60% in South Africa and 50% in Japan; for goods, percentages are – more countries are at near 20% - but still with significant high percentages in South Africa (47%) and Japan (51%);
- Finally innovative firms significantly collaborate with peers for their innovation activities; this is higher among large firms (as high as 80% in the UK, more than 70% in three Nordic countries, Belgium and Australia, and a majority of countries above 50%) than for SMEs (values are generally at 30-50% lower than for large firms).\(^{147}\)

The advent of Open innovation is largely driven by the development of modern ICT technologies, some examples illustrate this statement: (i) the availability of scientific data grounding many innovation and ease with which scientific networks could be established across borders have reached new dimensions never met before; (ii) the Internet and social networks are becoming essential for firms to get customer feedback and useful ideas to improve their products and services; (iii) open platforms – particularly in the software industry – allow for collaborative and distributed co-development even among competitors - as witness the widespread success of Android operating system for Smartphones.

Open innovation opens perspectives beyond the strict limits of corporate R&D. New actors – particularly skilled youth from developing countries – can now contribute to global innovation networks; these networks are by no means formal; joining them and gaining recognition is essentially a matter of technical competencies, originality and innovative skills.

Open innovation thus allows for the integration of ‘different streams and perspectives’;\(^{148}\) one of them lies in inclusive Innovation discussed below.

### 1.3 Inclusive Innovation

The term ‘Inclusive Innovation’ might seem as an oxymoron at first glance! In a classical Schumpetarian wisdom, although Innovation generates growth, its short-term effects are characterized by rising inequalities both because of innovators being the first to benefit from the proceeds of their innovations and innovations’ tendency to advantage skilled workers at the detriment of the unskilled (a phenomenon known as Job polarization).\(^{149}\)

\(^{147}\) (OECD, 2013a), p 124-125. Readers may consult p 122-123 and 126-127 of the same source for other data related with open innovation.

\(^{148}\) (ESWA, 2013c), p27.

\(^{149}\) It is true that eventually these inequalities tend to reduce due the unavoidable spread of innovations within the whole society and the economy – thereby reducing the innovators initial advantage - and adjustment through rising education levels (financed by growth) – reducing jobs inequalities. We have seen at the beginning of the previous chapter that this is currently not the case, rather the contrary. Economists like (Piketty, 2014) claim that global inequalities within the context of our early 21\(^{st}\) century will continue to grow unless capital taxation is established at *global scale*. 
The fact that the World is currently witnessing rising income inequalities has been acknowledged by leading economists and organizations.\(^{150}\) Nonetheless despite these rising inequalities, which developed concomitantly with an unprecedented spate of innovations, inclusive innovation can be justified on the grounds of at least four factors that emerged during the last decade, namely:

- significant involvement of the private sector and global value chains in innovation for the poor;
- the development of poor consumers as an accessible mass market;
- growth of technological capabilities within developing countries, and;
- the involvement of new technologies especially information and communication technologies such as mobile phones.\(^{151}\)

The above arguments are consistent with the observation that, although innovations generate inequalities they also contribute to generate solutions for improving the welfare of lower and middle-income groups and innovation by lower-income groups themselves, i.e. grassroots and informal sector activities that may lead to community-based solutions. Thus it is important to \textit{enlarge the scope of Innovation concept} – beyond the Oslo Manual - to include \textit{non-technological, social and business innovations}.\(^{152}\) With this understanding, inclusive innovation might contribute to poverty and inequality reduction.\(^{153}\) There is no one-size-fits-all approach for inclusive innovation which comes under different models, namely:

- \textit{Innovation platforms} are mechanisms to bring together a group of stakeholders with a focus on innovating to address a particular issue of common interest;
- \textit{Cluster innovation} is innovation that takes place within a co-located group, in which the innovation cannot be attributed to any individual but to a process of group learning. Typically this could be a group of micro-/small enterprise owners;
- \textit{User–producer interaction} focuses on the learning and innovation which occurs in the connection between producers and consumers;
- \textit{Grassroots innovation} is innovation ‘from below’, generally associated with innovation emerging from low-income communities, and;
- \textit{Frugal innovation} is innovation that seeks to minimize resource usage, cost and complexity in the production, constitution, and operation of new goods and services.\(^{154}\)

Inclusive innovation examples abound.\(^{155}\) One famous example illustrating frugal innovation is the development in India by Tata motors of the World’s cheapest car.\(^{156}\) Grassroots innovations address specific challenges met by local communities facing shortages in electricity power have led to the development of Pedal-powered washing machines equally in India.\(^{157}\) ICT also play a significant role in innovation in public services - primarily through mobile phones;\(^{158}\) these fall under inclusive innovation but will be discussed under the larger scope of ICT-enabled innovation below.

2. ICT-enabled Innovation in Public Services and the Economy

\(^{150}\) See (The Economist, 2014), (OECD, 2011), and (Piketty, 2014).

\(^{151}\) (Heeks et al., 2014) p 176.

\(^{152}\) (OECD, 2014b), p 17.

\(^{153}\) One might view inclusive innovation as essentially an \textit{accelerator} for spreading innovation benefits - particularly towards lower and middle-income groups- as well as improving skills; ICT acts in this context as a technology to spread information and distribute services at low-cost.

\(^{154}\) (Heeks et al., 2014) p 179.

\(^{155}\) See for instance (OECD, 2013b) and (Heeks et al, 2014).

\(^{156}\) Though at 2500 US$ it is still way beyond the means of the poorer population of India but might address a significant segment of its middle-income population.

\(^{157}\) Similar examples of grassroots innovation can be found on p 40 of (OECD, 2013b)

\(^{158}\) In the context of the Arab region see (Zain, 2014).
The advent of the Digital revolution materialized by the broadband Internet, mobile telephony and, more recently, mobile Internet with the concomitant development of Smartphones and all kind of communicating devices triggered many innovations not only within the ICT industry but in electronic services (e-services) supporting all kind of socio-economic areas; the Arab region was part of this global development.\footnote{See (ESCWA, 2013a) for a discussion of the impact of some e-services in the Arab region, (ESCWA, 2013b) for the impact of ICT on Arab youth, (ESCWA, 2013c) for an evaluation of the competitiveness of the ICT sector in the Arab region, and (ESCWA, 2013d) for a general profiling of ICT in the Arab region.}

Reviewing – even briefly – the whole set of potential e-services is much beyond the scope of this document; we will only consider as an example the innovation potential of e-services in two areas of government services and commerce.

By innovation potential it is meant how e-services, beyond their known effects of allowing a faster and pervasive communication at reduced costs, impact the area in which they are introduced with new features and capabilities; the bottom line is not e-government but how to make government services more effective, the government more transparent and combat inefficiencies and corruption; not mobile payment (m-payment) but how to improve financial inclusion and boost commerce.

2.1 Innovation in Government (e-Government)

All Arab countries have implemented an online presence for their respective governments with an associated set of e-government services at varying degrees of sophistication; half of the Arab countries – particularly among GCC – enjoy good ratings in the global bi-annual e-government survey carried out by UN DESA.\footnote{The last edition of this survey - (UN DESA, 2014), p17- ranks Bahrain (18th world-wide) among the countries having a very high E-Government Development Index (EGDI), and nine other Arab countries - the remaining five GCC, Egypt, Tunisia, Morocco, and Jordan - among countries with high EGDI.} This indicates that governments in the region have generally embraced e-government as a way to provide better services for their citizens.\footnote{See (ESCWA, 2013a) and chapter 7 of (ESCWA, 2013d) for more details.}

Beyond the convenience of offering citizens the possibility of carrying online their transactions with government and other public entities, e-government allows for better efficiency and transparency of government action; many governments are now sharing online some of their data\footnote{Breadth and sophistication of disclosed data vary among countries; national security concerns generally prevents the sharing of some kind of data though, again, governments significantly vary in their appreciation of which data affects or not “national security.”} both for information purposes and also to enlighten their citizens on the rationale behind public action: this is known as Open Government Data (OGD) ‘which can be defined as government information proactively disclosed and made available online for everyone’s access, reuse and redistribution without restriction.’\footnote{UN DESA, 2014} The last UN DESA e-government survey evaluates the breadth and sophistication of OGD through a dedicated questionnaire: five GCC countries plus Tunisia and Morocco are reported as having scored more than 66.6% in this respect.\footnote{Most data shared by governments concerns Government Spending, followed by Education, Health, Labor, Environment, and Social Welfare.} Making data available online is not enough; data can really be considered as open if ‘it is shared with an open license in a way that permits commercial and non-commercial use and reuse without restrictions.’\footnote{Ibid., p 170. Italics highlights are ours.}

\footnote{(UN DESA, 2014) p 163.}

\footnote{Ibid., p 165.}

\footnote{Ibid., p 166.}
Among Arab countries, only Bahrain, Morocco, and Tunisia are reported as providing such a scheme for their OGD; concretely this allows ‘everyone to develop web and/or mobile applications that improve government transparency and public participation’ as explicitly stated in the OGD policy of Bahrain.\textsuperscript{167}

The participation of stakeholders – commercial companies and, no less important, NGOs and civil society – is essential to ensure the success of OGD initiatives. Only thus can OGD ‘improve decision-making on complex problems in government and increase transparency’; moreover, ‘it can help governments improve the efficiency and effectiveness of their services by allowing the public to reuse and remix freely available data for any purpose, potentially leading to innovation, new services and thus to economic growth.’\textsuperscript{168}

\subsection*{2.2 Innovation in the Economy (m-payment)}

According to the World Bank, the percentage of people aged 15 and above having a bank account is low in many Arab countries: with the exception of GCC, where percentages vary from as high as 87\% in Kuwait to 48\% in Saudi Arabia, lower-income countries have rates between 39\% for Morocco down to 19\% for Palestine; notable are the low rates of Egypt and Iraq, both at near 10\%, with Sudan and Yemen at respectively 7 and 3.65\%; these and other data related with credit and debit cards as well as use of mobile phones to pay bills or send money are summarized on figure 8.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{financial_inclusion.png}
\caption{Financial Inclusion. Arab Countries, 2011.}
\end{figure}

Note: values are percentage of population at 15+

Figure 8 highlights low percentages of credit – and to a much lesser extent debit – card holders even among non-GCC countries enjoying medium levels of bank accounts. This is one reason that hinders the

\textsuperscript{167} Ibid., p171.
\textsuperscript{168} Ibid., p171. Italics highlights are ours.
development of e-commerce in the region\textsuperscript{169} – particularly outside GCC - as well as high prevalence of ‘cash on delivery’ as a payment method for e-commerce.\textsuperscript{170}

Mobile payment emerged as an interesting innovation following the success of M-Pesa service in Kenya,\textsuperscript{171} the idea grounding Mobile Payment is simple: use airtime credit of mobile phones and the possibility of transferring it between two mobile subscribers as a wallet that can be used for paying bills or sending money. Values of mobile payments in Arab countries are generally very low – for six countries no data is available or is officially at near zero percent; notable exceptions are Saudi Arabia, Bahrain, The UAE and Kuwait which have more significant values at between 10-15\% for paying bills with mobile phones; Sudan\textsuperscript{172} and Algeria at respectively 30 and 21\% for using mobile phones to send money are notable exceptions in the region (all other countries are at below 10\%).

It has already been outlined that mobile payment beyond ensuring financial services to the unbanked is also a gateway for introducing micro-finance loans particularly to young entrepreneurs and micro-enterprises; this is still nascent in the region.\textsuperscript{173} As a conclusion, while the Arab region is growing its adoption of mobile services, ‘there seemingly exists an opportunity for mobile banking but the right model must be found;\textsuperscript{174} this is essentially related with an elaboration of a proper regulatory landscape defining banks and mobile operator’s mutual prerogatives; cultural factors associated with reluctance to credit and Sharia-compliance should be addressed as well.\textsuperscript{175}

3. Innovation policies to develop RET

Green Innovation is an important area of the innovation landscape of developed OECD countries. In 2012, OECD countries spent nearly 6\% of their total government-funded R&D of 18.85 billion (PPP US$) – a billion\textsuperscript{-} on energy and environment.\textsuperscript{176} Over the period of 2008-10 a total of 33451 patents in environment-related fields were filed by OECD countries; it is notable that, over the same period, six BRIICS countries filed two-third (2021) of the remaining 3000 patents under the Patent Cooperation Treaty (PCT); total world patenting in environment-related fields was at nearly 8\% of total patents in 2008-10 up from only 5\% in the 1998-2000 period.\textsuperscript{177}

The above considerations enlighten the rationale behind the statement of the UNCTAD’s Technology and Innovation Report of 2011 devoted to RET that ‘the knowledge and technological capabilities required for their transfer to developing countries and LDCs are not easily accessible.\textsuperscript{178} Although the report adopts the IPCC’s\textsuperscript{179} claim that ‘many of the RETs needed in order to meet a larger share of the global energy demand already exist, or are on the verge of commercialization’ it prescribes that ‘developing countries will need to strengthen their innovation systems through innovation policy frameworks that foster

\textsuperscript{169} Middle East and Africa accounts for only 2.2\% of global Business –to – Consumer (B2C) e-commerce estimated at 1.2 trillion USS in 2013. (UNCTAD, 2015) p 14.

\textsuperscript{170} ‘Cash on Delivery’ accounted for 48\% of e-commerce payments in 2012 in Middle East and Africa (closest follower ‘Asia and Oceania’ is at 11\%). Ibid., p 36.

\textsuperscript{171} For the story of M-Pesa see a summary on p 31 of (ESCWA, 2013b).

\textsuperscript{172} This can be explained by Sudan’s economic and cultural similarity with nearby Kenya (note that data is for year 2011 before the secession of South Sudan as an independent state).

\textsuperscript{173} See (ESCWA, 2013b) p 30-32.

\textsuperscript{174} (Zain, 2014) p 73; see also the discussion of mobile financial services in p63-73.

\textsuperscript{175} (ESCWA, 2013b) p 30-32 highlights some emerging Sharia-compliant micro-financing schemes in the region.

\textsuperscript{176} (OECD, 2013a) p 154.

\textsuperscript{177} Ibid., p 155.

\textsuperscript{178} (UNCTAD, 2011), p 10.

\textsuperscript{179} The Intergovernmental Panel on Climate Change is the leading international body for the assessment of climate change established in 1988 to provide the world with a clear scientific view on the current state of knowledge in climate change and its potential environmental and socio-economic impact. http://ipcc.ch
capacity and linkages to enable wider RET dissemination and to promote a greener catch-up process.\textsuperscript{180} For this purpose, two interconnected legs for action are prescribed in developing countries: first, a ‘national innovation systems that provide the necessary conditions for RETs development’, and second ‘energy policies that promote the gradual integration of RETs into industrial development.’\textsuperscript{181}

Some concrete examples of RET innovation in developing countries might include ‘small-scale RETs’ which ‘may be very important in the provision of energy to rural areas’ as recent examples from India have shown.\textsuperscript{182}

Innovation can also take the form of identification of special natural assets leading to massive deployment of RETs; for instance Chile’s long coastline have been identified as having the potential to generate wind powered electricity due to abundant availability of wind; the country installed no less than 140 MW of wind energy in only two years (2009-2010) to reach a total of 162.5 MW.\textsuperscript{183}

Another potential area of RET innovation lies in ‘green technology clusters’ and special economic zones for low-carbon technologies; one example from the Arab region is Masdar (see Box 9).

Another important issue for developing countries lies in the improvement of their absorptive capacity for RETs: RET-specific training centers might be needed ‘to have well-trained workforce capable of installing, maintaining and adapting RETs, as well as trained target groups such as users, technicians, researchers/scientists, government officials and investors.’\textsuperscript{184}

Education, awareness and outreach are also essential. ‘Education should encompass firms, financial institutions, community cooperatives and individuals. Knowledge of the various incentives to invest in and produce energy from RETs, coupled with an awareness of the opportunities small-scale RETs can offer local communities, are all important for stimulating demand as well as supply.’\textsuperscript{185}

As a conclusion RET offer developing countries – and particularly resource-poor Arab countries – an opportunity to reduce their energy dependency but equally open avenues for innovation and human resources development both at national and local level through well-targeted projects.

Box 9. Masdar

Established in 2006, Masdar is a commercially driven renewable energy company based in Abu Dhabi, United Arab Emirates. As a strategic government initiative—and a subsidiary of the Mubadala Development Company—Masdar has a mission to invest, incubate and advance the establishment of a clean energy industry in Abu Dhabi and around the world.

The company comprises four entities: Masdar Institute a graduate level research university dedicated to advancing renewable energy and sustainable technologies, Masdar City designed as a cleantech cluster with special economic zone incentives, the city attracts companies to commercialize and deploy new energy technologies in the Middle East, Masdar Clean Energy a renewable energy developer and investor in commercially driven clean energy projects, and Masdar Capital an investor in promising cleantech companies.

\textsuperscript{180} Ibid., p10
\textsuperscript{181} Ibid., p140.
\textsuperscript{182} Ibid. p 116-117.
\textsuperscript{183} Ibid., p118.
\textsuperscript{184} Ibid., p 129.
\textsuperscript{185} Ibid., p130-131.
Masdar have nearly 1.5 GW of wind and solar in operation or under development with projects outside the UAE in Spain, the United Kingdom, Jordan, Oman, Mauritania and other countries.


Masdar City showcase how an urban environment can accommodate denser populations with fewer resources with energy and water demand reductions of 40%; it is home to 198 companies and growing as well as the headquarters of the International Renewable Energy Agency (IRENA).

Source: http://www.masdar.ac
IV. Challenges and Recommendations for the Transformation of Arab Countries to Knowledge-based Economies

As stated in the introduction of this report, leveraging STI to transform Arab countries into Knowledge-Based Economies is a growth necessity particularly in their current socio-economic situation. In this final chapter devoted to challenges and recommendations we proceed in two steps.

Challenges faced by this region both on the ground of the analysis carried out in this report but equally, and no less importantly, by considering their broader socio-economic and political context are first outlined. The objective is to set these challenges within a proper context allowing, in a second step, to devise recommendations whereby this transformation may contribute to the alleviation of the region’s problems.

Technology and Innovation, as stated at many instances in this report, never operate in a vacuum and can’t be effective or have significant impact if brought in isolation from their surrounding intellectual and socio-economic context.

It is useful to recall the above evidence prior to making recommendations. Some KBE-related assessment of this region focus on quantitative indicators related to researchers, students, universities, scientific papers, ICT infrastructure, and the like. To conclude – quite hastily – that some countries are well on their way of becoming KBE.

While such indicators address necessary building blocks of a KBE, they often represent the ‘easy part’ of the challenge. It is undeniable that, in some instances, political will – associated with financial clout - delivered some impressive results in a relative short/medium time like, for instance, universities and research centers equipped with the best technologies and staffed at record time. Despite undeniable benefits from such top-down – and paternalism tainted – approaches, they do not address the immense challenges faced by the region.

These challenges, lying at the origins of many of the region’s socio-economic as well as political problems, are: jobs, jobs and jobs. By jobs it is meant: (a) decent jobs particularly missing in the private sector, and (b) real jobs not social benefits in disguise, primarily in the public sector. By the reckoning of a recent ESCWA report, jobs are badly missing in this region where, by year 2030, some 60 to 100 million are needed. 

This is a tremendous challenge if we consider the Arab region as a country of 350 million needing to create such a huge amount of job opportunities within less than two decades.

There exists a correlation between innovation and KBE, on one hand, and job creation on the other; leveraging the untapped potential of innovation to create jobs is thus key to address this regional challenge of massive job creation; while this is not a sufficient condition, it is by far a necessary one; this will be the guiding principle when elaborating recommendations.

A. Challenges faced by Arab countries in their transition to KBE

Many challenges lie in the journey of Arab countries’ transformation to knowledge-based economy; these are related with the structure and organization of their STI system that we shall categorize and summarize. Prior to that, some socio-economic challenges are worth highlighting in order to put the STI challenges within a proper context.

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186 (ESCWA, 2014c) p 120.
187 Which it isn’t, even as an economically integrated region; see (ESCWA, 2014b).
188 Broader political economy reform recommendations for the region are discussed in (ESCWA, 2014c) and (ESCWA, 2014b) to which the reader is referred.
1. Socio-economic challenges

There is no exaggeration in the statement that ‘the Arab region is currently facing the most serious existential threat since the creation of independent Arab nation States in the mid-twentieth century.’

On the eve of the Arab spring in late 2010, Arab countries were facing a crisis of a ‘system’ irrespective of its exact constitutional or formal guise. This system is characterized by an omniscient rentier state and associated clientes - in the military, civil public and, no less important, private sector – sustaining a system of handouts at all levels which, somehow, compensated (or ‘justified’) lack of effective economic growth and decent job opportunities. A fragile social compact was thus maintained. This compact broke out when the handouts system became unsustainable and essentially ‘hijacked’ - notably during the first decade of this century - by an ever closer circle of ‘happy few’ at the top to the detriment of the poor and, particularly, middle classes. The resulting Arab revolts were led by disenfranchised youth and pauperized middle/vulnerable classes amid a context of growing economic inequalities.

Some characteristics of this ‘Arab system’ which, to date, is not yet replaced by something else, even in countries that witnessed political change, are highlighted by the following list of statements: they relate to industry, jobs and employment structure, and investment; all have impact on innovation and technology and the eventual transformation into a KBE.

- ‘Rentier economies in most Arab countries did not facilitate the growth of an entrepreneurial capitalist class of small and medium productive enterprises. Rather, even those in the private sector derived their incomes and privileges by virtue of political connections.’
- ‘Although the region’s employment growth was the highest in the world at 3.3 per cent a year on average between 1998 and 2009… the jobs that were created were largely in the informal low value-added sectors.’
- ‘Importantly, construction jobs and “other services”, which are mostly low value-added in nature, increased in all four [Syria, Tunisia, Egypt, and Jordan] countries.’
- ‘Other than employment in jobs in the low value-added sector, the main problem facing young people in the region is high unemployment, despite advancements in education.’
- ‘Formal private sector employment is very small, representing 13 per cent of total employment (or around 40 per cent of total formal employment). When the promise of public sector jobs was revoked, the formal private sector was unable to keep up with the demand for employment from new entrants. Therefore, many graduates in the 2000s, left with no other choice, joined the informal sector.’
- ’66 per cent of investment went towards mining and real estate over the period 2003-2010, which do not create much employment.’

Now that issues related with the surrounding socio-economic context have been highlighted, we summarize STI challenges of the Arab region under five families of issues related with Education and...

2. Education and Human Capital

Arab countries made huge investments in Education resulting in improved enrolment at all education levels - even in tertiary - including among women.\(^{194}\) Currently, there are nearly 1000 universities in the Arab world although only two of them are rated among the first 500 universities world-wide.\(^{195}\) The concrete result of this proliferation is a net increase in number and proportion of tertiary degree graduates among Arab youth but, quality-wise, the result is mixed.

As an example, the recent Arab Knowledge Report shed some light about cognitive skills of Arab students enrolled in tertiary education.\(^{196}\) Weaknesses were identified primarily in using foreign languages and in written communication skills in Arabic.\(^{197}\) The report draws the conclusion that ‘the weakness of communicative skills, in Arabic or in a foreign language – considered as essential inputs to knowledge – can result in priority being given to the practical-applied skills at the expense of the theoretical-analytical skills that can only be achieved with a mastery of language.’\(^{198}\) The report concludes that ‘these results are worrisome, especially when viewed from the perspective of capacity building for knowledge transfer and localization.’\(^{199}\)

A second no less concerning issue, discussed in this report, is the importance of Brain Drain; while this might be transformed into an asset as we shall discuss below, it is primarily a challenge whereby Arab scientists, among the most talented, have chosen to live abroad.

3. Science production and Research

In this report we shed light on two issues related with the low number of researchers in Arab countries (as percentage per million inhabitants) and low percentages of Research and Development expenditures relative to GDP.

Quality of produced research is most Arab countries is low as measured by the H-Index scores; scores are also low in the scientific and technical articles per billion of GDP output from the GII particularly among high-income GCC countries where only Saudi Arabia fares relatively better than its peers. This hints that efforts to establish cutting-edge universities and research centers – particularly when driven by expatriate talents\(^{200}\) – have not yet materialized into tangible outputs in some GCC countries.

However, a major – and global – resides in the main conclusion of a comprehensive ESCWA report on Science and Research in the Arab region is that ‘the cycle between research, universities and society has been broken.’\(^{201}\) One good – and practical - illustration of this broken cycle that is useful for the scope of this report lies in the recommendation that ‘research areas with clear socio-economic objectives that are

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\(^{194}\) For useful summaries see p 8-9 of (ESCWA, 2013b) as well as p 57-68 of (ESCWA, 2013d).

\(^{195}\) Webometrics Ranking of World Universities. http://www.webometrics.info/en/aw; the two universities are King Saud University (244) in Saudi Arabia and Cairo’s University (474) in Egypt. In the well-publicized Academic Ranking of World Universities for 2014 http://www.shanghairanking.com/ARWU2014.html King Saud and King Abdulaziz University from Saudi Arabia are the only two Arab universities (both at 151-200 positions). By comparison Israel has 6 of its universities among the top 500 with 2 among the top 100.

\(^{196}\) (UNDP, 2014); this follows a similar, and no less concerning, secondary level graduates (12th grade) assessment carried out in the previous edition (UNDP, 2011) – see a useful summary in (ESCWA, 2013b).

\(^{197}\) (UNDP, 2014) p 148-156.

\(^{198}\) Ibid., p 155.

\(^{199}\) Ibid., p 181.

\(^{200}\) Which is much less the case in Saudi Arabia than in other, more extrovert, GCC countries.

\(^{201}\) (ESCWA, 2014a) p 76.
specific to the country, where *users and social actors are present* need to be further developed by Arab universities and research institutions.\(^{202}\)

4. Innovation in the Economy

It has been shown in this report that the share of business enterprises in research and development efforts within Arab countries—whether in human resources or financing—is significantly low. While R&D does not necessarily equate with innovation, there is nonetheless a good correlation between the two; available data on firms’ innovation in Egypt that we discussed corroborate these low levels at least in the largest Arab country.

As a matter of fact many Arab countries, as shown on Table 1, when discussing the Global Competitiveness Index are in their majority at below the Innovation grade category. The World Bank report on Arab countries transformation to KBE highlights that Arab countries’ competitiveness appears to be increasingly factor driven rather than knowledge and innovation driven.\(^{203}\)

An indicator, measuring *net high-tech exports (as percentage of net total exports)* used by the GII,\(^{204}\) can be considered as a proxy, if not for innovation per se, at least for advanced technology transfer in the economy. Data reveals that, among Arab countries, only Tunisia had a relatively high value of 4.5% whereas all other Arab countries were at 0.6% and below.\(^{205}\)

It is notable that highest percentages for this Indicator are found among emerging countries in front of many industrialized developed countries (China is first at 28%); this could be explained by the fact that some of these countries are used as ‘factories’ for many multi-national companies established in developed countries and that we are dealing with *percentages not absolute values* of exports. Still, it is undeniable that these values of high-tech exports reveal that *a form of technology transfer has happened* which is not the case—except at a much lower scale for Tunisia—for any Arab country.

Another very important issue in Arab countries is the absence of a strong network of SMEs. The few research carried out in the business sector is primarily concentrated in the mining and extraction sector and could essentially be considered as efficiency innovations\(^{206}\) not prone to generate jobs (sometimes, even, rather the contrary). The largest sector of Arab economies is that of the informal or micro enterprises where very little—if any—research and innovation is taking place. The missing link between these two extremes lies in SMEs as it has been highlighted under the socio-economic factors.

It has been noted ‘that innovation can be found in larger ‘medium-sized’ companies, defined as around 300 employees, based on long technical expertise fed by continuous improvement in actual markets and interactions with clients and providers’ on the basis of field surveys carried out in Morocco and Tunisia.\(^{207}\) Other cross-country studies carried out by the World Bank of high-growth SMEs in the region established a ‘link between high SME growth and innovation’ among other factors.\(^{208}\) It is such SMEs—seeking primarily *market-creation innovations* for their growth—that are prone to generate the bulk of the missing jobs the region badly needs.

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\(^{203}\) (World Bank, 2013a), p 36.

\(^{204}\) Based on the UN Comtrade database.

\(^{205}\) (INSEAD, 2014), p 354.

\(^{206}\) Some innovation scholars distinguish three categories of Innovation: ‘sustaining’ aimed at replacing old products with new and better ones, ‘efficiency’ which helps companies produce more for less, and ‘market-creating’ that open new markets and address ‘non-consumption’ due either to high price of previous products and services or their non-fulfillment of target customers’ needs. See (Christensen et al., 2015).

\(^{207}\) (ESCWA, 2014a), p 67.

\(^{208}\) (World Bank, 2013) p 85 (Box 6.1).
5. Innovation in E-Services

The ICT revolution generated a wealth of innovation potential through electronic services (e-services) with potential to improve the daily life and generating growth in public services, the economy and entertainment. An impact assessment of such e-services in Arab countries has already been carried out in a previous study, we summarize and update the main findings from this study as well from the discussion of e-services in this document.

While the region has undeniably made great strides in ICT infrastructure during the last decade – even in lower-income countries – e-service offer is still nascent.

On the public services side, GCC countries in particular but other countries as well, heavily invested in e-government services: however, the on-line presence they created for their government and other public services did not yet materialize into a massive use or in the creation of an ‘eco-system’ around this presence (an example of which was given in the case of Open Government Data discussed above). There are still unmet potential in this respect not least taking into account, in some other war-torn countries, initiatives aimed at offering decent public services to displaced populations.

One must also note that, contrary to e-government, other public services like e-Education, e-Health and e-Agriculture services have taken off very timidly in the region and are still nascent.

On the economic side, e-commerce primarily addresses the affluent in the region but, in volume, it is still nascent. Despite significant recent growth of e-commerce, compared to total retail sales, the region is still below the percentages reached in advanced OECD countries (globally less than 1% versus 5%). We have already highlighted that the region (including Africa) represents only a meager 2.2% of worldwide B2C revenues and is expected to grow only to 3.5% of this total in 2018. Mobile payment and potential to introduce other mobile financial services to the poor through micro-credit are also only nascent in the region.

6. Innovation System

Credit and investment are weak in the region – particularly the former – and this applies to all countries even among high-income GCC. This has been shown when analyzing the market sophistication pillar of the GII. Box 7, discussing the UAE case, a rich and dynamic country, also highlights financing as a major issue for innovative startups leading them to have high likelihood of falling into the ‘Death Valley.’

Another issue affecting the innovation system is the limited technical talent in the region; more concerning is that, even when a sufficient pool of talent is available, ‘the research landscape in each Arab country is fragmented and small in scale’ where ‘the image of an “assemblage” of fragile, somewhat disconnected and constantly under-resourced institutions is perhaps a more apt metaphor to describe the science arrangements in most of these countries.’

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209 (ESCWA, 2013a).
210 On e-education see (ESCWA, 2013b); on e-agriculture many services were developed in developing countries – mainly in Africa and South Asia - (see http://www.ictinagriculture.org) but none significant in the region; on e-Health one must note the potential for the region on the backdrop that the region has the second highest percentage of ‘out-of-pocket’ health expenditures in the world (46.7% much above the lowest OECD average of only 13.5%)- see (ESCWA, 2014c) p 91; (Zain, 2014) p 75-101, also discusses some initiatives in the region related to the above three domains.
212 (ESCWA, 2014a), p 69.
Last but not least, despite efforts to build techno-parks, incubators, science parks and the like – which are laudable initiatives that need continuation as such efforts will bring benefits only in the mid/long term – innovation is not yet a clearly stated political priority in the region particularly as a lever to bring concrete and realistic solutions to the socio-economic problems faced by Arab societies.\textsuperscript{213} Cultural factors play as much a role – if more - than stated official policies and declarations. Trust in science is still limited in the region and social environment in most Arab countries does not yet encourage research and innovation.\textsuperscript{214}

As a matter of conclusion for this section, we highlight in Box 10 some issues highlighted by a recent STI policy review of Oman carried out by UNCTAD.\textsuperscript{215} Oman is a high-income GCC country endowed with a stable political environment, enlightened leadership, and good economic governance. While each Arab country faces specific challenges, it is revealing to observe those pointed out by this review as they provide concrete illustrations of many challenges outlined in this section and pave the way for the next section devoted to recommendations.

\textbf{Box 10. STI Policy review of Oman}

\textit{On Governance}: The Research Council (TRC), which is in charge of R&D strategy and policy and covers innovation policy issues, plays a particularly important role in the development of the country’s innovation system. Consultations and communication flows… are sometimes bound by a hierarchical organizational structure and communication cultures of some domestic institutions.

\textit{On Macroeconomic context, business environment and infrastructure}: growth based on importing a large percentage of low-cost labor can be a strong disincentive to innovation and technology-based growth and economic diversification. Much remains to be done in linking the educational system with industry requirements so as to produce a workforce that has the skills needed by firms. A significant challenge for innovation is presented by an economic structure dominated by large firms even though there are 91,000 active SMEs. Of these, only about 100 SMEs file tax returns, indicating that the middle-intermediary layer of firms is insufficiently developed. Oman has a high quality physical infrastructure, [] while these are positive developments, they have only a mild impact on innovation and entrepreneurship. Policies favoring procurement from local SMEs and enforcing environmental norms could help improve the impact to some extent. Diversifying the economy through innovation necessarily means enabling full and unhindered access to the global knowledge commons and the Internet.

\textit{On Human capital, education and research capabilities}: Social sciences continue to attract the majority of students, which is creating a serious mismatch between the output of the education system and the requirements of the labor market. The country spends 0.2 per cent of GDP on [R&D]. This percentage is very low, particularly in relation to the level of GDP per capita, but it is in the order of magnitude of other GCC countries. Most of the public research infrastructure is in academia and in government research centers.

\textit{On Innovation System and key interactions}: The innovation system of Oman is fundamentally fragmented; cooperation between key entities (between academic and business structures, among academics and among businesses) is uneven and often based on personal acquaintanceships. Oman’s economy is dominated by large firms that operate mostly in the petrochemical and natural resources, construction and trade sectors. Their innovative activity is not negligible, but it is insufficient to spur

\textsuperscript{213} Often innovation and knowledge-based society policies – when they exist- are full of eloquent statements about future society visions (2020 and beyond) at the expense of elaborating realistic roadmaps for the realization of such visions (apart from a shop list of government-led initiatives).

\textsuperscript{214} (ESCWA, 2014a), p 65-66.

\textsuperscript{215} UNCTAD carries out such reviews at countries’ request. Ten countries reviews were carried out since 2005; Oman is the only Arab country having requested such a review. See http://unctad.org/en/Pages/Publications/Science,-Technology-and-Innovation-Policy-Reviews-(STIP-Reviews).aspx
innovation throughout the economy and buttress the functioning of a meaningful national innovation system. Whatever innovation takes place benefits mainly several large firms and the companies operating under their umbrellas.

On policymaking: The key challenge is to improve coordination in the conduct and management of STI policies. While there is not much overlap, the absence of a national innovation strategy allows each ministry and related agencies to elaborate STI policies without much cross-consultation and coordination. The bulk of the R&D programs are developed by TRC within the context of the National Research Strategy. Program implementation appears to be slow: often it takes a minimum of two years from presenting an idea for a program to the first call for proposals for implementation.

On financing: Unless there is greater spending on R&D and support for innovation, there is unlikely to be much progress in innovation, in practical advances and in the development of a national innovation system. The national priority of diversification through innovation requires a fundamentally larger financial commitment in order to realize the innovative potential of Oman’s private sector and industries. The lack of venture capital is hindering innovation, although there is a project under consideration to establish a national venture capital company.

Towards an innovation policy: The development of a national innovation system is not yet integrated within national strategic planning and operational decision-making; it is critical that it become a key component of the Vision 2040 mandate. Overall public financial support to research and innovation remains quite small compared to, say, developing the road network infrastructure. In private firms, there is little support or incentives for R&D and innovation efforts. Public and joint public-private innovation support measures that aim at stimulating university-business cooperation in R&D and innovation are critically needed.


B. RECOMMENDATIONS TO FACILITATE THE TRANSITION OF ARAB COUNTRIES TO KBE

After reviewing challenges faced by Arab countries, it is now time to issue some recommendations. It is plain evident that those are general recommendations addressing major challenges faced by large majority of Arab countries; there will be, of course, lot of differences in the journey taken and priorities set by each country to reach the objective of becoming a KBE; these depend on each country’s initial situation and relative strengths and weaknesses.

Recommendations are be grouped under four general priorities, namely:

1. Transform the education system to produce more innovators

If curricula on innovation existed, they would have been widely known. Innovation is evidently not ‘taught’ in schools, universities, or even in the best management schools. Ingenuity and technical knowledge are of course useful backgrounder for innovation – though the latter is not necessary in all innovations as it has been widely discussed in this report. A typical innovator might have at least one of the above two qualities but a third one is essential: it is the ability of independent thinking which allows him/her to question the validity of existing ways of doing things: whether to produce goods or services, organize processes and people or address/create a demand for a new product or service.

A well-thought education system can steward – again, not teach – students into becoming independent thinkers and prone to becoming innovators if they have talent and good technical background; this is the good news. The bad news, though, is that this is not a known quality of the majority of Arab countries’
education systems; this deficiency of Arab education systems has been widely studied and documented, among others, by the Arab Human Development and Arab Knowledge reports already quoted.216

There is therefore no originality in stating that solutions prescribed in these reports to overcome this major shortcoming and others should be followed. However, we can be more specific and suggest at least three recommendations for education directly impacting innovation and KBE:

I. **Evolve education methods**: from rote memorization and lecture-based into knowledge acquisition through methods allowing students to discover by themselves the logic of taught concepts – through *workshop-style courses* for example where the teacher is essentially a *coach* training students to apply learned concepts to the solve original problems not directly mentioned in course and addressing concrete life situations.

II. **Enlarge enrollment in scientific disciplines at tertiary education**: but quality should not be sacrificed for quantity; often it is better to have *fewer and better engineers and scientists* if, concomitantly, a much larger number of *skilled technicians* are graduating from a developed and financially endowed *vocational training* system.

III. **Improve schools and universities interaction with society and firms**: more time should be spent by students in enterprises and external institutions (government but also NGOs and civil society) and this must be considered as an essential part of their curricula; one important consequence is that students should graduate from schools and universities with *much clearer vision* about the type of job or activity sector in which they will engage professionally.

It is evident that these recommendations are not independent from their wider context. As an example for each: adopting new teaching methods is definitely not independent from *teacher’s training and evaluation methods* and margins offered for them to *use resources outside the official curricula* (like, for instance, the Internet); enlarging recruitment in vocational training is not independent from a *value system of society* where success in studies is generally equated with graduating *only* as a physician, engineer, or from a business school (indicative list); improving schools and universities’ interaction with their socio-economic environment means that there are *enough firms* and enough institutions with *qualified professionals* capable of handling and coaching students spending training time within their entities.

2. **Shift Research and Development priorities towards potential innovations and societal problems**

The small Research and Development efforts in the region are primarily concentrated within universities and government research centers and much less in private sector. We also observed the dramatic underdevelopment of SMEs among all Arab countries. Addressing those issues is a long term endeavor which cannot be tackled without *concrete levers*; we suggest three levers with their associated recommendation; these are prone to generate tangible effects in mid-long term – though some effects can materialize in relative short-term – not only on the structure of R&D but also on industry and employment.

IV. **Leverage ICT-driven innovations**: decent to excellent level of ICT infrastructure is one of the region’s bright spots.217 As discussed, except for e-government, other e-services did not significantly taken off in the region.218 E-services might also particularly be useful in special conflict situations when physical communication and infrastructure are broken.219 Efforts should thus address the *development of a strong network of young SMEs specialized in e-services*. Classical incubation and techno-parks efforts should, of course, be continued but in the specific

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216 (ESCWA, 2013b) also deals with Arab youth education and training.
217 See chapter 2 on ICT infrastructure of (ESCWA, 2013d).
219 One might recall the example of M-Pesa which dramatically took-off in Kenya during a period of civil unrest and near civil-war following a contested presidential election.
situations of e-services there is a ‘hanging fruit’ of existing expertise within an emerging apps industry for Smartphones in some Arab countries; currently such apps are primarily geared towards gaming and entertainment; public procurement of e-services might strongly encourage these companies to develop and enlarge their focus towards socio-economic applications; in particular, e-government platforms – through OGD – might provide the needed data for such applications.

V. Leverage the potential of environmental and sustainability challenges: the region is known for its arid/hot climate, limited water resources, and desert preponderance; its economic development and high demographic growth over the last 50 years has led to record-high CO₂ emission levels – particularly in GCC countries, 220 rampant urbanism, land desertification, and strained water resources. Addressing those issues will necessarily lead to new economic activities revolving not only around higher use of RET –in both on-grid and off-grid deployments particularly in rural areas for the latter - and smart grid technologies, but also in clean public transportation, efficient irrigation, water purification, or manufacturing processes that minimize waste and pollution (indicative list). These are prone to create a new breed of innovative SMEs if proper policy incentives, financing, and incubation structures are deployed.

VI. Shift R&D towards socio-economic priorities and Youth: the research landscape in Arab countries, apart from being concentrated within universities and public research system, is fragmented and small in scale; furthermore, research areas addressing clear socio-economic objectives and linkage with the productive sector dramatically need development. 221 Another challenge for Arab R&D is the need to address the burning issue of Youth unemployment – the highest in the world – and develop original research – both in social sciences and scientific disciplines - on how to address it. Such measures might equally contribute, among others, to the restoration of the broken cycle between research, universities, and society in this region. 222

3. Develop policies that include and empower the actors of change

Any policy aiming to ensure a transition into a knowledge-based economy needs to spell out how it intends to support actors carrying out this transition. It is revealing that many policies from the region focus on government’s role both as planner and principal actor of this change. While sometimes government can – and should – play a leading role, particularly when its vision is ahead of society and economic actors, no sustainable change could last without eventually including and empowering those actors. The suggested recommendations are primarily aimed at this objective and would impact any design of an innovation or KBE policy.

VII. Enlarge access to credit particularly for innovative SMEs: we already outlined how the development model of the region did not allow the emergence of SMEs; further, the GII scores of all Arab countries in credit and – to lesser extent - investment are low. It is appropriate at this point to make a long quote that properly sums the rationale and recommendation: ‘careful choice of the optimal investment level and allocation across sectors, are essential for boosting economic growth that benefits large sections of society. This means reorienting the focus of public investment from grand projects to small scale projects, especially in rural areas. Moreover, credit policies should be designed to promote private enterprises with high employment elasticity. Greater efforts must be made towards ensuring a financial infrastructure conducive to market development, especially by improving access to finance for small and

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220 CO₂ emissions of GCC countries (in metric tons per capita) are amongst the highest in the world: Qatar, 40.3; Kuwait 31.3; Oman: 20.4; UAE, 19.9; Bahrain, 19.3; and Saudi Arabia, 17. By comparison the densely urban and industrialized Germany is at only 9.1 tons. http://databank.worldbank.org/data/home.aspx (data for year 2010).

221 (ESCWA, 2014a) p 69-70.

222 Ibid.
medium enterprises.\textsuperscript{223} We cannot but adopt verbatim this recommendation with the addition - specific to the scope of this report - that innovative SMEs should be given priority although, in practice, an SME with high employment elasticity is one that is likely to have invested in a form of market-creating innovation.

VIII. **Encourage Smart specialization initiatives:** some might argue that smart specialization is not particularly suited for the Arab region primarily due to the absence of a strong network of SMEs – often its prime actors - as well as regions with relative economic and governance margin – in, often, centralized countries; they likely do have a point. Nonetheless policies encouraging smart specialization initiatives seen primarily as a transformative process are useful to: (i) facilitate the emergence of innovative SMEs, and (ii) encourage the development of decision-making at regional level which is closer to involved actors. One must also note that some regions in Arab countries – particularly in the Mediterranean basin - do have a sort of specialization, whether in agriculture, tourism, or industry, which can be improved thanks to new technologies and/or development of new business opportunities.

IX. **Develop Inclusive innovation projects:** inclusive innovations in the region are appropriate particularly in the difficult context traversed by many countries. By inclusive, it is essentially meant finding solutions for populations facing socio-economic exclusion or displaced due to conflict situation (the latter could, sometimes, be at the origin of the former). A key role is played here by civil society actors but, no less, by economic actors; of course, balance must be found so that economic ingenuity and inventiveness does not boil down to sheer exploitation; hence the need to include population representatives to ensure both inclusiveness and fairness. *Innovations in this context are not necessarily at the frontier of knowledge;* they often evolve around finding concrete and optimized solutions to improve daily life of population facing difficulties (e.g., water and sanitation, electricity, food supply and conservation, access to basic health and other public services,…); it is worth noting that *ICT can play a key role* to circumvent problems raised by broken physical infrastructure.

4. **Evolve cultural attitudes**

Last but not least, evolving cultural attitudes is essential and cross-cutting to ensure the success of many, if all, of the above recommendations. In a nutshell: knowledge is not repetition of what has been learned; being knowledgeable is essentially a daily attitude characterized by a capability to learn and continuously update what has been previously learned; and innovation is, above all, an exercise of critical and independent thinking. The last Arab knowledge report survey of a panel of university students in four Arab countries ‘revealed positive attitudes towards a set of knowledge values (such as appreciation of education, academic integrity and studiousness), social values (modesty and cooperation) and universal values (respect of freedoms and religious tolerance);’ the report considers this as ‘positive indicator’ if such values are ‘derived from strong convictions and reflected in behaviors in daily life.’\textsuperscript{224}

X. **Develop a culture that supports innovation and value knowledge:** the survey of the Arab knowledge report revealed encouraging news about educated Arab youth’s values; still, the journey towards a ‘Copernican revolution’ in attitudes is a long one; the insistence of the Arab integration report’s conclusion to ‘swap oil for knowledge’\textsuperscript{225} is most revealing. Hence, the need for all actors – governments, enterprises, and civil society organizations – to promote by example and action–not only words and declarations – the emergence of this new culture that the region badly needs beyond innovation and KBE; simply for its development and Youth’s future.

\textsuperscript{223} (ESCWA, 2014c), p 123. Italic highlights are ours.

\textsuperscript{224} (UNDP. 2014), p 182.

\textsuperscript{225} (ESCWA, 2014b), p 198.
V. Conclusion

This report dealt with the issue of STI to build KBE in the Arab region. For this purpose it analyzed the role innovation plays in economic growth, what the term KBE really entails, and relationship between the two. Issues of innovation policies and measurement of innovation and KBE were addressed with presentation of major measurement frameworks. The situation of Arab countries was assessed both in light of their ranking in international measurement frameworks and through snapshots on some critical aspects of their research and innovation landscape. Best practices in innovation were discussed both in terms of innovation system organization and new areas prone to innovation. In light of the above, challenges faced by Arab countries in their journey towards a KBE were summarized and recommendations were issued to address them.

In addressing the subject matter, this report adopted a global approach whereby both ends of the problematic, STI, on one hand, and KBE on the other, are considered within their surrounding socio-economic and political context. This stems both from a methodological necessity, as examples of other developed and emerging countries – ahead of Arab countries in this journey - perfectly illustrate, and from the dramatic socio-economic situation and resulting political instability and war situations faced by many Arab countries, where the advent of a KBE is properly inconceivable if this goal does address those socio-economic challenges.

The subject is broad and complex and, moreover, does not lend itself to easy compartmentalization; this is compounded by an extra difficulty resulting from the fact that essential data on STI is lacking from many Arab countries not least among those having the highest income. The latter is revealing of the still embryonic state of STI systems in Arab countries but equally, and more concerning, that due to their rentier ‘development’ model, STI remains at best within the confines of academia and research centers away from socio-economic realities.

The example of advanced and emerging countries and deepening economic crisis of the rentier model has led some Arab countries to adopt concrete steps aimed at establishing this missing link between STI and socio-economic realities to generate growth and job opportunities for their youth. Alas, these efforts were not sufficiently comprehensive and came late; the Arab uprisings of late 2010 created a new – and even more dramatic – situation that needs to be addressed.

Consequently, the proposed recommendations seek ambition as they aim to cover major areas of a comprehensive policy aimed at addressing the roots of the main challenges facing Arab countries and enable a transition into a KBE. At the same time, the suggested recommendations seek realism by addressing concrete socio-economic concerns highlighting, when applicable, ‘hanging fruits’ and concrete levers for immediate action.

If this report is to be quickly summed up, it can be through a good and a bad news. To start with the latter, Arab countries –even amongst the most stable and best financially endowed - still need a long journey for their transformation into KBE; the good news, however, is that this transformation – if properly linked with concrete socio-economic needs – is not only feasible but equally useful to evolve their development model and offer a better future particularly for their Youth.

This general conclusion is consistent with other recent ESCWA reports addressing the broader socio-economic and political reform agenda for Arab countries. One famous proverb states that ‘necessity is mother of all invention.’ Likely, the current dramatic situation of the Arab region will, by necessity, lead to mentalities and values evolution and, consequently, pave the way for an invention of a new development model where knowledge and innovation will permeate the daily realities of life.
References


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### 1.3 Business environment

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<td>5.3.1 Royalty &amp; license fees payments, % total trade</td>
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<tr>
<td>2.1.2 Government expenditure on education/pupil, secondary</td>
<td>5.3.2 High-tech imports less re-imports, %</td>
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<td>2.1.3 School life expectancy, years</td>
<td>5.3.3 Comm., comp. &amp; info services imp., % tot. Trade</td>
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<tr>
<td>2.1.4 PISA scales in reading, maths &amp; science</td>
<td>5.3.4 FDI net inflows, % GDP</td>
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<td>2.1.5 Pupil-teacher ratio, secondary</td>
<td>6 Knowledge and technology outputs</td>
</tr>
</tbody>
</table>

### 2.2 Tertiary education

| 2.2.1 Tertiary enrolment, % gross | 6.1 Knowledge creation |
| 2.2.2 Graduates in science & engineering, % | 6.1.1 Domestic residents patent applications/billion PPPS GDP |
| 2.2.3 Tertiary inbound mobility, % | 6.1.2 PCT residents patent applications/billion PPPS GDP |

### 2.3 Research and development (R&D)

| 2.3.1 Researchers, headcounts/Million pop | 6.1.3 Domestic residents utility model applications/billion PPPS GDP |
| 2.3.2 Gross expenditure on R&D, % GDP | 6.1.4 Scientific & technical articles/billion PPPS GDP |
| 2.3.3 QS university ranking, average score top 3* | 6.1.5 Citable documents H index* |

### 3 Infrastructure

<table>
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<th>3.1 Information and communication technologies (ICTs)</th>
<th>6.2 Knowledge impact</th>
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<td>3.1.1 ICT access*</td>
<td>6.2.1 Growth rate of PPPS GDP-worker, %</td>
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<td>3.1.2 ICT use*</td>
<td>6.2.2 New businesses/thousand population 15–64</td>
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<td>3.1.3 Government’s online service*</td>
<td>6.2.3 Computer software spending, % GDP</td>
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<tr>
<td>3.1.4 E-participation*</td>
<td>6.2.4 ISO 9001 quality certificates/billion PPPS GDP</td>
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<tr>
<td>3.2 General infrastructure</td>
<td>6.2.5 High- &amp; medium-high-tech manufactures, %</td>
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### 4 Market sophistication

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<th>7 Creative outputs</th>
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<td>4.1.1 Ease of getting credit*</td>
<td>7.1 Intangible assets</td>
</tr>
<tr>
<td>4.1.2 Domestic credit to private sector, % GDP</td>
<td>7.1.1 Domestic residents trademark applications/billion PPPS GDP</td>
</tr>
<tr>
<td>4.2 Investment</td>
<td>7.1.2 Madrid trademark applications/billion PPPS GDP</td>
</tr>
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</table>

### 5 Knowledge and technology outputs

<table>
<thead>
<tr>
<th>5.1 Knowledge workers</th>
<th>7.2 Creative goods and services</th>
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</thead>
<tbody>
<tr>
<td>5.1.3 GERD performed by business, % GDP</td>
<td>7.2.1 Cultural &amp; creative services exp., % total trade</td>
</tr>
<tr>
<td>5.1.4 GERD financed by business, %</td>
<td>7.2.2 National feature films/million pop. 15–69</td>
</tr>
<tr>
<td>5.1.5 GMAT test takers/million population 20–34</td>
<td>7.2.3 Global entertainment &amp; media output/thousand pop. 15–69*</td>
</tr>
</tbody>
</table>

### 6 Knowledge and technology outputs

<table>
<thead>
<tr>
<th>6.1 Knowledge creation</th>
<th>7.3 Online creativity</th>
</tr>
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<tbody>
<tr>
<td>6.1.1 Domestic residents patent applications/billion PPPS GDP</td>
<td>7.3.1 Generic TLDs/thousand population 15–69</td>
</tr>
<tr>
<td>6.1.2 PCT residents patent applications/billion PPPS GDP</td>
<td>7.3.2 Country-code TLDs/thousand population 15–69</td>
</tr>
<tr>
<td>6.1.3 Domestic residents utility model applications/billion PPPS GDP</td>
<td>7.3.3 Wikipedia monthly edits/million population 15–69</td>
</tr>
</tbody>
</table>

### 7 Creative outputs

<table>
<thead>
<tr>
<th>7.1 Intangible assets</th>
<th>7.4 Video uploads on YouTube/population 15–69</th>
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<tr>
<td>7.1.1 Domestic residents trademark applications/billion PPPS GDP</td>
<td>7.4.1 ICTs &amp; organizational model creation†</td>
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### 8 Knowledge and technology outputs

<table>
<thead>
<tr>
<th>8.1 Knowledge creation</th>
<th>7.5 Creative goods exports, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.1.1 Domestic residents patent applications/billion PPPS GDP</td>
<td>7.5.1 ICTs &amp; organizational model creation†</td>
</tr>
</tbody>
</table>

### Table A.1. The Global Innovation Index composition.

**Source:** INSEAD, 2014. (⁎: composite index indicator, †: opinion survey indicator)